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PART II—NONMETALS

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[The dates of publication of the separate chapters are given in parentheses.]

ILLUSTRATIONS.

INSERTS.

MINERAL RESOURCES OF THE UNITED STATES, 1917—PART II.

FUEL BRIQUETTING.

By C. E. Lesher.

PRODUCTION.

The production of fuel briquets in 1917 was 406,856 net tons, valued at $2,233,888, an increase compared with 1916 of 111,701 tons, or 38 per cent, in quantity and $788,226, or 55 per cent, in

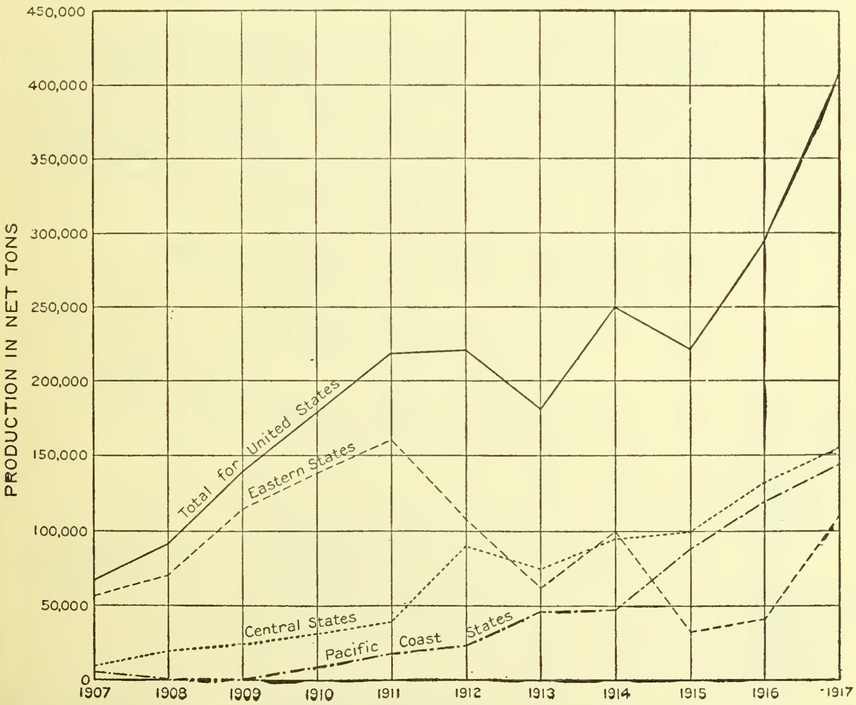

FIGURE 1.—Production of fuel briquets, 1907-1917, in the Eastern, Central, and Pacific Coast States and in the United States.

value. The production in 1917 was the greatest recorded. The progress of the industry for the 11 years from 1907 to 1917, inclusive, is shown graphically in the accompanying diagram.

The demand for fuel in 1917 was so strong throughout the year that the manufacturers of briquets had no lack of market to limit production. Most of the plants operated to their full capacity and reported a prosperous year, although binder and manufacturing costs increased.

The number of plants in operation in 1917 was two less than in 1916. Two of the plants that were operated in 1916 were dismantled in 1917—those of the Lignite Fuel Co., in California, and the Belgium Coal & Fuel Co., in Maryland. Two companies operating in 1916—the Coalette Fuel Co., in Michigan, and the Specialty Engineering Co. (now known as the Fuel Briquet Co.), in New Jersey—were idle in 1917. Two new companies that began operations in 1917 are the Johnson Fuel Co., at Scranton, N. Dak., and the American Briquet Co., at Philadelphia, Pa. The American Coal Refining Co., operating a plant at Denver, Colo., in 1916, was reorganized as the American Coal Reduction & By-Products Co., and continued the manufacture of briquets in 1917. The Virginia Navigation Co.'s plant at Norfolk was not completed in 1917 but is expected to begin operations in 1918.

RAW MATERIALS AND BINDERS.

Of the 13 plants in operation in 1917, 4 used anthracite as a raw material, 1 Arkansas semianthracite, 2 a mixture of anthracite and bituminous slack, 2 bituminous slack and subbituminous coal, 1 semibituminous coal, 1 brown lignite, and 2 oil-gas residue. At 2 plants coal-tar pitch was used as a binder; at 1, mixed coal-tar pitch and asphaltic pitch; at 5, asphaltic pitch; at 1, a patent binder; and at 4, no binder whatever.

Fuel briquets produced in the United States in 1916 and 1917.

	1916			1917		
	Number of operating plants.	Quantity (net tons).	Value.	Number of operating plants.	Quantity (net tons).	Value.
Eastern States:						
Maryland [a]	1					
New Jersey [a]	1					
Pennsylvania	3			4		
Virginia	1			1		
	6	38,833	$154,226	5	108,632	$344,068
Central States:						
Colorado	1			1		
Michigan [a]	1					
Missouri	1			1		
North Dakota [b]				1		
Wisconsin	2			2		
	5	132,619	627,425	5	155,140	1,056,051
Pacific Coast States:						
California	2			1		
Oregon	1			1		
Washington	1			1		
	4	123,703	664,011	3	143,084	833,769
	15	295,155	1,445,662	13	406,856	2,233,888

[a] No production in 1917. [b] No production reported in 1916.

Briquets produced in the United States in 1907–1909 and 1911–1917, in net tons.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
1907	66,524	$258,426	1913	181,859	$1,007,327
1908	90,358	323,057	1914	250,635	1,154,678
1909	139,661	452,697	1915	221,537	1,035,716
1911	218,443	808,721	1916	295,155	1,445,662
1912	220,064	952,261	1917	406,856	2,233,888

Raw fuels used in making briquets in 1916 and 1917, in net tons.

	1916	1917
Anthracite culm and fine sizes	65,337	137,659
Semianthracite Semibituminous Bituminous slack	136,358	161,269
Lignite and subbituminous coal Oil-gas residue	88,731	103,408
	290,426	402.336

Briquetting plants operated in the United States in 1917.

Group.	Name and address of operator.	Location of plant.	Date put in operation.	Raw fuel used.
EASTERN STATES.				
Pennsylvania	American Briquet Co., Twenty-fifth Street and Washington Avenue, Philadelphia, Pa.	Philadelphia	1917	Anthracite.
Do	Gamble Fuel Briquette Co., Ninth and Dock Streets, Harrisburg, Pa.	Harrisburg	1916	Anthracite and bituminous slack.
Do	Lehigh Coal & Navigation Co., Lansford, Pa.	Lansford	[a] 1909	Anthracite.
Do	Scranton Anthracite Briquette Co., Dickson City, Pa.	Dickson City	1907	Do.
Virginia	Delparen Anthracite Briquet Co., 1 Broadway, New York City.	Parrott	1915	Do.
CENTRAL STATES.				
Colorado	American Coal Reduction & By-Products Co., 738 First National Bank Building, Denver, Colo.	Denver	1916	Bituminous slack, subbituminous coal, and petroleum residue.
Missouri	Standard Briquette Fuel Co., 319 North Fourth Street, St. Louis, Mo.	Kansas City	1909	Arkansas semianthracite.
North Dakota	Johnson Fuel Co., Fairfax, S. Dak.	Scranton, N. Dak.	1917	Lignite.
Wisconsin	Berwind Fuel Co., 122 South Michigan Avenue, Chicago, Ill.	Superior	1912	Semibituminous slack.
Do	Stott Briquet Co., Merchants National Bank Building, St. Paul, Minn..	do	1909	Anthracite culm and bituminous slack.
PACIFIC COAST STATES.				
California	Los Angeles Gas & Electric Corporation, 645 South Hill Street, Los Angeles, Cal.	Los Angeles	1905	Carbon (petroleum residue).
Oregon	Portland Gas & Coke Co., 294 Yamhill Street, Portland, Oreg.	Linnton	1913	Do.
Washington	Pacific Coast Coal Co., 563 Railroad Avenue, South Seattle, Wash.	Renton	1914	Bituminous slack and subbituminous coal.

[a] Plant destroyed by fire in 1909; reconstructed in 1911.

STRONTIUM.

By James M. Hill.

INTRODUCTION.

Domestic strontium ores were used by makers of strontium chemicals to a considerable extent during 1917. Prior to 1916 most of the salts made in this country were products of imported celestite. In 1917, however, the domestic deposits supplied over 70 per cent of the domestic requirements.

Detailed notes on the known occurrences of strontium ores in the United States were given in the report for 1916.[1] Apparently few new commercial localities have been found, though extensions of the strontium area near Barstow, San Bernardino County, Cal., are reported. Difficulties of transportation continue to hinder the development of some deposits of celestite that appear to be of promise.

PRODUCTION.

From the best information available to the United States Geological Survey it would seem that approximately 4,035 short tons of strontium ore, valued at about $87,700, of which about 10 per cent was strontianite (strontium carbonate) and the remainder celestite (strontium sulphate), was mined in the United States during 1917. This ore was mined in California, Texas, and Washington. By far the greatest production was made from California deposits.

Approximately 1,700 tons of English celestite was imported in 1917 for use in this country.

MARKET.

The principal market for celestite and strontianite is in the East, the largest buyers apparently being the Foote Mineral Co., of Philadelphia, Pa., and the E. I. du Pont de Nemours & Co. (Harrison Works), of Philadelpnia, Pa. There is a small market on the Pacific coast among makers of fireworks and carbonate. Apparently the plants that operated for a short time near Los Angeles have been shut down, but the Beckman & Linden Engineering Corporation, of San Francisco, and a firm in Seattle are buying strontium ores.

Prices reported by sellers of celestite ranged from $20 to $22 a short ton, but for strontianite ores prices from $35 to $90 a short ton were reported. The Foote Mineral Co. on July 14, 1917, was selling ground celestite (90 per cent $SrSO_4$) at 2 cents a pound ($40 a ton) and ground strontianite (83 per cent $SrCO_3$) at 7 cents a pound ($140 a ton).

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[1] Hill, J. M., Strontium in 1916: U. S. Geol. Survey Mineral Resources, 1916, pt. 2, pp. 188–194, 1917.

STRONTIUM SALTS.

Four companies in the United States reported sales of strontium carbonate and strontium nitrate in 1917, aggregating about 3,000,000 pounds or 1,500 short tons. The principal salt sold was the nitrate. A few thousand pounds of strontium bromide was sold, and several thousand pounds of sulphide, which was presumably used for making other salts.

The demand for strontium salts comes principally from makers of fireworks and night signals. Quotations on strontium carbonate [1] have been steady throughout the year at 40 to 45 cents a pound for technical carbonate and 55 to 60 cents a pound for pure carbonate. Strontium nitrate was quoted at 42 to 52 cents a pound at the beginning of 1917 but declined to 25 to 30 cents a pound in June and remained at that figure till the end of the year.

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[1] Oil, Drug, and Paint Reporter, vols. 91-92, 1917.

PHOSPHATE ROCK.[1]

By Ralph W. Stone.

PRODUCTION.

PHOSPHATE ROCK SOLD.

The phosphate rock marketed in the United States in 1917 amounted to 2,584,287 long tons, valued at $7,771,084, an increase of 601,902 tons in quantity and of $1,874,091 in value over the production in 1916. The increase of 30 per cent in quantity is notable in view of the conditions brought about by the entry of the United States into the war. The quantity and value were greater than in 1915 or 1916 but less than in any other year since 1909. The production for the last 10 years is shown in the following table:

Phosphate rock sold in the United States, 1908–1917.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1908	2,386,138	$11,399,124	1913	3,111,221	$11,796,231
1909	2,338,264	10,796,456	1914	2,734,043	9,608,041
1910	2,654,988	10,917,000	1915	1,835,667	5,413,449
1911	3,053,279	11,900,693	1916	1,982,385	5,896,993
1912	2,973,332	11,675,774	1917	2,584,287	7,771,084

GENERAL CONDITIONS.

In 1917 a general effort was made to increase the production of phosphate rock, owing to the conviction that the people of the United States must increase greatly their production of foodstuffs. Besides supplying food for ourselves we were more and more imperatively required to make large shipments to our allies, and at the close of the year it was apparent that even greater effort must be made to add to the supply of food required for shipment abroad. A great increase in the production of foodstuffs implies a greater use of fertilizer and therefore more energetic mining of phosphate rock.

The entry of the United States into the war, however, brought about conditions that tended to reduce the production of phosphate rock. Among these was a shortage of railroad cars, due to demands for the transportation of war material, and a congestion of freight at certain points, which resulted in an embargo against the shipment of many commodities into the congested district. The lack of cars and the freight embargo seriously retarded production in the eastern phosphate fields. The inability of the Florida phospate producers to get

[1] The statistical tables in this chapter, except those showing imports and exports, were prepared by Miss L. M. Jones, of the United States Geological Survey, whose careful scrutiny and criticism of the returns from producers contributed largely to the accuracy and completeness of the report.

sufficient supplies of fuel oil to operate machinery was another obstacle, and shortage of labor was the third. The costs of mining and shipping were raised by a sharp advance in the prices of fuel and labor and an increase in railroad freight rates.

The fertilizer plants at Weymouth, Mass., Carteret, N. J., Philadelphia, Pa., Baltimore, Md., and Alexandria, Va., get their raw rock by boat from Tampa, Port Tampa, and Boca Grande, Fla., in fairly regular shipments throughout the year. The lack of storage capacity for sulphuric acid at these plants requires regular delivery of the rock to take up the acid as made. The rock is carried by boat because the rate by water is cheaper than that by rail. In 1917 five boats, each having a capacity of 4,000 to 5,000 tons, were regularly engaged in the traffic. The action of the Government in commandeering some of the boats interfered with these coastwise shipments somewhat during 1917, but the boats were allowed to continue in the phosphate business temporarily, and in November and December carried about the normal amount of phosphate rock. One boat of 1,000 tons burden carried phosphate rock throughout the year from Tampa, Fla., to Harvey and New Orleans, La.

Shipments of land-pebble phosphate from Tampa, Port Tampa, and Boca Grande, Fla., to domestic ports in 1916–17.[a]

Month.	1916	1917	Month.	1916	1917
	Long tons.	*Long tons.*		*Long tons.*	*Long tons.*
January	38,204	35,656	August	38,401	45,893
February	23,136	32,326	September	45,545	31,427
March	30,063	35,136	October	37,727	25,590
April	43,348	49,002	November	44,908	53,026
May	34,245	55,997	December	49,661	50,539
June	41,977	42,866			
July	32,120	59,186		459,335	516,644

[a] The American Fertilizer, p. 35, Feb. 2, 1918.

The receipts of phosphate rock by water at the fertilizer plants were augmented by shipments by rail, yet some of the plants were at times obliged to curtail operations or to shut down for lack of raw material. The condition of the industry was even worse early in 1918, when several plants were for a time compelled to close. The all-rail shipments from the Florida fields in 1917 were large, but they would have been larger if it had been possible to get cars. It was reported that Florida railroads were several thousand cars short in making deliveries in the midsummer of 1917.

The exports of land-pebble phosphate from Boca Grande and Tampa, Fla., went principally to Spain. Small shipments were made to Ireland, Scotland, France, and Netherlands. Several cargoes, each containing a few hundred tons, were sent to Matanzas, Cuba. Hard-rock phosphate was shipped from Fernandina, Fla., to Baltic ports in the first half of 1917 in three vessels, which carried in all 9,341 tons.

Imports of phosphate rock are rare. Occasionally a small lot is brought as ballast from islands in the South Pacific Ocean to a Pacific port.

PHOSPHATE ROCK MINED.

The quantity of phosphate rock mined in any year is not the same as that sold, for the quantity in stock at the mines at the end of the year is variable. The quantity mined in 1917 was 2,851,886 tons, an increase of 682,737 tons, or 31 per cent, over the output of 1916. In Florida the increase was about 37 per cent, although only 21 companies were operating as against 24 companies in 1916. In South Carolina the increase was 17 per cent, with 2 operators, the same number as in the previous year, and in Tennessee the increase was 7 per cent, with 15 operators instead of 17. In Kentucky 1 producer reported rock mined. In the Western States there were 4 producers in 1917 as against 2 in 1916, and the quantity mined increased 865 per cent.

STOCKS.

Stocks on hand at the close of 1917 showed an increase for the entire country of 22 per cent, being well over 1,350,000 tons. The stocks on hand in Florida, January 1, 1918, were reported to be about 1,280,000 tons, and the stocks in Tennessee were over 80,000 tons. According to estimates made by the producers the stocks in Florida increased 30 per cent and those in Tennessee decreased 39 per cent. In Kentucky and South Carolina the percentages of increase of stock were large, but the increase in quantity was small.

PRODUCTION BY STATES.

CONDITIONS AND OUTPUT.

The quantity, value, and average price per ton of the different kinds of phosphate rock sold in the United States in 1916 and 1917 are shown in the following table. In 1917 there was an increase in the price of Florida hard and soft rock, Tennessee brown rock, South Carolina land pebble, and western phosphate rock, but a slight decrease in the price of Tennessee blue rock. The average price per ton of phosphate rock of all kinds increased from $2.97 in 1916 to $3.01 in 1917.

Phosphate rock sold in the United States, 1916–17.

State.	1916			1917		
	Quantity (long tons).	Value.	Average price per ton.	Quantity (long tons).	Value.	Average price per ton.
Florida:						
Hard and soft rock	47,087	$295,755	$6.28	18,608	$159,366	$8.56
Land pebble	1,468,758	3,874,410	2.64	2,003,991	5,305,127	2.65
	1,515,845	4,170,165	2.75	2,022,599	5,464,493	2.70
South Carolina:						
Land rock	53,047	211,125	3.98	33,485	138,482	4.14
Tennessee:						
Brown rock	[a] 364,108	1,357,888	3.73	[a] 447,203	1,920,533	4.29
Blue rock	47,682	152,465	3.20	65,904	205,820	3.12
	411,790	1,510,353	3.67	513,107	2,126,353	4.14
Western States	[b] 1,703	5,350	3.14	[b] 15,096	41,756	2.77
	1,982,385	5,896,993	2.97	2,584,287	7,771,084	3.01

[a] Includes several thousand tons of brown rock from Kentucky.
[b] Includes, 1916: Utah and Wyoming; 1917: Idaho, Utah, and Wyoming.

FLORIDA.

In 1917 Florida, the leading State in the production of phosphate rock, marketed 2,022,599 long tons, valued at $5,464,493, or 78 per cent of all the phosphate rock sold in the United States, and an increase of 506,754 long tons, or 33 per cent, over the output of 1916.

Hard-rock phosphate, which was the variety most exported before the war, was mined in 1917 in smaller quantity than in 1916. Some of the hard-rock mines are owned by alien enemies and were taken over by the custodian of alien-enemy property. Several thousand tons of soft phosphate was mined but no river pebble. The increase in the quantity of land pebble sold in 1917 over that sold in 1916 was 535,233 tons, or 36 per cent. There was a slight increase in the quantity of phosphate sold as ground rock, 27,690 tons being so reported.

The average value per ton of land pebble advanced to $2.65, an increase of 1 cent over that of 1916, as shown in the foregoing table. The average value of hard and soft phosphate increased from $6.28 to $8.56.

Florida phosphate rock sold in 1913–1917.

Year.	Hard rock.		Land pebble.		Total.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1913	489,794	$2,987,274	[a] 2,055,482	$6,575,810	2,545,276	$9,563,084
1914	309,689	1,912,197	[a] 1,829,202	5,442,547	2,138,891	7,354,744
1915	50,130	265,738	1,308,481	3,496,501	1,358,611	3,762,239
1916	[b] 47,087	295,755	1,468,758	3,874,410	1,515,845	4,170,165
1917	[b] 18,608	159,366	2,003,991	5,305,127	2,022,599	5,464,493

[a] Includes a small quantity of river pebble.
[b] Includes several thousand tons of soft phosphate.

SOUTH CAROLINA.

The phosphate rock mined in South Carolina was land rock only and the quantity sold was 33,485 long tons, valued at $138,482, a decrease of 19,562 tons, or nearly 37 per cent, in quantity. There was an increase of 17 per cent in the quantity mined over that mined in 1916, and at the end of the year an increase of 136 per cent in the stock on hand. The average price per ton increased from $3.98 to $4.14. South Carolina rock constituted 1.3 per cent of the total quantity sold in the United States in 1917.

South Carolina phosphate rock sold in 1913–1917.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1913	109,333	$440,588	1916	53,047	$211,125
1914	106,919	415,039	1917	33,485	138,482
1915	83,460	310,850			

TENNESSEE AND KENTUCKY.

The quantity of phosphate rock sold in Tennessee and Kentucky in 1917 was 513,107 long tons, valued at $2,126,353. Nearly all this rock was mined in Tennessee, only a few thousand tons having been mined in Kentucky. The output of the two States in 1917 was 20 per cent of that of the entire United States and showed an increase of 101,317 tons, or nearly 25 per cent, over the output in 1916, in spite of difficulty in the latter part of 1917 of making shipments on account of freight congestion in certain parts of the country. The average price per ton increased from $3.67 to $4.14, becoming the same as that of rock mined in South Carolina. In 1917 the average price of Tennessee brown rock was $4.29 and of blue rock $3.12. By far the larger quantity of phosphate mined in Tennessee was brown rock, of which 447,203 tons were sold, the sales of blue rock amounting to 65,904 tons.

Tennessee phosphate rock sold in 1913–1917.

Year.	Brown rock.		Blue rock.		Total.	
	Quantity (long tons).	Value	Quantity (long tons).	Value	Quantity (long tons).	Value
1913	[a] 451,559	$1,774,392	(a)	(a)	451,559	$1,774,392
1914	[a] 483,203	1,822,770	(a)	(a)	483,203	1,822,770
1915	[b] 389,759	1,327,747	(a)	(a)	[b] 389,759	1,327,747
1916	[c] 364,108	1,357,888	47,682	$152,465	[c] 411,790	1,510,353
1917	[c] 447,203	1,920,533	65,901	205,820	[c] 513,107	2,126,353

[a] Blue rock is included with brown rock.
[b] Includes some blue and white rock and a very small quantity of rock from Arkansas.
[c] Includes a small quantity of brown rock from Kentucky.

In 1917 a report on the central Kentucky phosphate field, by W. C. Phalen, was published by the Kentucky Geological Survey in cooperation with the United States Geological Survey. This report describes deposits near Wallace and Midway, Ky., and the method and results of prospecting in those fields. The method of mining phosphate in Tennessee is described because it seems to be the method that should be used in developing the Kentucky deposits.

WESTERN STATES.

The phosphate-rock industry in the Western States showed an increase of 786 per cent in the marketed product in 1917. In 1916 there were 2 producers and an output of 1,703 tons (figures published by permission), and in 1917 there were 4 producers and an output of 15,096 tons. The total value of the product sold in 1917 was $41,756, or an average of $2.77 per ton, which was 37 cents less than the average value per ton in 1916. The output was about 0.6 per cent of that of the entire country.

The producers in the Western States were the San Francisco Chemical Co., mining near Montpelier, Idaho, Western Phosphate Mining & Manufacturing Co., near Paris, Idaho, Peter B. & Robert S. Bradley, Randolph, Utah, and Union Phosphate Co., near Cokeville, Wyo.

The day may not be far distant when the sulphurous acids now going to waste in the fumes of smelters in the Western States will be utilized for converting phosphate rock into fertilizer. The great smelter at Anaconda, Mont., for example, is only 35 miles from the Garrison phosphate field, and should furnish the acid for a fertilizer industry when the demand becomes great enough and the phosphate reserves are made available to development.

UNDEVELOPED DEPOSITS.

PHOSPHATE ROCK IN NEVADA.

Deposits of phosphate rock are reported to occur in Nevada, but they have not been examined in detail by the United States Geological Survey. A specimen found near Ely, White Pine County, contained 24.9 per cent phosphorus pentoxide (P_2O_5), and material found near Osceola, in the same county, seems to be disintegrated phosphate rock. It is reported that phosphate rock containing 15 to 17 per cent phosphorus pentoxide (P_2O_5) has been found near Ocala and Huxley, at the south end of Humboldt Lake, Churchill County, possibly in considerable quantity. Material of this sort, however, is of low grade in comparison with the rock found in parts of Idaho, Utah, and southwestern Wyoming, and can probably not compete with it. The demand for phosphate in the Western States is so small that even the high-grade rock in Idaho, though close to a railroad, has been produced only in meager quantity.

PHOSPHATIC OIL SHALE IN MONTANA.

In its investigations of shales that may be profitably distilled for their content of petroleum, the United States Geological Survey has sampled and tested some deposits in Montana that are of unusual interest. In October, 1916, C. F. Bowen found oil shales near Dillon that are peculiar in that they contain phosphate as well as bituminous matter that is convertible into petroleum. A sample of this shale from Muddy Creek basin a few miles south of Dillon yielded 7.5 gallons of petroleum per ton of shale and 15.56 per cent of phosphate, and a sample from Smallhorn Canyon, in the same region, yielded 24 gallons of petroleum per ton of shale and 2.62 per cent of phosphate. These shales present a problem that may be interesting economically as well as scientifically, for laboratory tests have shown that the phosphate is not distilled off but remains in the ash. The possibility of distilling oil from a shale and then getting a valuable fertilizer from the waste rock may at some future time make these shales the foundation of a new industry.[1]

A report[2] by J. T. Pardee, on the phosphate deposits near Garnet and Philipsburg, Mont., has also been published.

IMPORTS OF FERTILIZER MATERIALS.

The fertilizer materials imported into the United States in 1917 comprised many compounds containing phosphorus, nitrogen, and

[1] Bowen, C. F., Phosphatic oil shales near Dell and Dillon, Beaverhead County, Mont.: U. S. Geol. Survey Bull. 661, pp. 315-328, 1918.

[2] Pardee, J. T., The Garrison and Philipsburg phosphate fields, Mont.: U. S. Geol. Survey Bull. 640, pp. 195-228, 1917.

potash. Those containing phosphorus include bone ash, guano, basic slag, and crude phosphate rock. The potash fertilizers include various potash salts, kainite, manure salts, and double-manure salts. The nitrogen compounds are chiefly cyanamid, nitrates, and ammonium salts.

The quantity of calcium cyanamid, or lime nitrogen, used in the United States has increased from 5,000 tons in 1911 to 47,268 tons in 1917. It is a bluish-black odorless powder containing 20 to 22 per cent of nitrogen. The plants of the American Cyanamid Co., which manufactures it, are at Niagara Falls, Canada. It is used by more than 300 manufacturers of fertilizer in the United States, and is now a source of organic nitrogen in about one-fourth of the total ammoniated fertilizers consumed in the country.

Fertilizers imported and entered for consumption in the United States, 1913–1917.[a]

Fertilizer.	1913		1914		1915		1916		1917	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Apatite	2,962	$22,471	20	$300						
Bone dust or animal carbon, and bone ash, fit only for fertilizing	35,012	851,136	36,000	892,529	21,538	$543,243	18,117	$485,737	10,521	$308,497
Calcium cyanamid or lime nitrogen	26,729	1,410,248	21,793	1,119,785	30,043	1,322,195	40,516	1,755,644	47,268	2,472,936
Guano	16,674	518,429	25,335	761,562	9,874	220,768	12,992	378,036	7,067	160,923
Kainit	465,336	2,201,730	313,898	1,551,115	6,674	95,440	36	1,173		
Manure salts, including double manure salts	223,687	2,245,509	168,969	1,846,475	13,753	200,584	1,108	21,273	225	9,047
Phosphates, crude	17,121	124,815	15,079	136,526	5,359	50,606	4,612	36,389	92	1,169
Slag, basic, ground or unground	13,186	130,455	9,199	105,272	76	1,343	71	759	2	54
All other substances used only for manure	154,729	3,314,460	171,603	3,507,875	72,848	1,535,860	58,993	1,425,636	85,859	1,961,607
	955,436	10,819,253	761,896	9,921,439	160,165	3,970,039	136,445	4,104,647	151,034	4,914,233

[a] The statistics in this and following tables were compiled by J. A. Dorsey from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

This table does not include all the imported material that is incorporated in fertilizers manufactured and sold in this country. To the materials indicated should be added the potash salts listed as such in the import tables of the Bureau of Foreign and Domestic Commerce—potassium chloride and potassium sulphate—which are largely used in manufactured fertilizers. Moreover, considerable imported sodium nitrate (Chile saltpeter) is used in fertilizers. A large part of the sodium nitrate imported, however, is converted into nitric acid and nitrates for use in making gunpowder and other explosives, matches, and pyrotechnic material, in assaying and analytical operations, and in curing meats. The large importation of sodium nitrate is very significant. Sodium nitrate and potash salts are commodities for which the United States in past years has been entirely dependent on foreign countries. The production of potash salts, an infant industry in the United States, is described in another chapter of Mineral Resources.

Imported materials used in part in the fertilizer industry in the United States, 1915–1917.[a]

	1915		1916		1917	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Fertilizers	160,165	$3,970,039	136,445	$4,104,647	151,034	$4,914,233
Potassium chloride	57,741	2,296,606	1,160	348,961	610	158,410
Potassium sulphate	11,346	664,484	1,512	81,684	205	21,702
Sodium nitrate	770,628	22,844,746	1,219,609	38,131,364	1,545,456	60,573,474
	999,880	29,775,875	1,358,726	42,666,656	1,697,305	65,667,819

[a] The statistics in this table were compiled from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

There is a small trade in foreign fertilizer materials which, after being imported into this country, are shipped elsewhere. The following table compares the export of these foreign fertilizers in 1915–1917:

Foreign fertilizers exported from the United States, 1915–1917.[a]

Kind.	1915		1916		1917	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Ammonia sulphate	1,204	$85,255	452	$41,755	219	$23,505
Bone dust and bone ash	51	1,662			113	1,094
Guano		30	68	5,864		
Kainit				3		
Muriate of potash	565	66,599			29	10,465
Sulphate of potash	335	44,159	212	66,238	31	10,500
All other substances used only as fertilizers		113,882		33,103		21,441
	2,155	311,587	732	146,963	392	67,005

[a] The statistics in this table were compiled from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

EXPORTS.

A notable feature of the phosphate rock industry of the last three years has been the decrease in exports. The decrease in 1915 from 1914 was nearly 711,000 tons, and was due to the European war. In 1916, with shipping conditions remaining about the same as in the previous year, the exports fell off further only about 10,000 tons. Early in 1917 the United States entered the war and there was another sharp decrease, amounting to 77,320 tons, from the exports of 1916.

Phosphate rock exported from the United States, 1915–1917.[a]

Kind.	1915		1916		1917	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Phosphate rock, ground or unground, not acidulated:						
High-grade rock	34,572	$331,524	28,631	$286,948	12,403	$113,392
Land pebble	218,472	1,269,659	214,358	863,078	138,010	548,203
All other	377	2,668	689	6,365	15,945	173,450
	253,421	1,603,851	243,678	1,156,391	166,358	835,045

[a] The statistics in this table were compiled from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

The destination of these exports is shown in the following table:

Phosphate rock, ground or unground, not acidulated, exported from the United States, 1915–1917.

High-grade rock.

Country.	1915 Quantity (long tons).	1915 Value.	1916 Quantity (long tons).	1916 Value.	1917 Quantity (long tons).	1917 Value.
Denmark	7,700	$77,000				
Germany	745	7,450				
Mexico					10	$108
Norway					8,641	75,336
Portugal	6,423	64,230				
Spain	2,908	29,080	3,012	$30,120		
Sweden	16,791	153,714	25,283	253,099	3,596	35,958
Canada			336	3,729	111	1,375
Cuba					45	615
British Honduras	5	50				
	34,572	331,524	28,631	286,948	12,403	113,392

Land pebble.

Country.	1915 Quantity (long tons).	1915 Value.	1916 Quantity (long tons).	1916 Value.	1917 Quantity (long tons).	1917 Value.
Belgium					4,769	$16,930
France	4,000	$24,000	22,073	$60,125	8,208	23,124
Italy	7,964	45,984	6,069	16,387		
Netherlands	48,374	275,147	27,748	123,046	4,450	20,025
Portugal	3,500	21,000				
Spain	63,092	386,892	62,179	273,789	60,814	265,648
Sweden	9,955	59,730	31,192	151,543		
England	32,501	185,356	23,525	80,543	32,140	127,215
Scotland	14,876	80,290	9,699	37,050	5,100	18,337
Ireland	31,500	175,000	25,023	94,568	7,500	25,500
Canada	2,710	16,260	2,761	10,407	5,153	20,036
Cuba			4,089	15,620	9,876	31,388
	218,472	1,269,659	214,358	863,078	138,010	548,203

All other phosphate rock.

Country.	1915 Quantity (long tons).	1915 Value.	1916 Quantity (long tons).	1916 Value.	1917 Quantity (long tons).	1917 Value.
Canada	377	$2,668	676	$6,280	5,408	$61,205
Dutch East Indies			13	85		
Bermuda					298	2,905
British Honduras					1	9
Cuba					7,555	82,484
Mexico					1	120
Netherlands					2,182	20,727
British Oceania [a]					500	6,000
Salvador						
	377	2,668	689	6,365	15,945	173,450

[a] Not including Australia and New Zealand. Reported by Bureau of Foreign and Domestic Commerce as "Other British Oceania."

The European ports to which this phosphate rock was shipped were: Spain—Bilbao, Barcelona, Los Pasajes, Seville, and Valencia; France—La Palice; Netherlands—Rotterdam; England—Birkenhead and Liverpool; Scotland—Glasgow; Ireland—Cork and Dublin. Several thousand tons were shipped to Matanzas, Cuba.

The following table shows the quantity of phosphate rock produced in and exported from the United States during the last five years:

Phosphate rock marketed in and exported from the United States, 1913–1917.

Year.	Marketed production (long tons).	Exports (long tons).	Proportion of exports to domestic production (per cent).
1913	3,111,221	1,366,508	44
1914	2,734,043	964,114	35
1915	1,835,667	253,421	14
1916	1,982,385	243,678	12
1917	2,584,287	166,358	6

PHOSPHORUS.

METHOD OF MANUFACTURE.

The present demand for phosphorus for military use gives this derivative from phosphate rock special interest. Phosphorus was once made from bones by leaching them with sulphuric acid in lead-lined tanks, but in recent years electrical processes have largely replaced the older methods of its manufacture. A charge of phosphate rock, coke, and sand on being heated in an electric furnace yields about 86 per cent of crude phosphorus. This crude phosphorus is purified by filtration through porous tile, chamois skin, or canvas, the operation being carried on under lukewarm water, which keeps the phosphorus liquid.

Phosphorus is manufactured in the United States by two companies, the Oldbury Electro-Chemical Co., Niagara Falls, N. Y., and the American Phosphorus Co., North Third and Dauphin Streets, Philadelphia, Pa. Domestic phosphate rock is used. The following paragraphs on the method of manufacture and uses are abstracted from encyclopedia and chemical dictionaries.[1]

In the electrothermal process of manufacturing phosphorus calcium phosphate (phosphate rock) mixed with sand and carbon is fed into an electric furnace provided with a closely fitting cover and having an outlet leading to a condenser. At the temperature of the furnace the silica (sand) attacks the calcium phosphate, forming silicate and setting free phosphorus pentoxide, which is attacked by the carbon, forming phosphorus and carbon monoxide. As phosphorus boils at 290° C. (554° F.), it is produced in the form of vapor, which, mingled with carbon monoxide, passes to the condenser, where it is condensed. It is then cast under water. The calcium silicate remains in the furnace in the form of a slag, which may be run off, so that by letting in fresh raw material at the top the action is made practically continuous.

The crude phosphorus is purified by melting it under water and then filtering it through bone-black and afterward through chamois leather, or by treating it when molten with chromic acid or a mixture of potassium bichromate and sulphuric acid. This treatment causes the impurities to rise to the surface as a scum which can be skimmed off. Phosphorus is usually marketed in the form of sticks which are made by conducting the phosphorus from the melting pot through a pipe surrounded by water. It solidifies in the pipe and can be removed as a continuous rod.

PROPERTIES.

Perfectly pure phosphorus is a white, transparent, waxy solid, but commercial phosphorus is generally yellowish, owing to its content of allotropic "red phosphorus." At 25° to 30° C. it is soft and flexible, but it hardens when cooled and can then be cut only with difficulty. Phosphorus is nearly insoluble in water but dissolves in carbon disulphide, sulphur chloride, benzine, and oil of turpentine. Its density at 0° is 1.836.

[1] Thorpe, Sir Edward, A dictionary of applied chemistry, vol. 4, 1913; Rogers, Allen, Manual of industrial chemistry, 1915; Encyclopædia Britannica, eleventh edition, 1911, article "Phosphorus."

It is highly inflammable, taking fire in air at 34° C., burning with a bright white flame, and forming dense white clouds of the pentoxide. When exposed to the air a stick of phosphorus undergoes slow combustion, which is revealed by a greenish-white phosphorescence when the stick is viewed in the dark.

ALLOTROPIC PHOSPHORUS.

"Red phosphorus" is produced by heating yellow phosphorus to about 230° C. for 24 hours in an inert atmosphere or in closed vessels heated to 300° C., when the change is effected in a few minutes. The same form is also produced by submitting ordinary phosphorus to the electric discharge, to sunlight, or to the ultra-violet light. As this form does not inflame until it is heated above 350° C. it is manufactured in large quantities for use in making matches. It is usually made by heating yellow phosphorus in iron pots provided with air-tight lids, which, however, bear a long pipe open to the air. A small quantity of the phosphorus combines with the oxygen in the vessel, and the operation is then practically conducted in an atmosphere of nitrogen which affords additional safety from explosion. The product is ground under water and any unchanged yellow phosphorus it may contain is eliminated by boiling it with caustic soda. The product is then washed and dried and finally packed in tin boxes. The red variety is remarkably different from the yellow. It is a dark red microcrystalline powder, insoluble in such solvents as carbon disulphide and oil of turpentine, and having a density of 2.2. It is stable to air and light and does not combine with oxygen until it is heated above 350° C. in air or 260° C. in oxygen, forming the pentoxide. It is also nonpoisonous.

USES.

Therapeutics.—There are various medicinal preparations of phosphorus. Owing to its remarkable influence on the growth of bone in young animals, it has been used in the treatment of rickets and osteomalacia. Its most effective use, however, is as a nerve tonic in paralysis agitans, locomotor ataxia, impotence, and nervous exhaustion. It is also a remedy for some skin diseases. The hypophosphites have been recommended as a remedy for pulmonary affections, in which it is said to act as free phosphorus without being irritant, and the glycero-phosphates are certainly useful to stimulate metabolism. Dilute phosphoric acid is used as a gastric stimulant. It does not resemble phosphorus in its physiologic action and can not be used to replace it.

Toxicology.—Phosphorus is frequently taken or administered in poisonous amounts, criminally or accidentally, it being easily accessible to the public in the form of matches or of vermin pastes. A chronic form of industrial poisoning in the manufacture of lucifer matches is necrosis, known as phossy jaw, a localized inflammatory infection of the periosteum, ending with the death and exfoliation of part of the bone.

Safety matches.—Red phosphorus was used for making the well-known safety matches by J. E. Lundstrom, of Jonkoping, Sweden, in 1852. Red phosphorus is in itself perfectly innocuous, and no evil effects arise from freely working the compositions of which it forms an ingredient. The striking surface on the box, and not the match itself, contains the phosphorus required for ignition.

Phosphor-bronze.—Bronze is improved in quality and strength when fluxed with phosphorus. The alloys prepared in this way, known as phosphor-bronze, may contain only about 1 per cent of phosphorus in the ingot, which may be reduced to a mere trace after casting, but the phosphorus nevertheless enhances their value for use in making implements which require a hard strong metal, such as pump plungers, valves, and the bushes of bearings.

Signals and screens.—One of the constituents of the material used in distress signaling at sea is phosphorus in the form of calcium phosphide. The dense white smoke made by various phosphorus compounds when oxidized is utilized to screen or conceal vessels in danger of attack or whose movements it is desired to hide, and it is also used in trench warfare.

SULPHUR, PYRITES, AND SULPHURIC ACID.[1]

By Philip S. Smith.

SULPHUR.

DOMESTIC PRODUCTION.

Sulphur was produced in 1917 by eight mines, one in Louisiana, two each in Texas, Nevada, and Wyoming, and one in Colorado. The two largest producers of sulphur are the Union Sulphur Co., whose mine is at Sulphur Mine, Calcasieu Parish, La., and the Freeport Sulphur Co., whose mine is near Freeport, Brazoria County, Tex. These two companies furnished more than 99 per cent of the sulphur produced in the United States in 1917, and to avoid revealing their confidential reports the figures for the production of domestic sulphur will not be divulged; the figures will, however, be included in the table of the mineral production of the United States and in the tables for the States involved, but lumped with figures for other mineral products in such fashion that the quantity and value of the sulphur will not be disclosed.

Although precise statistics are not given, it may be said that the domestic production in 1917 was nearly 50 per cent greater than in 1916—a year during which several hundred per cent more sulphur was produced than in any year before the war. So far the deposits at neither of these two largest mines have shown indications of exhaustion, and in fact the result of a special investigation by Government geologists and mining engineers gives reasonable assurance of their continued production for several years at the high rate attained in 1917 and even of further increase. Not only have both these companies increased their production but they have also maintained large reserves of sulphur in stock to meet emergencies. In fact, the total stock on hand at the two mines on December 31, 1917, was slightly greater than it was at the beginning of the year.

Although the production from these two companies has increased, the production from the other sulphur mines has shown a marked decrease. Most of the mines that reported for 1916 a production of several thousand tons report for 1917 a production of only a few hundred tons. It is unfortunate that these smaller mines have not yielded more sulphur, for they might have supplied local needs and thus released some transportation for other purposes.

The only sulphur mines operating in 1917 and not in 1916 were those of the Yellowstone Sulphur Co., Cody, Wyo., and the Colorado Sulphur Production Co., which is developing a well-known deposit

[1] The statistics in this report were compiled by Mrs. Agnes L. Sullivan, of the United States Geological Survey.

south of Creede, in Mineral County, Colo., that has long been tied up by litigation. According to reports[1] 30,000 tons of ore averaging 50 per cent sulphur are known at this place. The sulphur is said to contain no arsenic, selenium, tellurium, or other deleterious elements.

A few localitites where sulphur has been reported in addition to those listed in the chapter on sulphur in Mineral Resources for 1916 are as follows: Arizona, in the vicinity of some of the ancient volcanoes; Colorado, in Delta County; Utah, about 12 miles south of Coalville; New Mexico, in the vicinity of Jemez Hot Springs; and Oregon, in Douglas County in the Umpqua Range, about 6 miles from Rogue River. None of these deposits appear to give promise of being extensively developed in the near future, as many of them are too far from transportation and the others are too small.

IMPORTS.

Up to 1900 the annual domestic production of sulphur was relatively insignificant and about 175,000 long tons of sulphur was imported each year. With the commercial development of the deposit in Louisiana the importation of sulphur suddenly decreased, and in 1907 the imports amounted to only about 20,000 tons. Since that year up to and including 1916 the imports of sulphur each year have been between 20,000 and 30,000 long tons. In 1917, however, owing to the restrictions imposed by certain of the foreign governments, the difficulty of obtaining ships, and the quantity of domestic sulphur available, less than 1,000 tons of foreign sulphur was received in this country.

The following table gives the data furnished by the Bureau of Foreign and Domestic Commerce concerning the country from which the sulphur came, the quantity, and the places in the United States at which it was entered:

Sulphur imported into the United States in 1917.

Country.	District of entry.	Quantity (long tons).
Japan	Washington	252
	Hawaii	101
	Oregon	600
	Southern California	2
Total Japan		955
England	New York	5
Canada	Montana	4
	Massachusetts	9
		973

From this table it may be seen that more than 98 per cent of the imported sulphur came from Japan and doubtless originated in that country. The sulphur imported from England and Canada did not originate in those countries but must have been reshipped.

The total value of the sulphur imported into the United States was $20,176, or an average value of $21.85 a ton. This price is considerably lower than the current market quotation for domestic mate-

[1] New source of sulphur in Colorado: Met. and Chem. Eng., vol. 17, p. 523, November 1, 1917.

rial, but is much higher than the average value received for the sulphur imported in 1916.

EXPORTS.

According to reports received from the Bureau of Foreign and Domestic Commerce, the quantity of crude sulphur or brimstone exported from the United States in 1917 was 152,833 tons, valued at $3,504,661. This was the greatest export of sulphur by this country in a single year, exceeding by nearly 20 per cent the previous record quantity exported in 1916. The exports in 1917 exceeded by more than 70 per cent the exports in 1913, which may be taken as fairly representative of normal conditions immediately before the war.

The following table shows the exports of crude sulphur to the different parts of the world and the customs districts from which it was cleared. Although the customs districts are distributed around the entire border of the country, it is evident that practically all the sulphur exported was produced by the two mines in Louisiana and Texas.

Sulphur exported from United States in 1917, in long tons.

Destination.	Ports.							
	New York City.	Maine, New Hampshire, Massachusetts, and Vermont.	St. Lawrence, Buffalo, and Michigan.	Dakota, Duluth, Montana, Idaho, and Washington.	California and Arizona.	Texas and Louisiana.	Alabama and Virginia.	Total.
North America[a]	613	26,292	45,962	7,788	89	9,911	3	90,658
South America	2,857	156				360	1,205	4,578
Europe	2,012		83			49,975		52,070
Asia	346			226	68			640
Africa	687					4,200		4,887
	6,515	26,448	46,045	8,014	157	64,446	1,208	152,833

[a] Principally Canada, Mexico, and Cuba.

Of the 90,658 tons of sulphur exported to North American countries, 82,148 tons went to Canada, 6,362 tons to Mexico, 1,403 tons to Cuba, and the rest to the West Indies and other outlying islands and Central America. Of the 4,578 tons exported to South American countries, 1,882 tons went to Argentina, 1,813 tons to Brazil, and 489 tons to Uruguay. Of the 52,070 tons exported to Europe, 39,511 tons went to England, 6,669 tons to France, 2,898 tons to Norway, and 1,899 tons to Portugal. The statistics given regarding exports to Asia also include exports to Australia, East Indies, the Philippines, and Japan. The only exports to Africa were to Britsh South Africa and British East Africa, amounting, to the former country, to 4,835 tons.

From the statistics given regarding the exports to Canada and Mexico it is evident that even if shipment by boat had been seriously hampered, at least 50 per cent of the sulphur exported in 1917 could have been distributed by rail.

The total value of the sulphur exported is stated by the Department of Commerce to have been $3,504,661, an average value of $22.93 a ton. Comparison of the total value of the sulphur exported with the value ($20,176) of the sulphur imported indicates to what an extent the balance of trade is in favor of the United States. It further indicates how much sulphur would be available for domestic use if an exigency should arise whereby foreign shipments should be prevented.

CHARACTER OF DOMESTIC DEPOSITS.

At both the large mines the sulphur occurs under essentially similar conditions. From the surface to a depth of several hundred feet are unconsolidated sands and muds. Beneath the unconsolidated deposits is a limestone in places as much as 100 feet thick, locally known as the cap rock, because it covers the sulphur deposits. Next beneath the cap rock is limestone, with some gypsum and large quantities of sulphur. Lower down the proportion of the limestone decreases, and in the next few hundred feet the beds are mainly gypsum, with some sulphur and little limestone. Still lower down the rock is massive gypsum. This gypsum member is said to rest on beds of salt of unknown thickness. The rocks below the unconsolidated deposits are apparently folded so that the rock surface forms a dome. In fact, the slopes of the sides of the rock dome are in places more than 45°.

The sulphur does not occur in massive beds but in stringers and lenses, which traverse the adjacent rocks irregularly and in some places form as much as 70 per cent of their bulk. The origin of the sulphur has not been definitely ascertained, but the most generally acceptable explanation is that it has been derived through an alteration of the gypsum.

The early attempts to mine the Louisiana deposit, which was the first to be discovered, were unsuccessful until the double problem of reaching the deposit and of extracting the sulphur was solved by Dr. Herman Frasch. The original Frasch patents having expired, the same general process is now being used both at the original locality and at Freeport, Tex. Briefly this process is as follows: Holes nearly a foot in diameter are bored to the deposit by rigs and drills similar to those used in boring for oil, and the sulphur, which liquefies at about 116° C., is melted by the introduction of superheated water. After the sulphur has melted and collected at the bottom of the hole, it is raised to the surface by the use of compressed air. The sulphur in the liquid state is piped to large bins, where on cooling it consolidates. The solid sulphur in the bins is blasted down by powder, picked up by steam shovels, and loaded into box cars for railroad shipment or on open gondola cars for transportation to the loading dock for ocean shipment.

The sulphur obtained is not further refined at the mines, but is sold with the guaranty that it is at least 99.5 per cent pure. It contains no arsenic or selenium. Usually not all the sulphur in the adjacent rocks is melted out by one well, and consequently the practice has been to abandon a well after a certain length of time and later to go back to the same general place and sink another well. The distance to which the steaming affects the rock varies greatly according to local conditions. In some places wells less than 50 feet apart show no interrelation, whereas in other places wells more than 1,000 feet apart show distinct intercommunication. Already several hundred wells have been sunk at each mine, but of these only four or five yield sulphur at a time. The number of wells in operation at a time is limited not only by the equipment required to furnish the necessary hot water but also by the necessity of avoiding the setting up of excessive pressures underground. The quantity of sulphur derived from individual wells differs considerably. The most productive wells are said to have yielded more than 100,000 tons of sulphur.

At all the other producing sulphur deposits the sulphur occurs in part at least at the surface and is mined by stripping or by subsurface drifting. The ore is then taken to retorts or furnaces, where it is heated so that the sulphur liquefies and runs out of the rock. The sulphur usually constitutes from 10 to 50 per cent of the ore, and although the ore can be mined at these places rather cheaply, the handling and further treatment required to free the sulphur from the worthless material is expensive. Furthermore, a good deal of the sulphur is not extracted by this rather crude method of treatment, and hence the difference between the original sulphur content of the ore and the quantity of sulphur recovered in practice is often very great.

Most of the companies producing small amounts of sulphur are developing localized deposits that seem to be more or less intimately connected with the dying out of volcanism or solfataric action. The richer parts of the deposit on a single property are therefore rather irregularly distributed and usually cover only a small area. The sulphur content is usually greatest in the surface portions, although in places the sulphur-bearing formation is reported to be as much as 40 feet thick.

USES.

Sulphur is used for many different purposes, but normally the greatest consumption is in the manufacture of paper and in the preparation of chemicals. According to information from paper manufacturers about one-eighth of a ton of sulphur is used for each ton of sulphite pulp manufactured. Although some of the sulphur required for this purpose is derived from the burning of ores of sulphur, most of the pulp manufactured in this country is made with native sulphur. According to census returns, the production of sulphite pulp in the United States in 1914 consumed 136,456 short tons of sulphur. By comparing the statistics for 1914 with those of 1904 it appears that the average annual increase in the consumption of sulphur in the paper industry is very small.

Under normal conditions not much native sulphur except that of the best quality is used for the manufacture of sulphuric acid, but lately, owing to the heavy demand for large quantities of all grades of acid, the quantity of sulphur so used has increased notably. According to the reports of the producers of acid, 463,364 long tons of domestic and 20,463 long tons of foreign sulphur were used by them in 1917. A considerable increase even over this enormous consumption, must, however, be expected if imports of pyrite are materially decreased. Statistics of the consumption of sulphur in chemical industries other than the manufacture of acid are not available.

Some native sulphur is used in various agricultural activities in addition to the direct use of sulphur for sulphuric acid in the manufacture of fertilizers. The quantity used for these purposes, including spraying, dipping, and dusting (sulphuring), is roughly estimated as between 35,000 and 40,000 tons a year. Possibly the use for agricultural purposes will be much greater in the future, for experiments suggest that native sulphur applied to some soils acts as a direct fertilizer. Many articles have recently appeared in the technical press on this subject, and an excellent list of references has been prepared by De Kalb.[1] It does not seem probable, however, that sulphur-bearing limestone and gypsum can be profitably mined and transported any considerable distance by rail for this purpose, for generally the calcareous ingredient of the mixture can be obtained near the place where the fertilizer is to be used.

No statistics regarding the quantity of native sulphur used for explosives during 1917 are available. A large quantity of low-power powder is made even in times of peace for many industrial purposes, and for the Army chiefly in saluting, as an igniter for nitrocellulose powders, and in fuses and primers.

PYRITES.

QUALITIES AND USES.

The term pyrites is the indefinite general trade name for any of the iron sulphide minerals, such as pyrite, marcasite, and pyrrhotite. Pyrite and marcasite when pure have identical chemical composition, namely, about 53 per cent sulphur and 47 per cent iron, but differ from each other in mode of crystallization. Pyrite forms cubical crystals, whereas marcasite forms tabular crystals. Pyrrhotite when pure contains about 40 per cent sulphur and 60 per cent iron, it is somewhat softer, tarnishes more readily than either pyrite or marcasite, and is magnetic, whereas the other minerals are not.

Pyrites is used mainly for the manufacture of sulphuric acid, and more than 1,250,000 long tons is consumed each year for this purpose. Pyrites, as commercially used, is generally referred to one of two classes, lump or fines. The lump ore, as its name implies, consists of pieces more than half an inch in diameter, with a certain allowable proportion of smaller particles, and is used in the condition in which it comes from the mine with little more than a preliminary crushing and sorting according to size. The fines consist of smaller particles and generally have been obtained by crushing the ore so small that the pyrites can be separated from worthless gangue by some mechanical process. They are also derived from ore that has disintegrated as a result of leaching. Owing to the different methods of treating these two kinds of pyrites for the extraction of their sulphur, they can not be used interchangeably. The lump ore commands somewhat higher prices than the fines, but, of course, it is more difficult to obtain a lump ore with as high a sulphur content as that of fines. As a result, only a few mines or parts of a mine can furnish lump ore and maintain a sufficient sulphur content, whereas

[1] De Kalb, Courtenay, Manufacturers' Record, December 20, 1917.

suitable fines may be obtained even from deposits in which the pyrites is sparsely disseminated.

No definite lower limit can be placed on the proportion of sulphur that a pyritic ore must contain to be of commercial grade. In practice, however, material containing more than 40 per cent of sulphur is specified, and practically none of the acid companies use material that carries less than 35 per cent of sulphur.

Several elements or substances by no means rare in pyritic ores are objectionable as material to be used in the manufacture of sulphuric acid and decrease the value of the ore in which they occur, or they can be used only by means of special treatment.

Certain elements, arsenic and antimony for instance, are poisonous and have a bad effect on the resulting acid, but some of the large fertilizer plants do not reject an ore containing less than 1 per cent of arsenic. These elements are also injurious from a manufacturing standpoint if the pyrites is used in plants making acid by the contact process, as they attack the platinum and cause it to lose its efficiency. According to Wilson,[1] pyrites carrying more than 8 per cent of copper can not be profitably employed in the manufacture of sulphuric acid. Carbonaceous material, such as the coal adhering to the pyrites or "coal brasses," is apparently heavily penalized by acid manufacturers because it yields acid of a dark color. This effect, however, should not prevent pyrites containing some material of this sort being used in making some low-grade acids for the manufacture of fertilizers and similar materials. On the other hand, however, most of the pyrites derived from the coal beds is marcasite, which decomposes readily, sometimes ignites through spontaneous combustion, or oxidizes to sulphuric acid, and is therefore a dangerous or expensive substance to leave in storage dumps.

CONDITION OF THE INDUSTRY.

The pyrites industry throughout 1917 showed an unsettled condition due largely to uncertainty as to whether importation of foreign pyrites would be continued. At times the impression would be prevalent that further imports of pyrites would be stopped and there would follow a feverish interest in finding possible sources of domestic ore. Before much progress had been made in this search, however, a contrary rumor would be circulated and activities would decrease or actually stop. These conditions alternated in their hold on the minds of those who might have been willing to undertake the rather expensive and time-consuming operation of developing mines capable of supplying the sulphuric-acid industry with pyrites. Because of this uncertainty some of the former users of imported pyrites decided to replace it with sulphur and thus reduce the quantity of imported ore required. This substitution required little change in technology in many of the plants and it was adopted by many manufacturers. By the last part of the year, however, it became evident that more domestic pyrites was necessary, and consequently several mines were opened. It takes time, however, to bring a pyrites mine to the producing stage, so that this activity had but little effect on the output of pyrites in 1917, but it will probably have a considerable effect on the output in 1918.

[1] Wilson, A. W. G., Pyrites in Canada: Canada Dept. Mines, Mines Branch, Pub. 167, p. 22, 1912.

In spite of this uncertainty there was an increase in output in 1917 of about 10 per cent. Three mines, unproductive in 1916, reported a total production of 10,000 tons in 1917; some of the mines, however, that were active in 1916 were unproductive in 1917. It is known that certain pyrites mines produced at least 40,000 tons less in 1917 than in 1916, a difference which more than offset the production of the new mines opened in 1917. The increase in 1917 is therefore to be attributed to the increased output of the mines that were producers in 1916. Although the domestic production increased somewhat less under the stimulus of the war than had been anticipated, it was much greater than it had been in any preceding year, and at the end of the year the industry was in a more favorable condition to yield a still further increase than it had been before.

The shortage of pyrites was made evident by the high price that was paid for it and the difficulty of obtaining considerable quantities even at prices three times those paid in 1916. The quotations given for pyrites in the technical press in 1917 range all the way from 20 to 35 cents a unit for the sulphur content. On the assumption that the pyrites carried 45 per cent sulphur, the latter price would bring a return of $15.75 a ton for the pyrites. The usual prewar price of pyrites was less than $4 a ton, and according to the statistics published by the Geological Survey the average price per ton even in 1916 was $4.64.

PRODUCTION.

The domestic production of pyrites in 1917, as shown in the accompanying table, was 462,662 long tons, valued at $2,485,435, an increase of about 39,000 long tons in quantity and of about $520,000 in value, as compared with the production in 1916. The above figures do not include the production in Colorado, which probably amounted to about 20,000 tons. At the time this report was prepared detailed statistics of the production of pyrites in Colorado were not available. The consumption of pyritic ore in 1917—that is, the domestic production plus imports—amounted to about 1,430,000 long tons and was about 240,000 long tons less than the consumption in 1916. This decrease was largely attributable to the great falling off in imports.

In addition to the pyritic ores reported here, returns from manufacturers of sulphuric acid (see p. 61) show that 708,500 long tons of domestic copper-bearing sulphide ores, 147,531 long tons of foreign copper-bearing sulphide ores, 594,100 long tons of domestic zinc-bearing sulphide ores, and 152,911 long tons of foreign zinc-bearing sulphide ores were treated in 1917 for their sulphur as well as for their metallic content.

Pyrites produced in United States in 1917.

	Quantity (long tons).	Value.		Quantity (long tons).	Value.
California	115,817	$333,501	Virginia	170,382	$1,378,043
Georgia	23,242	155,560	Other States [a]	115,407	498,776
Illinois	24,596	89,998			
Ohio	13,218	29,557		462,662	2,485,435

[a] Includes Alabama, Indiana, Kentucky, Missouri, New York, Pennsylvania, South Dakota, Tennessee, and Wisconsin.

This production was reported from 54 mines in 14 States. Grouped by certain broad general regions, 258,066 long tons, valued at $1,955,464, came from the Appalachian region, including New York, Virginia, Alabama, and Georgia; 39,463 long tons, valued at $129,318, came from the region east of the Mississippi, including western Pennsylvania, Ohio, Indiana, Illinois, and Tennessee; 49,316 long tons, valued at $67,452, came from the region west of the Mississippi, including Missouri, Wisconsin, and South Dakota; and 115,817 long tons, valued at $333,501, came from California, the only State west of the eastern front of the Rocky Mountains that reported production of pyrites for its sulphur content. The average value of the total pyrites as reported by the producers was $5.38 a ton.

The crude ore sold amounted to about one-third the quantity of concentrate sold, the record showing that 104,311 long tons of lump ore and 358,351 long tons of concentrate were marketed.

IMPORTS.

The imports of pyritic ore showed a notable decrease in 1917 from 1916 and were practically the same as in 1912. This decrease was due to the difficulty in obtaining ships for the transportation of ore from Spain, the country in which most of the pyrites imported by the United States is mined. The following table gives the statistics received from the Bureau of Foreign and Domestic Commerce for 1912 to 1917, inclusive:

Pyrites containing more than 25 per cent of sulphur imported for consumption in the United States, 1912–1917.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1912	970,785	$3,841,683	1915	964,634	$4,817,977
1913	850,592	3,611,137	1916	1,244,662	6,728,318
1914	1,026,617	4,797,326	1917	967,340	5,981,457

The distribution of the imported pyrites by ports of entry is shown in the accompanying table, the statistics for which were obtained from the Bureau of Foreign and Domestic Commerce.

Pyrites imported into the United States in 1917.

Country.	District of entry.	Quantity (long tons).
Newfoundland	New York	3,500
Canada (total, 210,615 tons)	Buffalo	1,395
	Vermont	31,956
	Ohio	102,864
	Chicago	73,600
	New York	800
Portugal	South Carolina	5,395
Spain (total, 747,830 tons)	Virginia	30,912
	Massachusetts	29,639
	New York	134,379
	North Carolina	18,025
	Philadelphia	242,275
	Maryland	126,837
	Georgia	95,001
	South Carolina	44,761
	Florida	21,244
	New Orleans	4,757
		967,340

From this table it will be seen that 214,115 long tons came from deposits in Canada and Newfoundland and 753,225 long tons from deposits in Spain and Portugal. It is evident that if importations of pyritic ores are curtailed or cut off because of lack of ships the quantity of ore that would have to be replaced in whole or in part by domestic pyrites or sulphur is represented by the imports from Spain and Portugal. According to these statistics the imports of Canadian pyrites increased 65,433 tons in 1917 over 1916, but on the other hand the imports from Spain and Portugal decreased 342,758 tons. A still further increase in the imports of Canadian pyrites is looked for in 1918, but a still greater decrease in the imports from Spain is also probable.

The total value of the pyrites imported into the United States in 1917, was $5,981,457, or an average value of $6.18 a ton; in 1916 the average value was $5.41 a ton. In this connection it should be noted that in 1916 the price paid for Canadian ore was considerably lower than that paid for the Spanish ore. The value of Canadian pyrites was stated to be only about two-thirds that of the Spanish ore. Some of this difference in price is warranted by the generally higher sulphur content of the Spanish ore, but some of the difference is caused by the unwillingness of the pyrites users to modify their old practice and to accept a substitute if Spanish ore is obtainable even at extra cost.

DEPOSITS OF PYRITES IN THE UNITED STATES.

The unprecedented demand for pyrites and sulphide ores in making the sulphuric acid required for fertilizers and explosives has led to numerous inquiries as to the location and character of domestic deposits of these minerals. In order to furnish this information the United States Geological Survey has made and is making investigations of many of the deposits that have been reported, especially in those States nearest the centers of manufacture and use of sulphuric acid where the deposits would be of most immediate commercial value. Some of these investigations will doubtless be presented more fully in other publications, but it has seemed desirable to present in the following pages the data now available. For some of the properties listed additional information is on file in the Geological Survey, but for many of them the data at hand are not complete, and the Geological Survey would be glad to have engineers and others supply supplementary facts.

The iron sulphides are very common minerals, being found in all parts of the country, but in order to be of value they must occur in deposits capable of yielding a considerable quantity relatively free from worthless material and so situated that they can be cheaply transported to market.

In the United States there are four main areas in which pyrites is so abundant that deposits may be sought with some promise of success. These are, from east to west, the Appalachian Mountain region, where pyrites occurs in lenses associated with schists; the interior States, where it is mainly associated with coal beds; the Rocky Mountain States, where in places it occurs in numerous veins and lenses often mixed with sulphides of the other metals; and the Coast ranges, where the pyrites is usually in lenses more or less intimately connected with igneous rocks. More than three-fourths of the domestic and imported pyrites consumed in the United States is used in the region east of Mississippi River. As a consequence many of the deposits in the Rocky Mountain States and farther west can not be profitably utilized under present conditions except for local demand. Enormous reserves of pyrites are known at many places in the Western States, but it has not seemed desirable at this time to give details regarding them, inasmuch as the cost of transportation to market alone from the deposits would exceed by several dollars a ton the entire cost before the war of pyrites delivered at Atlantic seaboard points. Hence in the discussion of these States only the mines that are actually producing pyrites for use in the manufacture of sulphuric acid are specifically mentioned.

In many States sulphide ores containing metals such as zinc or copper are also used for their sulphur content. More extensive use of these ores might be made if a shortage of pyrites should occur. How much of these ores could be used would depend on so many details of cost and of manufacturing processes that it has not seemed desirable to list these deposits except in so far as the ores are actually being used at present for their sulphur content.

In most coal mines the pyrites is separated from the coal when the coal is prepared for market, and at a few mines this pyrites is saved and sold. In general, however, it is discarded as waste. A considerable additional quantity of pyrites could doubtless be recovered from this source if necessary, but in many places this could not be done economically at prevailing prices and would probably tie up a considerable number of railroad cars unprofitably.

The mines and prospects listed have been divided into three classes—those which have developed ore bodies and which produced ore in 1917; those which did not produce ore in 1917, but appear to possess real merit and to deserve commercial investigation; and those which have been reported but concerning which data are not sufficiently detailed to permit a definite statement as to their value. Further information concerning the last-mentioned mines is particularly desired. The descriptions of the deposits are arranged by States.

ALABAMA.

In 1917 there were three producing pyrites mines in Alabama—those of the National Pyrites & Copper Co., the Southern Sulphur Ore Co., and the L. M. Mining Association. All three of these mines are in the east-central part of the State, in Clay County, near Pyriton. Deposits in this region have been known for some time, but the mines were reopened during 1917, and by the end of the year the first two were producing a considerable quantity of pyrite.

The deposit at the National Pyrites & Copper Co.'s mine, formerly owned by the Alabama Sulphur Ore & Copper Co., is in schist and consists of irregular lenses, some of them 300 feet long and 35 feet thick. The deposit has been opened by an incline of about 30° slope for a distance of 450 feet, and the average grade of ore shipped is reported to carry about 40 per cent sulphur. Both lump and fines are shipped. The ore also carries about 1 per cent copper.

The conditions at the property of the Southern Sulphur Ore Co.'s mine are essentially the same as at the National Pyrites & Sulphur

Co.'s mine, and both lump and fines, containing about 40 per cent of sulphur, are shipped.

The L. M. Mining Association has leased the old Mattison mine, about 2 miles from Pyriton. The ore body is reported to have an average thickness near the surface of about 8 feet, but this decreases in depth so that at the bottom of the shaft, which is 135 feet deep, it is only about 2 feet thick. The ore is reported to have an average content of 42 per cent of sulphur and more than 2 per cent of copper.

All three of these mines report great difficulty in getting an adequate supply of suitable labor. It is estimated that possibly during 1918 they may have a combined production of 25,000 tons.

The general belt in which the ore bodies described occur extends for a considerable distance beyond the area prospected and seems to be worth further investigation. In Coosa County, on Hatchet Creek near Bull Gap, and at the old McGhee gold mine, some pyritic ore has been mined in the past, and probably a small quantity could be quickly obtained if required and possibly a considerable output if systematic exploration and development were undertaken. According to the State geologist of Alabama, however, the pyrites at the Hatchet Creek locality is in irregular concretionary masses and consequently is probably of rather small extent.

A large deposit of what appears to be bedded limonite derived from pyrites is reported in Shinbone Valley, 10 to 15 miles northeast of Pyriton. This appears to be a gossan and if so it is worth testing with the drill, as the indications point to a considerable deposit of pyrites beneath it. W. S. Harper, of Wedowee, Ala., owns some of the properties on which this deposit occurs. Near Stonehill, in Cleburne County, in the vicinity of the Woods copper mine, are two deposits of pyrrhotite and pyrite. The ore is in general similar to that in the Ducktown district, Tenn., and the deposit at one of the localities is said to have been traced more or less continuously for a distance of 1,200 feet. An analysis of the ore is reported to have shown a content of slightly more than 30 per cent of sulphur.

Numerous reports have been received of indications of pyrites all the way from Chilton County west of Coosa River northeastward to the Georgia-Alabama State line, but details concerning promising localities are not at hand. Some pyrites has been reported near Gold Branch, in Coosa County, also along the eastern flanks of Talladega Mountain, at the old Hog Mountain gold mine, where a vein of pyrites 10 to 15 feet thick has been reported. H. D. McCaskey,[1] of the United States Geological Survey, also noted an apparent gossan at least 30 feet wide and possibly 50 feet wide on the south flank of Horseblock Mountain near the Chulafinnee-Abel road. This type of material trends about east and west and outcrops of it or of similar deposits have been recognized for a distance of about 2 miles. The eastern outcrop has been prospected for copper in the past but without success.

ARIZONA.

No pyrites is being mined in Arizona at this time for its sulphur content alone, but considerable sulphide ore valuable mainly for its copper content is mined, and part of its sulphur is recovered at the

[1] McCaskey, H. D., unpublished memorandum.

smelter of the Calumet & Arizona Copper Co., at Douglas, Ariz. Throughout the State there are numerous deposits containing large quantities of pyrites that are now mined for copper, zinc, lead, gold, and silver.

In the Bisbee district Ransome[1] reports a deposit mainly of massive pyrite containing small quantities of chalcopyrite and bornite, which is 500 feet long, 10 to 20 feet wide, and 270 feet thick. In the Clifton-Morenci district Lindgren[2] reports a vein of granular pyrite 50 feet wide. In the Patagonia district Schrader[3] reports large veins containing considerable quantities of pyrites, some of which has been tested for the manufacture of sulphuric acid and found to contain 36 per cent sulphur. Large deposits of pyrites are also reported to occur in the Santa Rita Mountains. These are only a few of the deposits that might be mentioned, but they serve to show that some of these deposits could furnish large quantities of sulphur ore if urgent necessity arose. Under existing conditions, however, the cost of mining and transportation is so great that the material can not be brought to markets east of the Mississippi, where the shortage of pyrites will probably be most acutely felt.

ARKANSAS.

No record has been obtained by the Geological Survey of any pyrites having been sold from Arkansas mines in 1917, though some pyrites is reported to have been saved in connection with the mining of coal in the vicinity of Russellville, in Pope County. Doubtless a small amount of pyrites could be obtained from many of the coal mines in the State, but, as already pointed out, this source usually can not be counted on to furnish a large supply rapidly and economically.

In the central part of the State, on the southern slopes of West Mountain, 2 miles west of Hot Springs, pyrites is so abundant in some of the veins traversing the sandstone country rock that it might be used in the manufacture of sulphuric acid.[4] At this place a zone 30 feet wide is thickly set with veins of pyrites. Individually the veins are small, few of them exceeding 4 inches in width, but they are so numerous that the whole zone might be mined and concentrated. A few prospecting shafts have been sunk in the deposit, and considerable drifting has been done.

CALIFORNIA.

In 1917 three companies produced a total of 115,817 tons of pyrites in California. This was much less than the production in 1916 and the decrease was due mainly to the closing down of the mine of the Daisy Farm Mining Co. The largest of the three producing companies is the Mountain Copper Co., whose mine is near Keswick, in

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[1] Ransome, F. L., unpublished memorandum.

[2] Lindgren, Waldemar, Copper deposits of the Clifton-Morenci district, Ariz.: U. S. Geol. Survey Prof. Paper 43, p. 106, 1905.

[3] Schrader, F. C., Mineral deposits of the Santa Rita and Patagonia mountains, Ariz.: U. S. Geol. Survey Bull. 582, p. 257, 1915.

[4] Purdue, A. H., and Miser, H. D., U. S. Geol. Survey Geol. Atlas, Hot Springs special folio (in preparation).

Shasta County. The other two properties are in Alameda County and are operated by the Leona Chemical Co. and the Stauffer Chemical Co. The mine of the Leona Chemical Co. was closed for more than four months owing to a fire, which was reported to be under control before the end of the year.

At the mine of the Mountain Copper Co. the ore occurs in a great lens 600 to 700 feet long and 50 to 200 feet wide that has been opened to a depth of 100 to 400 feet. The ore averages about 48 per cent sulphur and carries a little copper and zinc. The country rock in which the ore bed occurs is a light-colored granitic rock. At the deposits in Alameda County the country rock is a rhyolite containing locally a good deal of pyrites, which is supposed to have been leached from the upper part of the rhyolite and subsequently reprecipitated.

In addition to the deposits actually being mined many other pyrites deposits have been worked in the past, as for instance in Placer, Sierra, Nevada, and Plumas counties. In fact, California is so well provided with deposits capable of yielding a large output of sulphide ore that under pressure it could probably produce as much pyrites as is now marketed by all the rest of the country. The State, however, is so remote from the places where pyrites is at present most needed that these nonproducing deposits may be regarded as reserves not available under existing conditions. It seems unnecessary therefore to give further notes regarding the pyrites deposits of California in this report.

COLORADO.

Detailed statistics regarding the production of pyrites in Colorado had not been received by the Geological Survey in time for inclusion in this report. It is well known, however, that some pyrites is mined each year in this State—in fact, during 1916, according to C. W. Henderson,[1] 17,445 tons of pyritic ore was shipped from Leadville, for the manufacture of sulphuric acid. Some of the sulphur from the zinc and lead bearing sulphide ores from the mine of the Empire Zinc Co., at Red Cliff, Colo., was recovered at the plant of the Western Chemical Manufacturing Co., which is connected with the smelter at Denver. Like California, however, Colorado has vast reserves of pyrites that could be used if a market were available or if the demand should become so great that pyrites must be obtained regardless of cost. Colorado, however, lies so much nearer the markets for pyrites than California or the other States of the Pacific coast or the Great Basin region that it would not be surprising if in 1918 considerable quantities of its pyrites were used.

As an indication of the number of places at which pyrites might be obtained the following list prepared by J. M. Hill, of the Geological Survey, is significant, for it covers only the area of the Central City quadrangle, which comprises parts of Gilpin, Clear Creek, and Boulder counties, and it includes only the mines which are so situated that they could begin producing pyrites within a few weeks or possibly a few days.

In area tributary to Idaho Springs:

Belman vein, Big Five tunnel, 20 feet wide; 25 to 50 per cent of vein is pyrites.

Gem vein, Argo tunnel, 2 to 52 feet wide; in places pyrites forms solid mass 2 feet wide.

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[1] U. S. Geol. Survey Mineral Resources, 1916, pt. 1, p. 364, 1917.

- *Tropic tunnel*, 1 mile north of Idaho Springs; 20-foot vein of pyritic ore carrying 25 per cent pyrites.
- *East Lake vein*, 2 miles north of Idaho Springs; several bodies 6 feet wide of ore carrying 50 per cent pyrites.
- *Rockford tunnel*, 2½ miles west of Idaho Springs; many bodies of coarse pyritic ore, some 3 feet wide.
- *Donaldson-Champion district vein*, numerous bodies, some 3 feet wide, of coarse pyrites ore.

In area tributary to Blackhawk and Central City:

- *Mammoth vein*, long vein owned by several companies; contains large bodies of rock heavily impregnated with pyrites; in places 3 feet of solid pyrites.
- *National vein*, half a mile south of Central City; 6 feet of pyritic material containing large bodies of nearly solid pyrites.
- *Concrete-Grand Army-Gunnell vein*, opened by at least four shafts; about 20 feet of pyritic material requiring concentration of 4 to 1 to give a marketable product.
- *Saratoga vein*, 2 miles south of Central City; 5 to 20 feet of highly pyritic material and some veins of coarse pyrites.
- *Old Town vein*, 2½ miles southwest of Central City; 4 to 10 feet of highly pyritic granite gneiss and smaller veins of solid pyrites.
- *Becky Sharp-Pewabic and Iron veins*, 3 miles southwest of Central City; 3 to 10 feet of granitic gneiss heavily impregnated with pyrites and containing some veins of solid pyrites.
- *Mines north of Quartz Hill*, three-quarters of a mile southwest of Central City; veins are highly pyritic, and large bodies of country rock between the veins contain large quantities of pyrites.

Probably as imposing a list could be prepared of the mines from which pyrites might be obtained in the Leadville district and in other parts of the Front Range of the Rocky Mountains, as, for instance, at Red Cliff or in the San Juan country, where, in the Rico district, Ransome reports at the Princeton mine large lenticular masses of crumbling granular pyrites, one of which was at least 40 feet thick.

In the past a little pyrite has been collected in Colorado and sold as jewelry to tourists. The quantity thus used is negligible, and apparently none was provided for this purpose in 1917.

CONNECTICUT.

Pyrites deposits of sufficient purity to be mined have not been found in Connecticut. Pyrrhotite occurs at Prospect Hill, near Bradleyville, in the western part of Litchfield County, but the ore is not clean nor abundant enough to encourage commercial investigation. A deposit of limonite that possibly may represent a gossan formed by the weathering of a body of pyrites has been reported near South Kent, Litchfield County, in the extreme western part of the State, but no details regarding it are known.

DELAWARE AND FLORIDA.

No commercial deposits of pyrites have been discovered in Delaware or Florida, and the general geologic conditions and history of these States make it highly improbable that any workable deposits of this material occur in them.

GEORGIA.

By S. W. McCallie.

All the pyrites deposits of probable commercial value in Georgia have been examined by the geologists of the Georgia State Survey, and a more complete statement regarding the results of these investigations is given in a report[1] prepared by the State Survey, copies of which may be obtained from the State geologist, Atlanta, Ga.

Five companies reported having mined pyrites in Georgia in 1917; their total production was 23,242 long tons, of which about one-fourth was lump ore. The companies reporting production were the Standard Pyrites Co., Georgia Mining Co., Shirley Mining Co., Sulphur Mining & Railroad Co., and Marietta Mining Co. Small shipments were made in 1917 also by the Chestatee Pyrites & Chemical Co., the Arizona & Georgia Development Co., and the Southern Pyrites Ore Co. The Chestatee Pyrites & Chemical Co. shipped lump ore mined incidentally to development work at the Chestatee mine. The Arizona & Georgia Development Co. shipped high-grade concentrates obtained by working the old stock piles at the Tallapoosa or Waldrop copper mine. Late in the year the Southern Pyrites Ore Co. installed a plant and started reworking the tailings dump at the Sulphur Mining & Railroad Co.'s property. These companies are expected to become important producers in 1918.

The Standard Pyrites Co.'s mine is in Cherokee County, 7 miles southeast of Ball Ground, on the Louisville & Nashville Railroad. The deposit consists of two workable shoots in a continuous vein, 130 and 200 feet long, with maximum thicknesses of 11 and 5 feet, respectively, developed to a depth of 400 feet on the incline. The ore is loosely granular pyrites, not suitable for lump burners; however, it is all concentrated, although a concentration ratio of about 4 to 3 produces concentrates containing 45 per cent sulphur. The ore contains no copper, zinc, or arsenic. The deposit probably persists to a considerable depth, but on account of the small horizontal extent the rate of working is limited, and no great increase in production can be expected. However, on the 6,800 acres of land owned by the company there are indications of other deposits of pyrites, some of which will undoubtedly be workable.

The Little Bob and Shirley mines, operated by the Georgia Mining Co. and the Shirley Mining Co., respectively, but under the same management, are in Paulding County, at the intersection of the Southern and the Seaboard Air Line railways between Hiram and Dallas. The Shirley mine, although it has shipped some ore, is still in the development stage. A thickness of 12 feet of concentrating ore has been found. The Little Bob deposit is a vein or shoot of rich pyrites ore which has been worked for a length of 450 feet without reaching the limits of the deposit. The workings extend to a depth of 240 feet on the incline, and the maximum thickness of ore is 30 feet. Almost half the ore is shipped as lump, and the remainder requires only 4 to 3 concentration to produce concentrates carrying 38 per cent sulphur. Copper and zinc are irregularly distributed through the ore body, running higher in the lump ore than in the concentrates, but each probably makes up only a fraction of 1 per cent of the average ore. Arsenic is absent. The production of the Little Bob and Shirley mines could be quickly and greatly increased. The mines were closed for two months in 1917 on account of shortage of fuel and cars, and in the early months of 1918 the production was only about one-fifth of the capacity of the plants already installed, solely on account of inability to procure labor.

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[1] Shearer, H. K., and Hull, J. P. D., A preliminary report on the pyrite deposits of Georgia: Georgia Geol. Survey Bull. 33, 1918.

The mine of the Sulphur Mining & Railroad Co., a subsidiary of the Virginia-Carolina Chemical Co., is in Douglas County, 3 miles northeast of Villa Rica, and is connected with the Southern Railway by a railroad spur. After an active life of nearly 20 years the mine was closed in July, 1917. The reason for closing was not stated, but the equipment was previously allowed to deteriorate and is in need of extensive repairs. The deposit has a thickness of 4 to 25 feet and has been worked for a length of 700 feet and to a depth of 500 feet without reaching the limits. It is on a pyrites "lead" which has been traced for several miles along the strike by gossan showings and prospecting pits. The average grade of the ore is high. Some lump ore was shipped, but most of it was concentrated, although the ratio of concentration is said to have been only 5 to 4. However, the ore contains considerable magnetite and pyrrhotite, which prevented concentrates with more than 40 per cent sulphur being made. Copper, zinc, and arsenic are not present except as traces. On account of the inefficient operation of the old plant a great deal of sulphur ore went into the tailings, and is recoverable by reworking.

The Marietta Mining Co.'s mine is in Cobb County, 3 miles southwest of Marietta. The deposit ranges from 1 to 8 feet in thickness and has been worked for a length of 200 feet underground, with an extension of 400 feet more indicated by surface showings. The depth of the shaft is 360 feet on the incline. The ore is mostly of rather low grade, requiring concentration of 3 or 4 to 1, but it consists of granular pyrites with a schistose gangue of quartz and mica, is easy to crush, and produces clean concentrates. Copper and arsenic are absent. The mine was practically closed for six months on account of lack of fuel, but early in 1918 connection was made with the power line of the Georgia Railway & Power Co., and the plant will be ready to operate at full capacity as soon as electric machinery is installed. The Marietta Mining Co. is also developing the Jenny Stone prospect near Villa Rica, Carroll County.

The most extensive development under way in Georgia at the end of 1917 was that of the Chestatee Pyrites & Chemical Co. The mine is in Lumpkin County, on Chestatee River 6 miles east of Dahlonega. A power plant developing 1,000 horsepower had been installed on Chestatee River, and 10 miles of railroad to connect with the Gainesville & Northwestern at Clermont was under construction. The outcrop of the ore body is a ledge of gossan extending almost continuously for 2,000 feet southwest of the river, and fragments of float gossan indicate an extent of 5,800 feet. The workings were a tunnel extending 1,100 feet along the vein and an inclined shaft 190 feet deep, besides a small amount of drifting and stoping. The thickness of the vein in the explored portion ranges from 4½ to 40 feet. The ore is in part of lump grade and in part requires concentration. The shipments in 1917 consisted only of lump ore encountered in driving the tunnel. They contained 40 to 45 per cent of sulphur, 1.60 to 1.68 per cent of copper, and a fraction of 1 per cent of zinc, but no arsenic. The ore minerals are pyrite and chalcopyrite, and the gangue is chiefly quartz, sericite, and garnet. It is expected that after the concentrating plant is completed and put into operation this will rank as one of the large mines of the country.

The Arizona & Georgia Development Co. has leased from the Georgia Pyrites Co. the Tallapoosa or Waldrop copper mine, 3 miles northwest of Draketown, Haralson County, and 9 miles from Morgan or 48-Siding, on the Southern Railway. From 1880 to 1885 this mine produced for shipment about 7,500 tons of lump ore containing 3.25 per cent copper and 43 per cent sulphur, besides about 7,500 tons of concentrating ore, which was stacked near the mine. In 1917 the Arizona & Georgia Development Co. put up a concentrating plant and shipped a few hundred tons of high-grade concentrates (nearly 50 per cent sulphur) obtained from the old dump, but capital has not been raised for continuing underground work extensively, and labor will also present great difficulty. The ore body has been explored to a depth of 283 feet on the dip and for a length of 300 feet underground. The thickness of lump ore ranges from 1½ to 12 feet, and there is a greater unknown thickness of good concentrating ore. The deposit seems to be not a well-defined vein but made up of more or less lenslike parallel masses. The gossan outcrop of the deposit has been traced by shallow pits and trenches for 1,100 feet along the strike. The ore body contains irregular masses of magnesian limestone and is evidently a replacement deposit.

The Southern Pyrites Ore Co. in 1917 began reworking the tailings dump at the Sulphur Mining & Railroad Co.'s mine. The dump is estimated to contain 100,000 tons of ore which has an average of 15 per cent sulphur. By recrushing and 3 to 1 concentration the grade is brought up to 34 or 35 per cent sulphur, it being impossible to secure greater concentration on account of the large proportion of pyrrhotite, magnetite, and garnet in the ore. This company is also about to begin mining the Reeds Mountain deposit, on the line of Haralson and Carroll counties, on the Central of Georgia Railway, 2 miles south of Bremen. This is a large deposit of concentrating ore, from which about 4,000 tons of pyrites concentrates were shipped between 1910 and 1914. Surface indications of gossan extend 2,400 feet along the strike, and for at least a part of that distance there are three parallel veins, each averaging 10 feet thick. The ore is granular and schistose pyrite, quartz ,and chlorite, requiring about 3 to 1 concentration, but the texture makes working and concentration easy. The concentrates are pure pyrite, free from copper, arsenic, zinc, lead, and bismuth. Machinery for the concentrating plant has been ordered, and the production in 1918 depends largely on the supply of labor.

The No. 20 Copper Mining Co. in 1917 operated mine No. 20, in Fannin County, 3 miles southwest of Copperhill, Tenn. This is classed as a copper rather than a sulphur mine, but the ore is smelted at the smelter of the Tennessee Copper Co., and the fumes are used in the manufacture of sulphuric acid. The mine produced a larger quantity of ore during the year than any other mine in Georgia. The ore body ranges from 3 to 40 feet in thickness, has been worked underground to a depth of 175 feet and for a length of 550 feet, and has been explored for 1,000 feet by test pits and diamond drilling. The deposit is of the Ducktown type—that is, it has been formed by the replacement of limestone—and the ore minerals are chiefly pyrrhotite and chalcopyrite. The ore is said to contain 1.50 to 2.20 per cent of copper and 12 to 20 per cent of sulphur. The production of mine No. 20 could be increased quickly but is limited by the capacity of the Copperhill smelters and acid plants to use the ore, as the smelters belong to other companies which have ample ore reserves of their own.

Other deposits which have been worked in the past, or rather extensively explored and which may again become producers, are the Bell-Starr mine, 4 miles west of Woodstock, Cherokee County; the Swift or Blake mine, at Creighton, Cherokee County; the Canton or Rich copper mine, Cherokee County; the Swift or McClarity prospect, near Draketown, Paulding County; and the Mammoth Mining Co. prospect, near Hiram, Paulding County. Of these, the Bell-Star is on a large deposit of ore from which about 8,000 tons was shipped prior to 1908. All the ore requires 3 or 4 to 1 concentration, and the mine is handicapped by its distance from a railroad. Kennesaw, the most accessible shipping point, is 7 miles distant by road. The Swift mine, at Creighton, is adjacent to the Standard Pyrites Co.'s property, and the deposits are of similar type. There is an inclined shaft 287 feet deep, with drifts 780 feet along the vein, and about 40,000 tons of high-grade pyrites ore is actually blocked out. The Canton mine was worked for copper before the Civil War, and the ore contains also small quantities of lead, zinc, and arsenic. The Swift prospect, in Paulding County, was explored by diamond drilling in 1906, and one car of lump ore and four of concentrates were shipped. The Mammoth Mining Co. was engaged in 1917 in prospecting the continuation of the deposit from the Little Bob mine.

Besides the properties mentioned above there are a great many other prospects too small, of too low grade, or too little known to warrant definite statements, and also a few very promising prospects, such as the Berrong prospects, in Towns and Rabun counties, which are too inaccessible to have any probable value at the present time.

In general, deposits of pyrites in Georgia may be found anywhere in the areas of crystalline and semicrystalline or metamorphosed Paleozoic rocks, but the known productive deposits occur in a belt about 20 miles wide extending across the State, from Carroll and Haralson counties, on the western boundary, to Towns and Rabun counties, in the northeast corner, and in the extension of the Ducktown belt of Tennessee into Fannin County. There are two principal types of deposits. Those of one type are the result of the replacement of limestone by pyrite, pyrrhotite, and chalcopyrite, and include the mines of the Ducktown belt and probably the Canton and Tallapoosa mines. The deposits of the other type are fissure veins, subsequently metamorphosed, of pyrites, which may or may not carry copper. They generally occur in the belts of hornblende gneiss and schist, close to the margin of large masses of granite gneiss, and are associated with the Georgia gold veins.

There is good reason for believing that during 1918 the production of Georgia pyrites can be increased to nearly ten times the rate in 1917, provided a little additional capital and a supply of labor can be obtained. The labor supply presents greatest difficulties.

IDAHO.

No pyrites is mined in Idaho for its sulphur content. Like many of the other Rocky Mountain States, Idaho possesses large deposits of pyritic ore, but they are so far from market that the high cost of transportation will probably continue to prohibit their use in the near future. It should be noted, however, that some of the zinc sulphide ores of the State are transported to smelters in the Central States, and that some of the sulphur contained in them is utilized in the manufacture of sulphuric acid.

The pyritic deposits of Idaho, as well as those of some of the other Northwestern States where timber is abundant, might be used to some extent in near-by areas to furnish the sulphur gases required in the paper industry.

ILLINOIS.

Ten companies in Illinois report having mined in 1917 about 25,000 long tons of pyrites, of which three-fourths is lump ore. The larger part of the production comes from Vermilion County, in the extreme eastern part of the State, but some was also reported from Madison County, in the southwestern part of the State. All the pyrites is recovered in coal-mining operations. The following are the companies reporting their production for 1917 to the Geological Survey: Missionfield Coal Co., Carbon Hill Coal Co., Contract Mining Co., Taylor English Coal Co., Central Coal Co., Spangler & Hume, W. J. Watkins, J. W. Mauck & Sons, and Western Coal Co., all in Vermilion County, and the Madison Coal Co., in Madison County.

There are many other places in Illinois where pyrites could be recovered in the mining of coal, and two important papers dealing with the subject have recently been issued. One of these treats the general pyrites situation broadly and points out that "if pyrites be recovered from all mines in Illinois in which it may be produced at a profit, the output of the State will be raised to a significant figure, a paying side industry will become permanently attached to the mining of coal, and much-needed assistance will be rendered the United States in the present military emergency."[1] The other report deals with the commercial aspects of the pyrites industry.[2]

INDIANA.

For a number of years several of the coal mines in Indiana have together produced a few thousand tons of pyrites, but during 1917 the output was practically negligible and was furnished by only two producers, the Sugar Valley Coal Co. and Isaac Craft, both in Vigo County, in the extreme western part of the State. The general conditions of the pyrites industry in Indiana are much the same as those in Illinois already described, and doubtless a much greater production could be obtained if the value of the pyrites or "coal brasses" were more widely recognized by acid makers.

As a specific example of the places where more pyrites might be obtained in the State, G. H. Ashley has submitted the following note:

> In all the mines working coal No. 3 in southeastern Parke County the coal carries thin bands of bright bronze-colored pyrites that can be readily freed from the coal. Again nearly all the mines in Indiana and Illinois working coal

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[1] Pogue, J. E., The pyrite situation with special reference to coal mining in Illinois, 4 pp., Illinois State Geol. Survey, October, 1917.

[2] Holbrook, E. A., The utilization of pyrite occurring in Illinois bituminous coal, Illinois Univ. Engineering Exper. Sta., Aug. 20, 1917.

No. 5 find in the roof of that coal a greater or less number of so-called "niggerheads" consisting of pyrite or marcasite. In some of the mines these occur in masses several feet in diameter and in places are so abundant that the roof after the removal of the coal has a wavy or botryoidal appearance.

IOWA.

No commercial deposits of pyrites are known in Iowa, and except in the northeastern part of the State geologic relations do not indicate the probability of deposits. Even in the northeastern section the likelihood of any considerable deposit being developed is regarded as little more than possible.

KANSAS.

Deposits that appear capable of yielding pyrites in commercial quantities are not known and probably do not occur in Kansas.

KENTUCKY.

Only one mine reported production of pyrites in Kentucky in 1917. This was the property of the Stearns Coal & Lumber Co., near Stearns, in McCreary County, and the pyrites was obtained in connection with the mining of coal. Although more pyrites could probably be obtained from deposits in Kentucky than is represented by the production from this one mine, the only source in the State from which such pyrites will be obtained in commercial quantities is believed to be the coal-bearing rocks.

LOUISIANA.

No deposits of pyrites have been discovered in Louisiana, and its general geologic conditions and history make it highly improbable that any workable deposits of this material occur in the State.

MAINE.

No deposits of pyrites in Maine have been mined for their sulphur content. According to Emmons[1] the pyritiferous copper deposits near Blue Hill could probably be successfully worked, and the ores or concentrates from them would be rich in sulphur and could without doubt be sold to acid works. If the paper mills of New England should adopt the practice followed in some European plants they could possibly make their sulphur dioxide gas advantageously from this local material. The lodes near Blue Hill are reported to be from 5 to 20 feet wide and to persist along the strike for several hundred feet. The center of the veins is usually massive pyrites, but at the margins the pyrites grades into the country rock.

The deposit near Katahdin Iron Works, in Piscataquis County, which was mined for nearly 50 years for its iron content, has been shown to be a gossan overlying an enormous body of pyrrhotite. This deposit was examined by E. S. Bastin, of the Geological Sur-

[1] Emmons, W. H., Some ore deposits in Maine and the Milan mine, N. H.: U. S. Geol. Survey Bull. 432, p. 16, 1910.

vey, from whose statement the following general notes concerning the property have been made:[1]

The present indications show that this deposit has a length of at least 2,300 feet and a width varying from 300 to 700 feet. If the average width is taken as only 400 feet the deposit contains 100,000 long tons of ore for every foot in depth. Several analyses of the ore show that it contains from 26 to 35 per cent sulphur, 0.006 to 0.009 per cent phosphorus, 0.0008 per cent arsenious oxide, and 0.1 per cent nickel. The cost of mining and laying the material down in New York at prevailing prices is estimated to be about $4 a ton, which for ore carrying 30 per cent sulphur would be equivalent to 13.3 cents per unit of sulphur. As a source of sulphur for the manufacture of acid, this deposit appears worthy of most careful consideration. The value of the ore does not consist only of its sulphur content, and the fact should not be lost sight of that the residue or cinder after the sulphur has been extracted is also valuable as an ore of iron.

MARYLAND.

The deposits of Maryland that are known to contain considerable pyrites occur in clays in which the pyrite is in disseminated masses and in veins that have been mined for copper. On Magothy River, between Annapolis and Baltimore, considerable pyrite occurs in the sands and clays. As early as 1821 this material near Sable Point was used for the manufacture of copperas, alum, and possibly sulphuric acid, and this was probably the first place in the United States where these chemicals were produced. These deposits, however, are too small to be of commercial importance at the present time.

The copper-bearing rocks occur in three belts; one extends from New London in Frederick County northeastward to Union Bridge, another extends from Skyesville through Carroll County to and beyond Finksburg, and another is in the Bare Hills, north of Baltimore. None of these deposits appear to hold out much promise of yielding pyrites in commercial quantities, unless it is produced mainly as a by-product.

Although none of the known sulphide deposits seem to be worthy of much further investigation at this time, some of the old iron deposits may prove to be gossans lying above minable deposits of pyrites. It is believed that their investigation with the drill might lead to disclosing valuable bodies of pyritic ore. The only deposits of this kind, so far as can be judged from the published descriptions, are those at the old iron mines near Midway Station and near Unionville. The iron mines northeast of Frederick and the large body of iron ore that crosses the Potomac at Point of Rocks are, according to A. C. Spencer, apparently not gossans.

MASSACHUSETTS.

For many years the Davis mine, in Franklin County, in the northwestern part of Massachusetts, produced pyrites, but it has not been in operation since 1911. The deposit consisted of a great lens of pyrites 6 to 24 feet thick, about 600 feet long, and about 1,000 feet deep. The lens occurs between a sericite schist on the west and a chloritic schist on the east. No recent examination of the deposit has been possible because the mine has caved, but it is understood that the ore body has been worked out. Even if this ore body is exhausted, it seems possible that there may be others in the vicinity.

[1] Large pyrrhotite deposits in Maine: Eng. and Min. Jour., vol. 104, pp. 758–759.

A. C. Spencer, who visited the region in October, 1917, reported that the possibility of finding new ore bodies seemed to be better by prospecting in the direction of the dip rather than along the strike. It is commonly reported that prospecting in the neighborhood of the old mine is soon to be undertaken.

One mile west of Charlemont, in Franklin County, at the mine formerly known as the Hawkes or the Mount Parke mine, the Charlemont Pyrite Co. is carrying on development work and expects to be producing ore before the close of 1918. Another deposit that has been partly opened is about 2 miles west of the Davis mine. The ore, which would require concentrating to make a salable product, is scattered through 15 to 20 feet of schist and has been exposed by stripping and crosscutting for a distance of 700 feet. At Windsor Bush, in the northeast corner of Hampshire County, 11 miles southwest of Charlemont, a vein of pyrites was reported which was said to be 17 feet wide and to have been opened by a shaft 100 feet deep.

Deposits of pyrites that may warrant further exploration occur in other parts of Massachusetts. For instance, W. C. Phalen reported a prospect 2½ miles northwest of Stockbridge, in Berkshire County, which formerly shipped ore to sulphuric acid plants in New Jersey and at Troy, N. Y. A. C. Spencer reported a pyrrhotite zone, which apparently extends from a point 1 mile southeast of East Templeton, in Worcester County, southward for a distance of nearly 3 miles into Hubbardston. Ore from this zone was formerly used for making copperas. The material seen by Spencer seems to be of too low grade to consider as a source of sulphur, though further prospecting in the neighborhood may be justified if acid makers are willing to use some pyrrhotite.

MICHIGAN.

No pyrites has been mined in Michigan, and from what is known regarding the geology of the State it seems improbable that pyrites will be produced except as a by-product of coal mining. The main coal-bearing area is the country in the vicinity of and southwest of Saginaw Bay.

MINNESOTA.

Practically nothing is known regarding the occurrence of pyritic ore in Minnesota. A report has been received that a considerable body of pyrites has been discovered in a greenstone formation about 25 miles east of Baudette and a short distance south of the international boundary. No details concerning the prospect are available and no development work has been begun except a shaft 24 feet deep, which is said to be in ore practically all the way from the top to the bottom. Inasmuch as considerable areas in northern Minnesota are greenstone rock, which in near-by parts of Canada in places contain workable deposits of pyrites, there is reason to believe that large bodies of pyrites may be discovered and that possibly it may be practicable to mine them. The probability now seems remote, however, that any volume of pyrites will be obtained from this region in the near future.

MISSISSIPPI.

In many parts of Mississippi nodular masses or concretions of pyrites (mainly marcasite) occur in the rather recent slightly consolidated deposits. At most places the pyrites forms so small a part of the deposit that it has no value as a source of sulphur. E. N. Lowe, the State geologist of Mississippi, has pointed out,[1] however, that at apparently three places in the State the deposits seem to warrant a more thorough examination. These three places are near Leakesville, on Pascagoula River, in Greene County; at Mineral Bluff, on Cole Creek, 12 miles west of Fayette, in Jefferson County; and at Broughton Plantation, 1½ miles upstream from Mineral Bluff. At the last locality the sandstone which forms the country rock is intensely black, because for a thickness of several feet it is so heavily impregnated with marcasite.

MISSOURI.

Two operators in Missouri reported a production of pyrites in 1917. These were the Empire Carbon Works, in Crawford County, and the Commercial Acid Co., in Franklin County, both in the east-central part of the State. During part of the year the mine of the Commercial Acid Co. was on fire, and consequently production from it was practically suspended for more than nine months. In the past the Buckland mine, 3 miles west of Rolla, operated by the Rolla Mining Co., produced considerable pyrites, but the mine is now said to be worked out. A small output has also been made in past years from the pyrites saved in coal mining. Development of pyrites deposits, especially in Madison County, in the southeastern part of the State, has been undertaken during the last year. In this region the ore bodies are flat-lying and those that are being opened lie so near the surface that possibly they can be mined by open-cut or surface methods which would make the cost of mining low.

Many of the limonitic iron ore deposits afford a promising field of search for pyrites. These deposits occur most commonly in the southeastern and central parts of the State and are locally known as sink deposits. Some of these iron deposits appear to be the oxidized surface portions of pyritic bodies. The Missouri Geological Survey is planning to investigate these deposits during the field season of 1918. Until the results of this work are published, the searcher for deposits of pyrites in Missouri will find much helpful information in the report on the iron ores of the State.[2] Copies of this report can no longer be obtained from the State Survey but may be consulted in the larger libraries. The map which accompanies the volume and which shows the location of the iron deposits will be republished and can be obtained from the State geologist, H. A. Buehler, Rolla, Mo. On this map nearly 500 limonitic iron-ore deposits are indicated. Although many of the deposits represented doubtless are not the oxidized portions of pyritic ore bodies, the evidence obtained by drilling shows that some of them are worth careful investigation.

In pointing out the places where pyrites has been produced in the State, it should be remembered that Missouri produces also a large quantity of zinc ore, from which sulphur for the manufacture of acid is obtained. An increase in the use of ore of this kind for its content

[1] Unpublished letter, Jan. 11, 1918.

[2] Nason, F. L., Report on iron ores: Missouri Geol. Survey, vol. 2, 366 pp. 1892.

of sulphur seems desirable. This could be accomplished, even if the quantity of this ore mined and treated should remain the same as in the past, by a more complete recovery of the sulphur in the smelter fumes.

MONTANA.

No ore is mined in Montana for its sulphur content alone. This State, however, is one of the world's greatest producers of sulphides of the base metals, and some of the sulphur-bearing gases from these ores are utilized for making acid at plants connected with the copper or zinc smelters. A much greater proportion of the sulphur content might be recovered if more extensive and better equipment were used. These ores form an important source from which the production of sulphuric acid in the country could be materially increased. Their distance from the centers where much acid is now used, however, makes it uncertain whether a great increase in the production of acid would be profitable under existing conditions.

NEBRASKA.

No pyrites has been mined in Nebraska, and it seems improbable that deposits which can be profitably developed occur within the State.

NEVADA.

Nevada is another of the States in which are enormous reserves of pyrites that under prevailing conditions can not be profitably utilized to meet the great demand for material for the manufacture of sulphuric acid needed in the States east of Mississippi River. Practically no local market exists in Nevada for any considerable quantity of acid. Some of the suphur in the sulphide ores of the State that are now use for their metallic content could be recovered at local smelters, but the expense of transporting the resulting acid to the East would probably be prohibitive unless a more serious shortage is experienced than is now anticipated.

NEW HAMPSHIRE.

In Coos County, N. H., is the Milan deposit, which is now idle. The ore from this property was for many years shipped to acid works and its copper content was recovered from the resulting cinder. The deposit consists of overlapping lenses of pyrites, parallel to the schistosity of the country rock. Two ore bodies have been mined, one 5 to 25 feet thick and the other about 15 feet thick, and each has been traced for a length of at least 250 feet. Much of the ore was solid pyrite, analyses of which show a content of more than 40 per cent of sulphur. So far as can be ascertained it does not seem probable that this mine could furnish pyrites in the near future. There is, however, a possibility that other deposits occur in the neighborhood.

A number of other deposits have been reported in New Hampshire, and during the fall of 1917 they were visited by A. C. Spencer. None of them, however, seem to afford indications of being worth further investigation as sources of pyritic ore with the possible exception of the old Neal mine at Unity, about 4 miles east of Charleston. The ore as exposed in an old shaft of this mine occurs in a distinct vein about 5 feet wide. The vein trends about north and its course as indicated by scattered outcrops of rusty rock has been traced for a distance of about 1,200 feet.

NEW JERSEY.

In 1904 a small output of pyrites was reported from New Jersey, but none since that time. The most promising source of pyritic material seems to be in the vicinity of some of the old iron mines. Although further investigation and possibly exploration by drilling would be necessary for definite information, there are indications that some of the iron deposits are really gossans overlying veins of pyrites. Among the deposits that may be of this kind are the Hackelbarney iron mine, near Highbridge; the Sulphur Hill mine, near Andover; the Silver iron mine, near Vernon; and the Pochuck mine, near McAfee.

At the Hackelbarney mine the ore is extremely pyritic in the part exposed, which suggests that it is even more pyritic in depth. The gneiss at the Silver iron mine is highly pyritiferous and in places has been described as a "veritable sulphur deposit."[1]

The Pochuck deposit has been examined in some detail by A. C. Spencer, who suggests that it has been formed by the decomposition of a deposit of pyrites. If this explanation is correct the iron ore should grade into pyrites at about the level of ground water and the pyrites should probably continue to a considerable depth.[2] Doubtless, however, many of the iron deposits of New Jersey have not been formed through the oxidation of sulphide deposits, and anyone undertaking their investigation should realize that expense will be necessary and that the results are by no means assured.

In some of the unconsolidated deposits on the shores of Raritan Bay, between South Amboy and Keyport, nodules of pyrites are reported to be abundant. The nodules washed from the cliff by the sea accumulate on the beach and might furnish a very small amount of material for local use.

NEW MEXICO.

No deposits are being mined for their pyrites content in New Mexico. Like many other parts of the West, the State is too remote to tempt exploitation of deposits of this mineral for consumption in the East. There are, however, large reserves of pyrites, and doubtless some of the sulphur in the ores that are smelted for their metals might be profitably utilized if the need should become pressing.

NEW YORK.

New York ranked third among the States in the quantity and second in the value of pyrites produced in 1917. All the ore was obtained in St. Lawrence County and came from the mines of the St.

[1] Cook, G. H., Geology of New Jersey, p. 621, Newark, 1868.
[2] Spencer, A. C., U. S. Geol. Survey Geol. Atlas, Franklin Furnace folio (No. 161), p. 23, 1908.

Lawrence Pyrites Co. and the Northern Ore Co. The geology and general features of these deposits as well as of many scattered prospects both in St. Lawrence and Jefferson counties have recently been described in reports by Buddington and by Newland.[1] These reports give such complete information that repetition of the facts they set forth seems unnecessary, and the reports themselves should be consulted for information about the region. It may be appropriate, however, to quote from the introductory letter of transmittal of Buddington's report by Prof. J. M. Clarke, State geologist of New York, the following:

This resurvey and report indicate that this State carries large natural supplies of pyrite and that the present production is far below possible production under favorable market conditions.

In regard to the possible increase in the pyrites industry in northern New York, Newland[2] says: "An output of 250,000 tons of concentrates a year would seem to be within the range of the natural resources of the district." According to Newland, also, the pyrites could probably be produced at a cost of about $4.50 a ton.

Several other deposits of pyrites have been reported at other places in the State. Of these probably the most widely known is the old Phillips mine, near Peekskill. The ore at this mine was pyrrhotite, which occurred in a lens extending 100 feet along the strike, 300 to 400 feet in depth, and in places 50 feet across. For a time the ore was used at a local sulphuric acid plant, and it is reported to have been especially sought because of its freedom from arsenic. Probably the known lens has been mined out, but other bodies may occur in the vicinity, which would be disclosed by careful search perhaps supplemented by a local magnetic survey.

NORTH CAROLINA.

No pyrites was produced in North Carolina in 1917, but several properties were being opened and at least one will probably produce pyrites in 1918. All the known deposits of pyrites were visited during August and September by C. S. Ross, of the United States Geological Survey, who conducted the work in cooperation with the North Carolina Geological and Natural History Survey. A summary statement of the results of Mr. Ross's investigations supplemented by a careful consideration of the information obtained from all other sources is given below.

The Carolina Pyrite Co. is actively developing the old mine formerly known as the Oliver pyrite mine or the Crouse mine. This is situated about 4½ miles southeast of Crouse on the Seaboard Air Line Railway in the northeastern part of Gaston County. The vein on this property has been traced on the surface for 2½ miles and opened at intervals by shallow pits or trenches through half this distance. The ore has a thickness ranging from 3½ to 7½ feet. An analysis in the laboratory of the Geological Survey of a representative sample collected by Mr. Ross shows the following results: Sulphur, 46.49;

[1] Buddington, A. F., Pyrite and pyrrhotite veins in Jefferson and St. Lawrence counties, N. Y.: New York State Defense Council Bull. 1, 40 pp., Albany, 1917. Newland, D. H., Zinc-pyrite deposits of the Edwards district (St. Lawrence county), N. Y.: New York State Defense Council, Bull. 2, 72 pp., Albany, 1917.

[2] Newland, D. H., Pyrite in northern New York: Eng. and Min. Jour., vol. 104, pp. 947–948, 1917.

iron, 39.92; copper, 1.38; zinc, 2.30; lead, 0.30; arsenic, trace; insoluble, 6.59. From 75,000 to 100,000 tons of ore of this quality has been blocked out.

At the Macon pyrites mine, also known as the Cabe pyrites mine, development work is actively being pushed, and it is expected that the mine may begin producing ore early in 1918. The mine is 1½ miles southeast of Otto, in Macon County, on the Tallulah Falls Railroad. The ore is a massive pyrrhotite with considerable pyrite and chalcopyrite. An analysis in the laboratory of the Geological Survey of a sample of the ore collected by Mr. Ross gave the following results: Sulphur, 33.29; iron, 45.67; zinc, 1.14; lead, 0.26; copper, 0.21; arsenic, trace; insoluble, 4.38. Eastward from the mine a very strong gossan deposit can be traced for nearly 2 miles.

The Ore Knob mine is in Ashe County, about 11 miles in an air line from the nearest railroad, which is at West Jefferson. The ore body at this mine is from 8 to 16 feet wide and is said to have been prospected for a distance of 2,800 feet and to a depth of 400 feet, and much good ore is reported in sight. The sulphides are mainly pyrrhotite and chalcopyrite which range in relative proportion from 3:1 to 10:1. Assays of samples taken by the company show also from 0.71 to 1. 08 per cent nickel, 0.09 per cent cobalt, and 0.75 per cent zinc. It does not seem probable that this ore can be successfully developed for its sulphur content alone.

Three miles south of Kings Mountain, in Cleveland County, are the so-called Yellow Ridge iron mines, which were worked during the Civil War for iron. The iron oxide gives place in depth to pyrite. From the trend of these deposits there is a strong suggestion that the iron deposit may be in the same general pyritic zone as the Caroline Pyrite Co.'s mine near Crouse.

The Elk Knob Copper mine is on the north slope of Elk Knob, 5 miles north of Elkland, in the northern part of Watauga County. The mineralized zone is about 6 feet wide and is composed of bands of ore consisting mainly of pyrrhotite, pyrite, and chalcopyrite, which alternate with bands of amphibolite. With better transportation facilities the deposit might be worthy of further investigation, but not unless its copper content is also considered.

Three other deposits of pyrites have been reported, but the information regarding them is too meager to permit stating whether or not they appear promising. These are the Ore Gap deposit, 18 miles northeast of North Wilkesboro, in Ashe County; the Capps and Jane vein, 5½ miles north of Charlotte, in Mecklenburg County; and the Sawyer mine, 5 miles west of Sophia, in Randolph County. The mineralized zone at the Capps and Jane vein is said to have a minimum width of 20 feet and to have been traced on the surface for about 3,000 feet. At the Sawyer mine the mineralized zone is reported to have a width of 22 feet and to have been traced along the strike for 1½ miles.

NORTH DAKOTA.

No deposits of pyrites are reported in North Dakota, and from the facts known about the general geology of the State it seems unlikely that any notable quantity of this material occurs there.

OHIO.

Thirteen companies in Ohio reported in 1917 a total production of 13,218 long tons of pyrites, valued at $29,557, as a by-product from the mining of coal. All these mines are in Tuscarawas, Jefferson, and Harrison counties in the east-central part of the State. The future increase in production of pyrites in Ohio depends mainly on more careful separation and saving in coal-mining operations of this material, which was formerly regarded as worthless. In this way doubtless an increased production could be obtained, but it would be a production widely scattered, as each producer would contribute only a few hundred or at most a few thousand tons a year.

OKLAHOMA.

No lode deposits of pyrites that can be profitably mined are known in Oklahoma. Some pyrites has been recovered in the past as a by-product of coal mining, but the recovery from this source is small, and even if the industry were greatly stimulated the increase would probably be negligible from a national point of view.

OREGON.

Sulphide-bearing lodes are known in several places in Oregon but they are so far distant from the market that they can not be regarded as worth development at this time as a source of sulphur for making acid. Possibly some of these ores might be used in the manufacture of paper pulp.

PENNSYLVANIA.

Pyrites was recovered in connection with coal mining in Pennsylvania in 1917 by the Mercer Iron & Coal Co. in Mercer County and by the Cascade Coal & Coke Co. in Clearfield County. The output from this source could probably be increased, and it is reported that the Topographic and Geologic Survey Commission of Pennsylvania plans to make an investigation as to the quantity of pyrites that can be recovered at some of the coal plants.

In the past some pyrites was sold from the mines near Breinigsville, Trexlertown, Fogelsville, and in the Saucon Valley, a few miles west of Friedensville. On the whole, however, the outlook for a large production of pyrites from Pennsylvania does not seem promising.

RHODE ISLAND.

No commercial deposits of pyrites are known in Rhode Island.

SOUTH CAROLINA.

The only place in South Carolina where pyrites was actively mined in 1917 was at the old Haile mine, which is being developed by the Kershaw Mining Co. This mine is about 3½ miles northeast of Kershaw, in Lancaster County. The country rock is a sericite schist. In places this schist is so heavily pyritized that it forms irregular lens-shaped masses of hard ore. The greater part of the ore, however, requires concentration. This deposit was examined in July, 1917, by F. C. Schrader, of the United States Geological Survey, who estimated that 100,000 tons of ore was in sight and that probably 600,000 tons is available in the main deposit. This ore as mined will carry an average of 23½ per cent of sulphur.

The samples collected by Mr. Schrader were analysed by Benedict Salkover in the laboratory of the United States Geological Survey with the following results:

Analyses of pyrites ore from the Haile mine, Lancaster County, S. C.

	1	4	5
Sulphur	44.89	31.56	36.11
Zinc	.048	.056	None.
Arsenic	.136	Trace.	.153
Copper	None.	None.	None.
Insoluble matter	10.22	31.52	12.81

Numerous other bodies of pyrites have been found in some of the old gold workings on the property and in some of the recent prospecting with the drill. Preparations at this plant are in progress to handle an output of 50,000 tons a year.

In York County the same general belt that occurs at the Carolina Pyrite Co.'s mine and the Yellow Ridge iron mine in North Carolina appears to be marked by deposits of iron ore. Concerning these old iron mines Graton[1] says:

East of Blacksburg on one of these ridges, some pits have been sunk on iron-rich places in the schist, and a comparatively small amount of iron ore has been taken out. It consists of both limonite and hematite but at depths of 20 to 25 feet becomes pyritic and soon passes into solid pyrite. * * *.

Iron ore of good grade, occurring in streaks or veinlike masses, was once mined to a small extent from the Ross property, near Wolf Creek. Here too the percentage of sulphur increased with depth, and finally, it is said, the ore became such massive pyrite that it was used in the manufacture of sulphuric acid.

During Revolutionary times iron was mined at the Hills iron works on Nannies Mountain, York County. The rock, an impure foliated quartzite, is cut by a "vein," which strikes N. 15° E. and dips 80°–85° E. Where best exposed it is 6 feet wide, but must have been much wider in places, to judge from the width of some of the pits on it. This band is composed of mixed limonite and hematite, much of it porous. Near a small stream which crosses the belt a shallow pit reaches granular quartz heavily impregnated with ore. It is evident, therefore, that the iron mined was simply the oxidized cap of a pyrite vein. It is said that prospecting by means of a diamond drill showed a heavy body of sulphides, partly pyrrhotite, at a depth of 400 feet. * * *.

It is probable that these sulphide bodies represent veins and fahlbands and are distinct in origin from those deposits which are believed to have accumulated in bogs.

The Ormond mine, 5 miles northeast of the town of Kings Mountain, has been more developed than any of the iron deposits of the district described. The main shaft, 173 feet deep, encountered some good ore bodies at the bottom, considerably below the present water level. On the other hand, masses of pyrite and pyrrhotite have been found in various portions of the workings.

This group of iron-capped pyrites veins seems to offer much promise for pyrites and to be worthy of careful prospecting.

[1] Graton, L. C., Reconnaissance of some gold and tin deposits of the southern Appalachians: U. S. Geol. Survey Bull. 293, pp. 115–116, 1906.

SOUTH DAKOTA.

A small production was reported from one mine in South Dakota, operated by H. H. Francis. This mine is in Pennington County, in the Black Hills region, in the southwestern part of the State. There are many large deposits of pyrite in this region, but no local demand for the ore, and the cost of transporting it to a market has been prohibitory. The Whizzers mine is an instance of a large deposit of pyrites now lying idle. This mine is almost within the city limits of Deadwood, and according to Storms[1] a body of nearly solid pyrites, 600 feet long and 45 feet wide, has been opened. The pyrites usually forms more than 80 per cent of the vein material, which also carries subsidiary values in copper and gold.

TENNESSEE.

Large quantities of sulphur-bearing ore are annually produced in the Ducktown district of Tennessee. This ore is pyrrhotite, mined mainly for its copper content, though a large part of the sulphur is used for the manufacture of sulphuric acid. The quantity and value of this ore is not included in the statistics of the production of pyrites in the State. The only production carried in these statistics is that obtained as a by-product of coal mining, which was reported by the Brier Hill Collieries Co., in Overton County, and the Fentress Coal & Coke Co., in Fentress County.

The general situation regarding the deposits in the vicinity of Ducktown has recently been summarized by J. H. Taylor,[2] on the basis of whose report the following statements are made. As a source of sulphide ore not now being used there are the Isabella-Eureka deposit and the School Cherokee deposit. The Isabella portion is owned by the Ducktown Sulphur, Copper & Iron Co., and it is estimated that within a few weeks it could, if necessary, produce 200 tons of ore a day. In this deposit 2,500,000 tons of ore containing 29 per cent of sulphur and 0.8 per cent of copper is said to be blocked out. The Eureka deposit is owned by the Tennessee Copper Co., and it is estimated that within a few months it could produce 200 tons a day. Two million tons of ore carrying 29 per cent of sulphur is said to be blocked out. The School Cherokee property is leased by W. Y. Westervelt. The ore is said to contain 32.65 per cent of sulphur, and it is estimated that within six months 200 tons of ore a day could be mined and that ultimately this quantity might be increased to 1,000 tons a day. Additional deposits containing a much greater percentage of pyrite have been discovered by boring, so that ore carrying 42 per cent of sulphur may be obtained.

Taylor's views are summarized by himself as follows:

> In brief, there are in the Ducktown district three properties partly developed that give every indication of being able to supply 500 to 1,000 tons of ore daily for a generation to come. These ores can be made available in from a few weeks to a year's time. The sulphur content would in general be 30 per cent in th form of pyrrhotite and pyrite intimately associated. In addition there is a lesser amount of pyrite averging 40 per cent sulphur that can be made available in six months' time.

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[1] Storms, W. H., A noted pyrite deposit: Min. and Sci. Press, vol. 91, pp. 290–291, 1905.

[2] Taylor, J. H., Pyrite and pyrrhotite resources of Ducktown, Tenn.: Am. Inst. Min. Eng. Bull. 134, pp. 529–533, February, 1918.

According to Ashley,[1] pyrites has been mined on Stony Creek, in Carter County, 12 miles northeast of Elizabethton, where in past years 1,000 tons a year have been produced. Some pyrites, according to Ashley, has been found also in Moore, Cheatham, and Greene counties.

TEXAS.

Some time ago a list of places where pyrites had been found in Texas was prepared by F. W. Simonds.[2] Although, as shown by his list, pyrites is found at a great many localities in Texas it does not occur in commercial quantities so far as known. Paige[3] has described deposits in Llano County, along the east face of Riley Mountain, which in places are as much as 15 feet wide. The ore contains much arsenical pyrites and this would probably make the material unsuitable for use in the manufacture of sulphuric acid.

UTAH.

Although large quantities of sulphide ores are mined in Utah for their copper content and some of the sulphur is recovered by the by-product plants at the smelters for the manufacture of acid, no pyrites is at present mined in the State for its sulphur content alone. A larger output of sulphur could be obtained by a more complete recovery from the smelter fumes or by the treatment of more ore. According to B. S. Butler, the only district in Utah where pyrites deposits might be commercially developed at the present time is the Bingham district, where there are enormous bodies of pyritic ore containing too little copper to pay for treatment. These ores might be mined quickly in case there were extreme need of the sulphur. It seems improbable, however, that ore from this source will be able to enter the eastern markets.

VERMONT.

All the known deposits in Vermont that might afford ore suitable for the manufacture of sulphuric acid were visited by A. C. Spencer in 1917. The following statements are abstracted from his notes. In Orange County in the east-central part of the State, are three copper mines, at which concentrating plants are installed. These are the Hecksher or Elizabeth mine, near South Strafford; the Ely or Copperfield mine, in Vershire; and the Pike Hill mines, in Corinth. At all these mines the principal sulphide is pyrrhotite, the value of the ore depending at this time on the copper present. The practicability of utilizing these deposits for their sulphur is problematical. The three plants together should be capable of producing about 100 tons of pyrrhotite concentrates containing from 32 to 36 per cent sulphur at a cost, including delivery at Atlantic points, of about 20 cents a unit of sulphur.

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[1] Ashley, G. H., Outline introduction to the mineral resources of Tennessee: Tennessee State Geol. Survey Bull. 2–A, p. 61, 1910.

[2] Simonds, F. W., Minerals and mineral localities of Texas: Texas Univ. Min. Survey Bull. 5, p. 71, 1902.

[3] Paige, Sidney, U. S. Geol. Survey Geol. Atlas, Llano-Burnet folio (No. 183), p. 15, 1912.

At Cuttingsville, 11 miles southeast of Rutland, on the Central Vermont Railway, is a pyrrhotite lode that was formerly mined and treated at a local copperas works. The deposit could be readily attacked at several points, and a fairly large tonnage could be obtained if a body of sulphide 5 feet or more wide exists. The form of the deposit could not be satisfactorily determined from the surface exposures, and therefore no adequate opinion as to its commercial possibilities could be formed. Little exploration, however, would be required to show whether or not a large body of pyrrhotite exists. Inasmuch as the ore is pyrrhotite and not pyrite the question of its utilization for the manufacture of sulphuric acid, even if it proved to occur in a body of large dimensions, would still need to be carefully considered.

VIRGINIA.

By Thomas L. Watson.

For many years Virginia has produced more pyrites than any other State, and in 1917 its output was 170,382 long tons, or about 37 per cent of the total quantity produced in the United States. Production of pyrites was reported in 1917 by the Arminius Chemical Co., the Sulphur Mining & Railroad Co., the Boyd Smith mine of the E. I. du Pont de Nemours & Co., all near Mineral, Louisa County; the Cabin Branch mine of the American Agricultural Chemical Co., near Dumfries, Prince William County; the Austin Run mine of the Old Dominion Sulphur Corporation, near Garrisonville, Stafford County; and the Gossan mine of the General Chemical Co., near Monarat, Carroll County.

The sulphide ores in the deposits which have been worked are of three types—pyrite, pyrrhotite, and the sulphides of lead, zinc, and copper, the last three mined for their metal and not for their sulphur.

The largest known deposits of pyrite in Virginia lie east of the Blue Ridge, in the central and northeastern parts of the State, in a well-defined belt which runs northeastward through Buckingham, Fluvanna, Louisa, Spotsylvania, Stafford, and Prince William counties. All the deposits are lens-shaped and occur in schists, with the dip and strike of which most of them conform rather closely. The largest lens in Louisa County measures 700 feet in length and 80 feet in thickness; the largest in Prince William County measures 1,000 feet in length and 14 feet in thickness. Most of the deposits are sharply defined, but some of them grade into the country rock. The lodes show pinches and swells in the direction of both strike and dip.

The ore in the typical pyrite deposits is fine to medium grained and generally consists of nearly pure pyrite from wall to wall. It contains also very small amounts of sphalerite, chalcopyrite, galena, and magnetite, as well as copper in the form of chalcopyrite, which, however, seldom forms as much as 1 per cent of the ore. At most of the mines the copper is saved by precipitation from the mine waters as cement copper.

The three producing mines in Louisa County are grouped about Mineral, the shipping point on the Chesapeake & Ohio Railway, with which the mines are connected by a standard-gage branch line. The mines of the Arminius Chemical Co. and Sulphur Mining & Railroad Co. are extensively developed and have been continuously worked for pyrite for more than 35 years with large annual production. The Boyd Smith mine, reopened four or five years ago after a long period of idleness, is now a large producer. The ore bodies strike in general northeastward and dip 60°–70° SE. The greatest depth reached in mining is about 1,200 feet, on an incline of about 65°. At each mine is a milling plant capable of handling all the ore that the present equipment is able to produce. The product shipped includes both lump and fines, but consists mostly of fines containing 40 to 45 per cent of sulphur.

The Cabin Branch mine, recently purchased by the American Agricultural Chemical Co. from the Cabin Branch Mining Co., is about 1½ miles west of Dumfries, in Prince William County. The deposit here was first opened in 1889, and the mine has been operated continuously since the early nineties. The mine is connected by a narrow-gage railroad at Barrow Siding with the Richmond, Fredericksburg & Potomac Railroad and its wharf on Potomac River, which is about 7 miles from the mine. The mine has been developed to a depth of more than 1,800 feet on an incline ranging in slope from 25° to 60°. The pyrite lens is 1,000 feet long and from 5 to 14 feet wide. The ore body strikes northeastward and dips northwestward, in places at an angle as high as 60°. Both lump and fines are shipped. The ore carries a larger average content of copper than that from the Louisa County mines, for it includes more chalcopyrite, which is irregularly distributed through the ore body in masses that can be readily cobbed. A concentrating mill is in operation at the mine. The ore shipped contains an average of 40 to 45 per cent of sulphur.

The Old Dominion Sulphur Corporation has bought from the Austin Run Mining Co. a pyrite mine about a mile south of Garrisonville, on Whitson Run, a tributary of Austin Run, in Stafford County. Considerable work has been done in rebuilding the mill and in providing power equipment, and the mine is now reported to be ready to make a large daily output of pyrite. The product shipped is fines, which carry an average content of more than 45 per cent of sulphur. The ore body at this mine, which was developed several years ago, has been opened to a depth of 200 feet and has an average width of about 5 feet. It contains chalcopyrite in amounts that vary from place to place. The ore body lies in schists, which strike N. 35°–45° E. and have in general a dip of 60°–80° NW., though in places the dip is vertical.

The Gossan mine of the General Chemical Co., at Monarat, Carroll County, in southwestern Virginia, is near the southwest end of the "Great Gossan lead," on the Cripple Creek extension of the Norfolk & Western Railway. For about 12 years the mine has been a considerable producer of pyrrhotite for use in making acid. The ore averages about 30 per cent of sulphur. It is mined from open cuts and shipped to the Pulaski plant of the General Chemical Co., where it is crushed and used in making sulphuric acid. The residue ("blue billy") is nodulized and smelted for iron. The nodulized cinder is reported to contain only 0.05 per cent of sulphur.

The "Great Gossan lead," is the largest and most valuable body of pyrrhotite in the State and one of the largest if not the largest known body in the eastern United States. It lies in a belt of crystalline metamorphric rocks, chiefly schists, which passes through Floyd, Carroll, and Grayson counties and is readily accessible by lines of transportation, being traversed by two branches of the Norfolk & Western Railway. The deposit was first mined for copper, and in the early fifties it was actively worked for its rich secondary copper ores. In 1854–55 a large output was made from eight mines. The deposit can be traced continuously by its outcrop from New River, near Oldtown, northeastward beyond Betty Baker mine, a distance of 18 miles. Throughout this distance the vein is capped by a heavy iron gossan which, as shown by the old mine workings that are distributed from one end of it to the other, reaches a probable average depth of 35 feet. The vein beneath the gossan strikes in general northeastward, ranging from nearly N. 20° E. to nearly N. 65° E., and dips southeastward at an average inclination of 45°. The vein is well defined and reaches a maximum width of 100 feet.

Measurements made at 18 places where the vein had been mined for its content of copper gave an average width of 27 feet and extremes of 6 and 60 feet. About 5 miles southwest of the Betty Baker mine, which is near the northeast end of the "Great Gossan lead," a diamond-drill hole was put down to a depth of 524 feet, which proved the ore body down the dip for a distance of 700 feet and a thickness of 35 feet. Other drill holes, ranging in depth from 100 to 600 feet, showed that the ore body is at least 25 feet thick. The vein consists essentially of pyrrhotite, which contains disseminated particles and stringers of chalcopyrite. It is not a solid mass of pyrrhotite from wall to wall but is interlayered with more or less micaceous material, including talc, and in places with some hornblende and quartz. The ore contains an average of less than 1 per cent of copper. A complete chemical analysis of the pyrrhotite shows that it contains 34.6 per cent of sulphur, 53.15 per cent of iron, 0.866 per cent of copper, and 2.99 per cent of silica.

In addition to the producing mines, several properties in the State which once produced pyrites are in course of development and are expected to resume production in 1918. Two mines in Louisa County, which did not produce in 1917, appear worthy of special mention—the Julia and the Old Dominion.

Active work is in progress at the Julia mine, which is about 1¼ miles southwest of Mineral. A strongly marked gossan can be traced on the surface for nearly 2,000 feet. The deposit here was formerly opened by a vertical shaft about 110 feet deep, but the results of the recent work, which is extensive and systematic, include many shafts and considerable mine equipment. The last shipment reported from this mine was made in 1911, when four or five carloads of high-grade pyrite was produced. The ore body lies in schists that strike N. 20° E. to nearly N. 30° E. and dip 50° SW. The ore is similar in general character to that produced at the three operating mines in Louisa County already described.

At the Old Dominion pyrite mine, which is about a mile east of the Arminius mine, a double-compartment shaft is reported to have been sunk in a lens of good pyrite, which appeared to be 60 feet wide within a few feet of the surface. The mine produced some pyrite in 1910 but has been idle since 1911.

Deposits of pyrite that contain more or less copper have been opened at a number of places in the northeastern part of Buckingham County. The openings are made on two nearly parallel belts of greenstone schist which lie on the east and west sides of the well-known Arvonia slate belt. The eastern belt of schist, which runs along Phelps Creek, extends slightly west of south from New Canton, on the south side of James River. Shafts have been sunk on four properties, all within 2 miles of New Canton. The names of these mines and the depth of the shafts sunk are as follows: The McKenna, 60 feet; the Margaret or Terrell, 90 feet; the Johnson, formerly known as the Staples, 278 feet; and the Hudgins, 70 feet. The information available indicates that the conditions are similar at all the openings. The schists strike N. 30° E. and dip nearly vertical. The ore bodies probably average about 5 feet in width and are composed of bands of solid granular pyrite, the largest 18 or 20 inches thick, alternating with bands of schist that are more or less heavily impregnated with pyrite. The ore contains chalcopyrite, which varies widely in amount from place to place. Some exploratory work has recently been done at the McKenna mine, and definite plans are being formulated for its systematic development. An analysis of the ore from the 40-foot level gave 43.26 per cent of sulphur, 39.96 per cent of iron, and 0.54 per cent of copper.

In the western belt of greenstone schist two principal openings, 8 miles apart, along a line extending northeastward, have been made. The most northerly of these openings is the Lightfoot mine, which is about 2 miles northwest of Arvonia. At this mine a shaft 85 feet deep has been sunk on a body of pyrite which in places is as much as 5 feet wide and which carries chalcopyrite in variable amounts. No recent work has been done at this mine, but the possibility of producing pyrite in commercial quantities is fairly encouraging. The most southerly opening, known as the Anaconda, is 3½ miles west of Johnson and about 5 miles north of Dillwyn, both stations on the Buckingham branch of the Chesapeake & Ohio Railway. A shaft 75 feet deep has been sunk at the Anaconda, and according to reports a small quantity of copper-bearing ore has been shipped from it to the Norfolk smelter.

The Piedmont Pyrites & Mineral Corporation has recently put down two shallow shafts and several crosscuts on a body of high-grade pyrite in Madison County, a short distance southwest of Lost Mountain, in the drainage basin of Beautiful Run, a tributary of Rapidan River. The workings are about 9 miles northwest of Orange and 5 miles south of Madison. Samples of the ore indicate that it is massive pyrite of unusually high grade, an analysis of which is reported to have shown a content of 51.49 per cent of sulphur. Plans have been made for the early development of this property.

Near the northeast end of the "Great Gossan lead" is the Betty Baker mine. Ore was last produced at this mine in 1900, when nearly 2,000 tons of pyrrhotite was shipped to the Southern Chemical Co. at Winston-Salem, N. C., and used in making acid. This ore is reported to have contained 33 per cent of sulphur and, after roasting, 58 per cent of iron.

The facts here presented indicate that there are large available deposits of pyrite in Virginia which can be rapidly drawn on in case of national need and that probably an increased annual output of several hundred thousand tons could be made from the mines now known with practically no additional equipment. The chief obstacles to a great increase in the present production seem to be the shortage of labor and the failure of pyrite consumers to enter into long-time contracts, while uncertainty exists as to the Government's policy concerning the use of domestic sulphur and the importation of overseas pyritic ores.

WASHINGTON.

No pyrites has been mined in the State of Washington for its sulphur and, although deposits of this material are known, they are valuable at this time only for the metals other than iron which they may contain. The growth of the wood-pulp industry in the Northwestern States may develop a demand for sulphur dioxide which could be locally supplied from burning pyrites.

WEST VIRGINIA.

The known deposits of pyrites in West Virginia occur in connection with the coal beds and no use is now made of them. Estimates have shown that in some mines nearly 15 per cent of the material mined is pyrites. In fact in many places the pyrites is reported to be so abundant that it causes an expense to dispose of it so that the coal-mining operations can be carried on. A considerable increase in production of pyrites from this source might be obtained if acid makers were either willing to use the "coal brasses" or to pay the price for them that their sulphur content in comparison with the sulphur content of other pyrites entitles them to receive.

WISCONSIN.

Two companies in Wisconsin reported a considerable output of pyrites associated with the zinc sulphides for whose metallic content the ore was primarily mined. These companies are the Wisconsin Zinc Co., and the National Zinc Separating Co., both in Lafayette County.

A special investigation of the possibilities of obtaining from southwestern Wisconsin a production of pyrites for sulphuric acid has been made by R. E. Davis under the direction of the State geologist. This report is not yet published, but by the courtesy of the State geologist (to whom application should be made for more detailed information), the following statements may be given regarding the results of the investigation. Practically all the pyrites is the orthorhombic form, marcasite. Many of the prospects examined do not justify further exploration, but some of those occurring in limestone, which has been wholly or largely replaced, appear to be worthy of development. Several mining men have recently been investigating the subject, and there is a strong probability that active development of some of these ore bodies will be begun in the near future.

Mr. Davis also calls attention to the wasteful practices at present indulged in at some of the roasting plants whereby much sulphur is allowed to pass off in fumes. To make this sulphur available would require building acid works, a project that is subject to the objections of cost, time involved, and uncertainty of future market conditions. The quantity of acid that could be obtained, however, would be much greater than could be derived from the total output of pyritic ores that will be mined in the district.

WYOMING.

No pyrites is mined in Wyoming for its sulphur content, and although deposits of pyrites are known in the mountainous western part of the State their development at this time for sulphur alone seems inadvisable. Some of the sulphur from the sulphide ores of the metals, such as zinc, is recovered as a by-product at smelters in other States, and doubtless, if the need became acute, much sulphur could be produced by increased consumption of ore at idle or new plants or by better practice at the old plants.

SULPHURIC ACID.

CONDITION OF THE INDUSTRY.

The production of sulphuric acid in 1917 was nearly twice as great as the production in 1913, which may be taken as a normal prewar year. The expansion in the industry to meet the conditions imposed by the war had been begun in 1916, so that the increase in 1917 over 1916 was much less than the increase in 1916 over 1915. It may be of interest by way of comparison with present-day conditions to refer to the condition of the sulphuric acid industry during the later part of the Civil War. In 1865, according to W. H. Adams,[1] only 40,000 tons of sulphuric acid was manufactured in America, notwithstanding the extraordinary consumption due to war demands. In 1917 the production was much over 7,000,000 tons.

Although there was some increase in the production of the weaker acids in 1917 it was not nearly so great as the increase in the acids of strengths higher than 66° Baumé. The increased consumption of acids of the highest strengths is of course to be attributed directly to their use in the manufacture of munitions of war. Even the great quantity of stronger acids shown in the accompanying table does not express adequately their total output, for many of the companies either purchase weak acid and bring it up to the higher strengths, restore some of the waste acids from various industries, or transfer some of their own acid which has been produced by the chamber process to their contact-process plants and concentrate it. In order to avoid counting over again the same acid in its different forms it has been necessary to omit from the report the acid purchased and the acid produced by restoring works. If a company reports making weaker acids which are then concentrated by it to acids of higher strengths the statistics given show only the quantity of the final product. It has not been possible, however, to trace accurately the product of each plant, and consequently the

[1] Adams, W. H., Pyrite as a material for the manufacture of sulphuric acid: Jour. Anal. and App. Chemistry, vol. 5, pp. 601–615, 661–670, 1891.

figures understate rather than overstate the quantity of the stronger acids.

The uncertainty regarding the supply of ore for the manufacture of sulphuric acid has already been noted. The effect of this uncertainty on the acid industry was for a time disquieting. At one stage a curtailment of the use of acid for fertilizers was threatened, and the situation became critical. Gradually, however, the difficulties have diminished, and the industry does not seem to be facing any difficulties more insuperable than are inevitably imposed on all activities by the war. Many of the manufacturers of acid have overcome the shortage of imported pyrites by changing their plants, at least in part, into sulphur burners. This has relieved the situation to a marked degree, but it does not seem good economic practice for this to continue after pyrite supplies become available; for the native sulphur is too valuable a commodity to be sacrificed for the poorer grades of acid.

There has been a marked tendency on the part of manufacturers of acid to avoid experimenting with pyrrhotite ores, with which they have not been familiar. Experiments by C. H. MacDowell have shown that, if ground fine, this material is entirely suitable for the manufacture of acid, and that in most places it can now be obtained at a less price per unit of sulphur than is paid for pyrites. Enormous deposits of this material are known in the eastern United States. It is believed that this material plus some crude sulphur would yield the gas required for adequately operating many of the existing acid plants. To adapt the process to particular plants would require investigation of the details by chemical engineers, but the broad principles have already been put into successful operation.

The prices obtained for acid gradually rose throughout the early part of the year but dropped somewhat toward the end. Even after the decrease the price was considerably higher than in 1916. On the whole, the higher price charged does not seem out of proportion to the increased cost of raw material and operating expenses.

In spite of the high prices of acid and the ready market many of the plants were not operated on full time, and there is available capacity in the existing plants for producing more acid if required. Furthermore, several new plants are being constructed by private capitalists as well as by the Government for its own use; hence a still further increase of acid seems assured. Additional examination of the capacity of the acid plants has recently been completed by A. E. Wells, of the Bureau of Mines. A report of the results of his investigations has not yet been published, but it is understood that his conclusions as to surplus capacity in existing plants is in accord with the foregoing statement.

The outlook for the acid industry in 1918 seems to be good so far as demand for the product is concerned. The difficulty of getting enough suitable raw material will probably increase, as a curtailment of shipping facilities for imports seems inevitable. That there are adequate supplies of sulphur and sulphur ore in the country seems evident, but to procure these supplies will entail expense, and their utilization will require experimentation and freedom from past tradition and prejudice against certain ores. Shortage of labor and difficulty of transportation are anticipated as more men are called from the industries for active military service and as the transportation facilities are further burdened with handling supplies and materials for the immediate military needs. The sulphuric acid industry, however, is so vitally connected with the successful prosecution of the war, both in the fertilizer industry necessary for foodstuffs and in the manufacture of munitions, that it will probably be less adversely affected than many other industries.

USES.

Sulphuric acid is probably used in a greater variety of ways in the chemical arts than any other substance. According to Lunge,[1] the principal applications of the acid are as follows:

1. *In a more or less dilute state* (*say from 144° Twad. downward*).—For making sulphate of soda (salt cake) and hydrochloric acid, and therefore ultimately for soda ash, bleaching powder, soap, glass, and innumerable other products. Further, for superphosphates and other artificial manures. These two applications probably consume nine-tenths of all the sulphuric acid produced. Further applications are for preparing sulphurous, nitric, phosphoric, hydroflouric, boric, carbonic, chromic, oxalic, tartaric, citric, acetic, and stearic acids; in preparing phosphorous, iodine, bromine, and sulphates of potassium, ammonium, barium (blanc fixe), calcium (pearl-hardening); especially also for precipitating baryta or lime as sulphates for chemical processes; sulphates of magnesium, aluminum, iron, zinc, copper, mercury (as intermediate stage for calomel and corrosive sublimate); in the metallurgy of copper, cobalt, nickel, platinum, silver; for cleaning (pickling) sheet iron to be tinned or galvanized; for cleaning copper, silver, etc.; for manufacturing potassium bichromate; for working galvanic cells, such as are used in telegraphy, in electroplating, etc.; for manufacturing ordinary ether and the composite ethers; for making or purifying many organic coloring matters, especially in the oxidizing mixture of potassium bichromate and sulphuric acid; for parchment paper; for purifying many mineral oils, and sometimes coal gas; for manufacturing starch, sirup, and sugar; for the saccharification of corn; for neutralizing the alkaline reaction of fermenting liquors, such as molasses; for effervescent drinks; for preparing tallow previously to melting it; for recovering the fatty acids from soapsuds; for destroying vegetable fibers in mixed fabrics; generally in dyeing, calico printing, tanning; as a chemical reagent in innumerable cases; in medicine against lead poisoning, and in many other cases.

2. *In a concentrated state.*—For manufacturing the fatty acids by distillation; purifying colza oil; for purifying benzene, petroleum, paraffin oil, and other mineral oils; for drying air, especially for laboratory purposes, but also for drying gases for manufacturing processes (for this, weaker acid also, of 140° Twad., can be used); for the production of ice by the rapid evaporation of water in a vacuum; for refining gold and silver, desilvering copper, etc.; for making organo-sulphonic acids; manufacturing indigo; preparing many nitric compounds and nitro ethers, especially in manufacturing nitroglycerin, pyroxylin, nitrobenzene, picric acid, etc.

3. *As Nordhausen fuming oil of vitriol* (*anhydride*).—For manufacturing certain organo-sulphonic acids (in the manufacture of alizarin, eosin, indigo, etc.); for purifying ozokerite; for making shoe blacking; for bringing ordinary concentrated acid up to the highest strength as required in the manufacture of pyroxylin; and for other purposes.

The most important of the classes of manufacture, enumerated above, so far as the consumption of the acid is involved, are (1) the manufacture of fertilizers; (2) the refining of petroleum products; (3) the iron, steel, and coke industries; (4) the manufacture of nitrocellulose, nitroglycerin, celluloid, etc.; and (5) general metallurgic and chemical practice. According to Utley Wedge, of Ardmore, Pa.,[1] the amount of 50° Baumé sulphuric acid consumed in the

[1] Lunge, George, Manufacture of sulphuric acid and alkali, vol. 1, pt. 2, pp. 1169–1170, 1903.

United States for various purposes during normal years is as follows:

	Short tons.
Fertilizers	2, 400, 000
Petroleum	300, 000
Iron, steel, and coke industries	200, 000
Explosives (prewar conditions)	150, 000
All other industries	200, 000
	3, 350, 000

PRODUCTION.

GENERAL STATEMENT.

The production of sulphuric acid in 1917 expressed in terms of 50° Baumé, was 5,967,551 short tons, valued at $71,505,536, to which must be added 759;039 short tons of acids of strengths higher than 66° Baumé, which can not be converted for purposes of calculation into acid of 50° Baumé, valued at $16,034,645. The total value of all the sulphuric acid produced in 1917 was therefore $87,540,181. This production shows an increase in 1917 over 1916 of the acid expressed as of 50° Baumé of more than 325,000 short tons in quantity and of about $8,800,000 in value and an increase in stronger acids of more than 315,000 short tons in quantity and $5,225,000 in value. The value of the total production of sulphuric acid in 1917 was therefore more than $14,000,000 greater than the value in 1916.

Sulphuric acid produced in the United States in 1915, 1916, and 1917.

Grade.	1915			1916			1917		
	Quantity (short tons).	Value.	Price per ton.	Quantity (short tons).	Value.	Price per ton.	Quantity (short tons).	Value.	Price per ton.
50° Baumé	a1, 518, 271	$10, 681, 246	$7. 04	1, 829, 471	$17, 484, 273	$9. 55	2, 199, 224	$30, 552, 396	$13. 89
60° Baumé	657, 076	4, 976, 453	7. 57	1, 119, 753	12, 362, 884	11. 04	1, 350, 416	15, 129, 343	11. 20
66° Baumé	1, 019, 024	14, 211, 381	13. 95	1, 580, 100	32, 860, 212	20. 80	1, 359, 739	25, 823, 797	18. 99
Stronger acids	189, 795	2, 787, 971	14. 69	443, 332	10, 806, 757	24. 38	759, 039	16, 034, 645	21. 12
	3, 384, 166	32, 657, 051	9. 65	4, 972, 656	73, 514, 126	14. 79	5, 668, 418	87, 540, 181	15. 44
Total reduced to 50° Baumé.	b3, 868, 152	b29, 869, 080	b 7. 72	b5, 642, 112	b62, 707, 369	b11. 11	b5, 967, 551	b71, 505, 536	b11. 98

a Includes not only acid reported as 50°, but also 52°, 53°, and 55° acid reduced to the equivalent.
b Exclusive of "stronger acids."

The totals given above include by-product acid—that is, acid produced at copper and zinc smelters. The production of acids from this source in 1917, expressed in terms of 60° acid, was 1,336,209 short tons, valued at $14,516,104, to which must be added 119,048 short tons of acids of strengths higher than 66° Baumé, which can not be calculated in terms of acid of 60° Baumé, valued at $2,374,441. None of the stronger acids are reported to have been produced at copper smelters, and no 50° acid was reported to have been produced at either the copper or the zinc smelters.

[1] Royal Ontario Nickel Comm. Rept., p. 491, Toronto, 1917.

PRODUCTION AT COPPER AND ZINC SMELTERS.

Sulphuric acid produced at copper and zinc smelters, 1915–1917.

[Reduced to 60° Baumé acid].

Source.	1915			1916			1917		
	Quantity (short tons).	Value.	Price per ton.	Quantity (short tons).	Value.	Price per ton.	Quantity (short tons).	Value.	Price per ton.
Copper smelters	360,522	$2,749,633	$7.63	398,004	$3,988,615	$10.02	427,646	$3,254,962	$7.61
Zinc smelters	484,942	4,292,493	8.85	671,585	8,169,651	12.16	908,563	11,261,142	12.39
Stronger acids [a]	59,189	579,115	9.78	92,802	1,941,661	20.92	119,048	2,374,441	19.94
	904,653	7,621,241	8.42	1,162,391	14,099,927	12.13	1,455,257	16,890,545	11.63
Total reduced to 50° Baumé.	[b]1,056,830			[b]1,347,082			[b]1,683,623		

[a] Includes stronger acid reported as oleum, etc., carrying varying percentages of free SO_3.
[b] Exclusive of "stronger acids."

PRODUCTION BY STATES.

In 1917, sulphuric acid was produced by 221 plants in 33 States. Of these plants, 139 reported 50° Baumé acid, 66 reported 60° Baumé acid, 60 reported 66° Baumé acid, and 38 reported acids of higher strengths. In Pennsylvania and New Jersey the acid produced was valued at more than $10,000,000 each, and in Virginia, Maryland, Illinois, and Georgia the acid produced was valued at more than $5,000,000 for each State. The total production of these six States amounted to over $50,000,000, or considerably more than 50 per cent of the entire value of the acid produced in the country. Statistics giving the output of the individual States can not be published, because the publication of State figures would reveal confidential information or because certain of the large companies having plants in several States were unable at this time to furnish detailed statements of the production of the individual plants, although they could furnish accurate statements of the total production.

IMPORTS.

Very little sulphuric acid is at any time imported into the United States. In 1917, about 10,000 short tons of sulphuric acid was imported. This is several times the amount imported during any preceding year—in fact, it is practically the same as the total imports during 1913 to 1916 inclusive. The statistics of imports of sulphuric acid for the last five years, as furnished by the Bureau of Foreign and Domestic Commerce, are as follows:

Sulphuric acid imported into the United States, 1913–1917.

Year.	Quantity (short tons).	Value.
1913	975	$11,992
1914	3,955	45,766
1915	4,693	69,920
1916	706	21,672
1917	10,071	228,982

Information as to the countries from which this acid was received is not available at this time. In 1916, however, 99 per cent of the acid received in the United States was entered at ports on our northern border and evidently came from Canada, and a large part of the imports of acid in 1917 probably came from that country also.

EXPORTS.

The exports of sulphuric acid during the last five years, according to the Bureau of Foreign and Domestic Commerce, have been as follows:

Sulphuric acid exported from the United States, 1913–1917.

Year.	Quantity (short tons).	Value.
1913	4,484	$103,725
1914	6,588	140,375
1915	38,919	998,249
1916	33,231	1,847,995
1917	31,771	1,006,125

ORES USED FOR MANUFACTURE OF ACID.

For the production of all the grades of sulphuric acid in 1917 the following quantities and kinds of sulphur ore were used:

Sulphur and ore used in the manufacture of sulphuric acid in 1917, in long tons.

	Sulphur.	Pyrites.	Gold and silver bearing pyrites and galena.	Copper-bearing sulphides.	Zinc-bearing sulphides.
Domestic	463,364	376,955	17,380	708,502	584,100
Foreign	20,463	880,183	....	147,531	152,811
	483,827	1,257,138	17,380	856,033	736,911

In the column headed "Pyrites" are tabulated all the sulphide ores used that are not treated further for their copper, lead, zinc, gold, or silver content. Much of this material doubtless contains small quantities of these metals, but inasmuch as they are not recovered their presence in the ore is of no economic importance.

A comparison of the different kinds of ore used in 1917 and in 1916 shows that over 210,000 long tons more sulphur, 90,000 tons more copper-bearing sulphides, and 110,000 tons more zinc-bearing sulphides, but 220,000 tons less pyrites were used in 1917.

In the eastern part of the country—that is, in the area extending westward from the Atlantic Ocean to include Alabama and other parts of the Appalachian Mountains, but not Ohio—approximately 350,000 tons of domestic sulphur, 16,000 tons of foreign sulphur, 210,000 tons of domestic pyrites, 770,000 tons of foreign pyrites, 3,000 tons of domestic copper-bearing sulphides, 147,000 tons of foreign copper-bearing sulphides, 98,000 tons of domestic zinc-bearing sulphides, and about 135,000 tons of foreign zinc-bearing sulphides were used in the manufacture of sulphuric acid. In the central part of the country, extending westward from the Appalachian Mountains and including the States of Montana and Colorado, approximately 105,000 tons of domestic sulphur, 3,500 tons of foreign sulphur, 68,000 tons of domestic pyrites, 105,000 tons of foreign pyrites, 17,000 tons of domestic gold and silver bearing sulphides and galena, 600,000 tons of domestic copper-bearing sulphides, 500,000 tons of domestic zinc-bearing sulphides, and 18,000 tons of foreign zinc-bearing sulphides were used in the manufacture of sulphuric acid. In the Pacific Coast States, including Utah, approximately 2,500 tons of domestic sulphur, 90,000 tons of domestic pyrites, and 105,000 tons of domestic copper-bearing sulphides were used in the manufacture of sulphuric acid.

MAGNESITE.

By Charles G. Yale and Ralph W. Stone.

GENERAL CONDITIONS.

Until 1917 practically all the domestic magnesite was produced in the State of California, but in that year the newly developed deposits in Stevens County, Wash., yielded nearly one-third of the domestic output. Formerly this county imported from 250,000 to 350,000 tons of magnesite (stated in terms of crude material), mostly from Austria-Hungary and Greece. Practically all the California output was consumed on the Pacific coast, mainly as a digester for wood pulp in paper mills, but to some extent as plastic material for flooring, plaster, and cement. The freight rate to eastern points from California was prohibitive, in view of the cheapness of the imported material. Since the opening of the war, however, and especially since the United States became involved in it, the importation from Austria-Hungary has ceased, and, except for a comparatively small quantity derived mostly from Greece and Canada, the country has been compelled to rely upon the domestic product. The natural result of this condition has been renewed activity in the larger mines and the opening and development of numerous new properties.

At the beginning of 1917 the crystalline magnesite from Washington was new on the market and untried. It so quickly proved its value that the market consumed all that the new quarries could produce. Toward the end of the year, however, embargo against shipments into the freight-congested district east of Chicago and north of Ohio and Potomac rivers began to delay and limit shipments from both California and Washington, for many of the plants that make refractory products from magnesite are east of Chicago. In spite of this embargo the continued demand caused an increase of more than 100 per cent in production in 1917 over 1916, the previous record year.

PRODUCTION.

The crude magnesite produced and sold or treated in the United States in 1917 amounted to 316,838 short tons, valued at $2,899,818, as compared with 154,974 tons, valued at $1,393,693, in 1916. In 1917 California produced 211,663 tons, valued at $2,116,630, and Washington 105,175 tons, valued at $783,188. California's increase in quantity over the production of 1916 was 37 per cent. Washington began production in December, 1916, 715 tons being shipped by the end of the year.

Crude magnesite produced and sold or treated in the United States in 1917.

State and county.	Quantity (short tons).	Value.
California:		
Alameda, Kern, Riverside	3,292	
Fresno	6,077	
Mendocino, Placer, San Benito, Tuolumne	5,161	
Napa	40,209	
Santa Clara	9,410	
Sonoma	5,386	
California—Continued.		
Stanislaus	8.255	
Tulare	133.873	
	211,663	$2,116,630
Washington:		
Stevens	105,175	783,188
	316,838	2,899,818

Crude magnesite produced in the United States, 1913–1917.

	Quantity (short tons).	Value.
1913	9,632	$77,056
1914	11,293	124,223
1915	30,499	274,491
1916	154,974	1,393,693
1917	316,838	2,899,818

IMPORTS.

The following statistics of imports of magnesite are obtained from the Bureau of Foreign and Domestic Commerce, Department of Commerce:

Magnesite imported for consumption in the United States, 1915–1917.

	1915		1916		1917	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Magnesia:						
Calcined, medicinal	94,309	$10,451	54,981	$14,659	34,808	$11,819
Carbonate of, medicinal	48,817	2,757	8,202	1,048	23,197	4,295
Sulphate of (Epsom salts)	3,560,701	16,050	674,594	4,036	101,170	1,647
Magnesite:						
Calcined, not purified	53,148,739	232,071	18,539,704	204,183	7,931,159	232,601
Crude	99,527,772	255,140	150,689,445	634,447	60,554,420	232,105

The statement regularly contained in the reports of the Bureau of Foreign and Domestic Commerce of imports of merchandise by articles and countries is what is termed "the statement of general imports," and embraces imported articles entered for immediate consumption on arrival and also articles entered for warehouse as distinguished from the statement of "imports for consumption," which consists of imports entered for immediate consumption and withdrawals from warehouse for consumption.

Magnesite calcined, not purified, imported into the United States, 1914–1917, in short tons.

Country.	1914	1915	1916	1917
Europe:				
Austria-Hungary	109,797	10,997		
Belgium	11			
Denmark	103			
Germany	912	307		
Greece	4,631	9,560	6,346	
Italy	22	688		
Netherlands	4,717	2,706	235	
Norway		22		11
United Kingdom:				
England	129		2	25
Scotland	64	242	593	833
North America: Canada	197	2,543	2,094	3,092
South America: Venezuela		508		
British South Africa				2
	120,583	27,573	9,270	3,963

DEVELOPMENT.

CALIFORNIA.

Prospecting for magnesite was very active throughout the coast and valley regions of California in 1917, and several deposits were found which have become productive. The majority of the deposits were found on agricultural or stock ranches and were worked in a small way by men who leased the mining rights from the landowners. Other deposits have been located on public lands in the serpentine belts of the State. The output of most of these smaller mines was sold to the larger companies that were equipped with calcining plants or had commercial facilities for disposing of it. The growth of the magnesite industry in California in recent years is briefly shown in the following table:

Crude magnesite produced in California, 1913–1917.

Year.	Producing mines.	Quantity (short tons).	Value.
1913	1	9,632	$77,056
1914	6	11,293	124,223
1915	16	30,499	274,491
1916	45	154,259	1,388,331
1917	65	211,663	2,116,630

The effects of the war on the California magnesite industry are plainly shown in this table. The increase in output in 1917 as compared with 1916 was 57,404 tons, or 37 per cent. So great has been the demand for this mineral during 1917 that large quantities were hurriedly shipped east in a crude state, the buyers being unwilling to wait for calcination of the ore; and moreover, the newer mines were not equipped with calcining plants. Of the 211,663 crude tons mined, about 80,000 tons was calcined before being shipped, producing 39,355 tons of calcined magnesite. The loss in weight on calcination is about 50 per cent.

The price of crude magnesite at the mines in California in 1917 may be said to have averaged $10 a ton, but some small mines sold to larger companies for less, and others sold for more to buyers who were in a hurry. Calcined magnesite was sold at $30 to $45 a ton, according to character; but if the calcined had also been ground fine for plastic use it brought from $40 to $50 a ton. The consumers in the Eastern States had to pay from $10 to $12 additional for transportation. Thus to the price of the crude material had to be added the cost of transportation and the cost of calcination, and also the loss in weight resulting from calcination had to be considered, so that the minimum cost even to large eastern consumers was much greater than when foreign material, cheaply mined and shipped by sea, was available.

The demand for California magnesite was great throughout the year 1917, but has fallen off to some extent since its end. Indeed, in the closing months of 1917 some of the smaller mines began to shut down when costs increased after croppings were mined and when winter had set in and made hauling over the roads more difficult and expensive. Probably the best of these mines will be reopened in the spring. Some operators believe that the shipments from the very large deposits in the State of Washington will lessen the demand for California magnesite. The owners of the larger well-developed deposits, which are favorably situated with relation to railroads and have their own calcination plants, do not share this opinion, believing that if any mines are affected, it will be only the smaller ones in which costs of production are higher than in well-equipped properties.

The automobile truck has played an important part in the development of the magnesite industry in California in the last two years, permitting the profitable working of mines at distances that were formerly prohibitive. The calcined material is hauled by autotrucks 40 miles from one large deposit to the railroad.

The opinion has prevailed very generally that, owing to its exceptional purity, the ordinary run of California magnesite is not adapted to refractory purposes and that it should be confined largely to making plastic material and to other nonrefractory uses. A paragraph from a recently published Survey bulletin [1] will explain this.

> Most of the refractory magnesite that has been in general use has peculiar and distinctive properties that are not found in the magnesite deposits of the common type. The value of this refractory material depends not only on its resistance to the corrosive action of heat and metallic slags, but also on the permanence of the forms in which it is put into the furnace. This permanence is due to a natural bonding which tends to make the loose crushed material cling together under furnace heat and thus makes brick forms molded from it more durable. Bricks and granular furnace bottoms made of magnesite that lacks this bond break, and the magnesite floats off on the fluid molten metal and is lost in the slag. Thus, though magnesite that contains a small percentage of iron may be somewhat less resistant to extreme heat than a purer form, the slight fusibility given to the material by the iron tends to hold it in place. For this reason, in part, a type of magnesite so far found only in Austria and Hungary has been the principal source of the refractory magnesia used in this country. The purer magnesite from Greece, California, and elsewhere is used in making plaster or cement or material for other relatively minor uses.

Thus the exigencies of the war have been the means of proving that some of the California deposits are capable of furnishing excellent refractory material, and this is perhaps the most notable feature connected with the California magnesite industry in 1917. Practi-

[1] Gale, H. S., Our mineral supplies, magnesite: U. S. Geol. Survey Bull. 666-BB, 3 pp., 1917.

cally all the steel plants on the Pacific coast have been recently and are now using, to their entire satisfaction, locally produced magnesite in their basic open-hearth and electric furnaces. The White Rock (or Sweasey) mine, in Napa County, has an abundance of magnesite carrying more iron than common and a low percentage of lime. During 1917 magnesite from this mine was dead burned in 15 vertical furnaces (11 at the mine and 4 leased), and two more furnaces are under consideration. This mine has been and is now furnishing all the dead-burned magnesite for the Pacific Coast Steel Co., in San Francisco, where the company has 5 open-hearth furnaces, 2 of 30 tons and 3 of 40 tons daily capacity. Two furnaces of this company at Seattle are using the same kind of material. Other Pacific coast users of the dead-burned magnesite from this mine are the Judson Manufacturing Co., Emeryville, with two 25-ton furnaces; West Coast Iron Co., San Francisco, one 40-ton furnace; Columbia Steel Co., Pittsburg, one 20-ton furnace; Llewellyn Iron Works, Los Angeles, two 30-ton furnaces; Superior California Iron & Steel Co., Los Angeles, two 25-ton furnaces; Vancouver Engineering Works, British Columbia; Utah Iron & Steel Co., Salt Lake City, Utah. Electric furnaces on the coast using the same material are operated by the Warman Steel Castings Co., San Francisco; two plants at Stockton, Cal.; Puget Sound Iron & Steel Co., Seattle, Wash.; Washington Iron Works, Seattle, Wash.; Western Reduction Co., Portland, Oreg.

The Refractory Magnesite Co.'s mine, at Preston, is yielding magnesite which is made into refractory brick used by the Selby Smelting & Lead Co., on San Francisco Bay, and by smelters in Salt Lake City.

This list of the users of this local material is sufficient to disprove the assertion that no good refractory magnesite is produced in California.

REVIEW BY COUNTIES.

Alameda County.—The Cedar Mountain was the only productive mine in Alameda County in 1917, and all the ore was shipped in a crude state, the 5-ton calcining equipment not being used. The Livermore Fire Brick Co., at Livermore, continued prospecting and development work, but made no shipments and its lease on the property expired during the year. Several calcining plants doing custom work in Alameda County obtain their magnesite from mines in this or other counties. These are the John D. Hoff Asbestos Co., with 4 vertical kilns, at East Oakland; the Sedan Calcined Magnesite Co., at Emeryville, with 2 kilns; and the Pure Carbonic Gas Co., at Oakland, with 2 vertical kilns. The Pacific Carbonic Gas Co. has 2 vertical custom mills at Oakland, but owns no mine.

Fresno County.—The most productive mine in this county is that of the Piedra Magnesite Co., at Piedra. This was formerly the Tarpey mine operated by the Fresno Magnesite Co. The new company began operating the mine in July and the plant in October. The magnesite shipped was all calcined in the new 50-ton rotary kiln, which has displaced the old vertical kiln formerly used. Magnesite was produced also from the Ward deposit near Piedra. At or near Sanger, the Hazel, Seibert, Snyder, and Terrill mines made some output. The Hughes Creek mine is reported as worked out, and the Levensaler-Spier mine at Piedra was idle in 1917.

Kern County.—The Rex Plaster Co. produced from deposits near Bissell and near Tehachapi in 1917, but at the end of the year sold them both to other operators who will continue mining.

Mendocino County.—The Pearson-Smith Mining Co. shipped several carloads of high-grade magnesite in 1917 from a new mine near Hopland, and J. S. Wood mined on the Hixon ranch near Pieta, shipping from Preston. A promising ledge on the Hixon ranch was leased by Arthur McCray and quickly mined out, for it proved to have no depth.

Napa County.—In quantity of magnesite produced Napa County is second only to Tulare County, the leader. In 1917 Tulare County produced 63 per cent of the total output of the State and Napa County produced 19 per cent, or more than all of the 11 other producing counties combined. The principal producer is the White Rock mine, at Pope Valley. During the year the output of this mine was greatly increased and 6 vertical kilns were added, making 11 in all. Besides these, the company has under lease 2 kilns at Rutherford and 2 at Oakland. Calcining in the kilns at the mine is done with coke dumped in alternately with the ore. The dead-burned product from this mine is in much demand at the basic open-hearth and electric steel furnaces on the Pacific coast, as noted elsewhere in this chapter, and this product was hauled 20 miles by autotrucks to the railroad.

The Tulare Mining Co., after taking several thousand tons from their property in Chiles Valley, closed the mine before the end of the year. Magnesite was produced by the Minerals Development Co. from mines in Chiles Valley east of Rutherford. A small output was made by the Giant & White Horse mine, near St. Helena, and an important yield by the Soda Creek mine (Detert & Elder). At Rutherford, Sears & Cubbage have a custom calcining plant consisting of two vertical kilns, but they operate no mine.

Placer County.—A small quantity of magnesite was shipped from the Sullivan mine at Towle, but the Lee mine at Alta made no production.

Riverside County.—The old Magnesco Refractory Products Co.'s mine at Winchester, now owned by the Innes-Speiden Co., of New York, was operated for only two months in 1917 and made a small output.

San Benito County.—The Sampson mine, in San Benito County, was worked by the John D. Hoff interests in 1917 and all the ore was calcined in 3 vertical kilns at the mine. The product is hauled by autotrucks about 40 miles to the railroad at Mendota. On other magnesite properties near the Sampson, development work only was done during the year.

Santa Clara County.—Several small mines in the vicinity of Madrone, owned by the Bay Cities Water Co., were worked by lessees; and the Sherlock mine, in the same neighborhood, made a small output. In the Red Mountain district there was a small yield by the Springer mine, and the Pacific Magnesite Co.'s mine was operated part of the year, its output being purchased by the John D. Hoff Asbestos Co., of Oakland. There is a small kiln at this mine. A small quantity which originated in the Red Mountain district was shipped from Lick station. The Western Magnesite Development Co., owning what was formerly the most productive mine in this district, is in the hands of a receiver and litigation prevented operation of the mine and the two vertical kilns during the year.

Sonoma County.—The Sonoma Magnesite Co., near Cazadero, has equipped its property with two rotary kilns and continued shipments until fall, when activity was centered in completing a railroad to the plant. Small quantities of crude ore were shipped from the Standard group, at Cazadero, and the Elsey, Albertz, and Leighton deposits, near Cloverdale.

Considerable ore was also shipped from the Melville ranch, Cloverdale, where a deposit supposed to be worked out was reopened by L. C. Stephens, who mined underground rather than by open cut. The Refractory Magnesite Co., near Preston, dead-burned all its magnesite in a kiln at the mine and shipped the product to Stockton, where it was made into refractory brick. These bricks are in use at the Selby Smelting & Lead Co.'s plant on San Francisco Bay and also in furnaces at Salt Lake City, Utah. The demand on this company for magnesite brick in 1917 was greater than it could fill and at the end of the year it was far behind in its orders. No output was made from the Lucky Elsie, or the Sotoyome Magnesite Co.'s deposit near Healdsburg, or the Morey deposit at Warfield. The Gilliam Creek (Harker) deposit produced some magnesite, which was hauled to a kiln at Guerneville, but as the plant was not completed by the end of the year, there was no marketed output.

Stanislaus County.—The Red Mountain Magnesite Co. (or Butcher) mine operated during the last six months of the year and shipped both crude and calcined material from Patterson. One vertical kiln has been installed at the mine. Other producers in the county were the Gustine Magnesite Co., the Quinto mine, and the Maestretti mine operated by the Sedan Calcined Magnesite Co. Some mines were formerly listed as in Merced County which are really over the line in Stanislaus County.

Tulare County.—This has always been the leading county of California in the production of magnesite. In 1917 the output of magnesite was 63 per cent of the total crude ore of the State and 64 per cent of the calcined. Tulare County had 23 magnesite mines, large and small, which reported production in 1917. Most of the mines are in the vicinity of Porterville, but some are at Lindsay, Exeter, Dinuba, and other points. The most productive mine in the Porterville district (and in the State) is that operated under lease from Charles S. Harker, by the Porterville Magnesite Co. of California. It made a much larger output in 1917 than in 1916. The property is equipped with two large rotary furnaces and more than half of the output was shipped calcined. The mine of the Tulare Mining Co., the pioneer in this field, is several miles east of Porterville and a large producer. This company has two vertical kilns and its entire product was calcined before shipment. Much of the output of this mine is utilized in the manufacture of paper from wood pulp, but some is used for plastic purposes. This company also purchased several thousand tons of crude magnesite from small operators in the vicinity. The Lindsay Mining Co. made a large output, which was all shipped crude. The property adjoins and was sold to the Tulare Mining Co. at the end of the year. The Magnesite Refractories Co., of Los Angeles, worked a property at Porterville until August, 1917, and shipped its entire output crude. The Oakland Magnesite Co., of

Oakland, Alameda County, acquired a mine in the Porterville district from J. W. Langley in April, 1917. The product was shipped crude. A small output was made from the mine at Porterville owned by the Rex Plaster Co., of Los Angeles, and at the end of the year the property was sold to the Lindsay Mining Co., of Porterville. The Rex Plaster Co. also worked the Avery mine at Porterville during the year and made some product, but finally surrendered the lease to the owner. Among the smaller properties in this district which made some product in 1917 were the Weed, Behr, Deer Creek, Gill lease, Gill land, Monacac, Fowler, and Smith lease. The Hathaway deposit, Howeth mine, and Chamberlain mine in this district were not worked in 1917. The American Magnesite Co. had in operation at Porterville two 50-ton rotary kilns, but did custom calcining only, having no mine. The Dinuba Magnesite Co. and H. T. Haden produced several thousand tons of magnesite at Dinuba. The Joyner deposit at Exeter was worked until August by the owner and then sold to the Rex Plaster Co., of Los Angeles. The Hawley Paper & Pulp Co., of Oregon City, Oreg., shipped calcined magnesite from Magnesite siding up to July, after which time the property was operated by the Tulare Mining Co. In the vicinity of Lindsay, aside from the Lindsay Mining Co., heretofore mentioned, the following were producers in 1917: Clark & Weisman, P. J. Montgomery, E. F. Schrei, and Burr Bros. After a very small output Burr Bros. ceased operations because the veins were too small. The Woods & Hyde mine was not worked after November, 1916.

Tuolumne County.—A nominal output was made by the Minerals Development Co. at Chinese, in Tuolumne County, and later the property reverted to the original owner, Henry Sims, of Chinese.

CALCINING PLANTS.

Calcining plants for handling crude magnesite ore in California are owned and operated by the larger producing companies, which have their plants at or near their respective mines. There are also in operation several custom calcining plants which treat ores sent to them by smaller mine operators who have no calcining furnaces of their own. The calcining plants in operation during 1917 were as follows:. Pure Carbonic Co., Berkeley, Alameda County, 2 vertical kilns, daily capacity of 14 tons (custom); John D. Hoff Asbestos Co., Oakland, Alameda County, 4 vertical kilns, 40 tons per day calcined (custom); Pacific Carbonic Gas Co., East Oakland, Alameda County, 2 vertical kilns (custom); Sedan Calcined Magnesite Co., Emeryville, Alameda County, 2 kilns; West & Son, of Pittsburg, Contra Costa County, 2 vertical kilns for calcining magnesite for use of the Columbia Steel Works, but no mine; Piedra Magnesite Co., Piedra, Fresno County, 1 rotary kiln, 50-ton capacity; White Rock mine (Sweasey), Pope Valley, Napa County, 11 vertical kilns; Sears & Cubbage, Rutherford, Napa County, 2 vertical kilns, 10-ton capacity (custom); Magnesco Refractory Products Co., Winchester Riverside County, 1 rotary kiln; Sampson mine (Hoff-Price Co.), Sampson Peak, San Benito County, 3 vertical kilns; Western Magnesite Development Co., Red Mountain (Livermore), Santa Clara County, 2 vertical kilns, 30-ton capacity; Pacific Magnesite Co., Red Mountain, Santa Clara County, 1 vertical kiln; Sonoma Magnesite Co., Cazadero, Sonoma

County, 2 rotary kilns; Refractory Magnesite Co., Preston, Sonoma County, 1 vertical kiln, 5-ton capacity for dead burned; International Magnesite Co., National City, San Diego County, 1 vertical kiln, 20-ton capacity; Red Mountain Magnesite Co., Patterson, Stanislaus County, 1 vertical kiln; American Magnestite Co., Porterville, Tulare County, 2 rotary kilns, 50-ton capacity; Porterville Magnesite Co. of California, Porterville, Tulare County, 2 rotary kilns, 28-ton and 80-ton capacity; Tulare Mining Co., Porterville, Tulare County, 2 vertical kilns, 40-ton capacity.

WASHINGTON.

GENERAL STATEMENT.

The production of magnesite in Washington began in December, 1916, and yet the new industry produced more than 100,000 tons of crude material in 1917. Four companies took part in this development. The pioneer in the field was the Washington Magnesite Co., formed by R. S. Talbot, Spokane. In May, 1917, this company was taken over by the Northwest Magnesite Co., formed by San Francisco, Seattle, and Spokane capital, with Mr. Talbot as president. The new company operated throughout the year and made the largest output of the State, practically all of which came from one quarry. The American Mineral Production Co., of Chicago, began development in the spring of 1917, opened four quarries, and by the end of the year had mined a considerable part of the State's output. Early in the summer a quarry was opened 18 miles west of Springdale by the United States Magnesite Co., of Spokane, and several carloads were shipped to the plant of the American Fire Brick Co. near Spokane. There seems to have been an error in the original analysis, for the material proved after shipment to be unusable. Quarrying was discontinued by this company in August. The Double Eagle, which later in the year became the Valley Magnesite Co., was formed and directed by F. M. Handy, of Pullman, Wash. This company opened a quarry 12 miles west of Valley, built three shaft kilns, and made a small production in the fall of the year.

The total quantity of magnesite mined in Washington in 1917 was 105,175 short tons, valued at $783,188, as compared with 715 tons, valued at $5,362, mined in 1916. Most of this sold for $7.45 or $7.50 per ton f. o. b., but a small quantity seems to have been sold for about $6.50. Demand for magnesite at eastern plants caused more than half of the output, or 63,573 tons, to be shipped crude. This material is valued at approximately $474,420. As development progressed kilns were installed, and more and more of the rock was calcined before shipment. The returns from the three companies show that 36,356 tons of crude rock produced 16,464 tons of calcined magnesite, which was sold for $533,298. The price of the calcined material delivered to the railroad in box cars was $32.50 per ton. From these figures it is seen that the total value of crude and calcined magnesite sold from Stevens County, Wash., was $1,007,718, in the first year of the industry, or, including the output of December, 1916, $1,013,080 in 13 months. In view of the fact that a great part of the work done by the companies in this new field was purely development, and that the deposits are several miles from a railroad, this production was a notable achievement.

CHARACTER AND ORIGIN.

The magnesite deposits in Stevens County, Wash., are about 60 miles north of Spokane, and 5 to 12 miles west of Valley and Chewelah. They are in the mountainous country on the western side of Colville Valley, where forest cover and hillwash conceal most of the bedrock and where roads are few and poor. The Stevens County magnesite has been formed by the replacement of lenses of dolomite in sedimentary rocks, probably of pre-Cambrian age. The strata are evidently of sedimentary origin, although the recrystallization of the purer magnesium carbonate may have been secondary, possibly influenced by the intrusion of basic magnesian rock, which occurs above and below the magnesite in some places. So far as observed in a brief examination, the basic igneous rock was not found in contact with the magnesite. The dolomite is interbedded with schist, slate, and quartzite, and the lenses are from a few hundred to a few thousand feet long. Replacement by magnesite is variable from place to place, some parts of an original dolomite deposit being wholly replaced and others scarcely altered at all. The magnesite differs very much from the common California material, being crystalline and colored. The Washington magnesite ranges in grain from fine to coarse, and is gray, white, black, pink, and red. In appearance it is readily mistaken for marble or dolomite, and the quality of the rock can be determined only by chemical analysis.

The magnesite deposits are very large. On more than one of the properties an estimate of 1,000,000 tons of ore within 200 feet of the surface is reasonable; diamond drilling at the Finch quarry of the Northwest Magnesite Co. is reported to have proved the presence of more than 1,000,000 tons of commercial ore.

NORTHWEST MAGNESITE CO.

The production of magnesite in Washington was begun in December, 1916, by the Washington Magnesite Co., of Spokane. In May, 1917, this company interested other capital and became the Northwest Magnesite Co. Its principal holdings are the Finch and Keystone deposits and a calcining plant at Chewelah.

Finch deposit.—The quarry from which most of the State's output was derived in 1917 is 5 miles in an air line southwest of Chewelah and north of Browns Lake. The original quarry is about 30 feet above the valley bottom and at the base of a hill 300 feet high. The quarry floor is about 200 feet long and the face 40 feet high. After the quarry was well developed air drills were installed. Broken rock was trammed to a bunker with eight chutes, from which the lump rock was loaded into wagons and autotrucks for hauling to Chewelah, a distance of about 7 miles by road. The cost of delivery to the plant at Chewelah was $2.50 a ton. A 5-mile aerial tram was completed about the end of the year from the quarry to the kilns, and the rock was crushed at the quarry. At the calcining plant near Chewelah the crushed rock is pulverized before delivery to the rotary calciners. Three cement mills, 125 feet in length and 7½ feet in diameter, are installed and fired with powdered coal. It is planned to install three additional calciners and to make ferromagnesite at this plant, beginning in May, 1918, by mixing iron ore with the fine-ground raw magnesite and dead-burning the mixture.

After taking many thousands of tons of magnesite from the Finch quarry it was found that the block of ore being mined is separated from the main deposit by faults. Diamond drilling and surface cleaning proved this condition and developed the fact that the large body of commercial ore could be worked better by a quarry a few hundred feet away on the other side of the hill and by underground mining.

Keystone deposit.—The Keystone deposit of the Northwest Magnesite Co. is 10 miles by road west of Valley. A quarry at this deposit yielded the first few hundred tons of magnesite produced in Washington. From 1898 to 1903 the United States Marble Co. quarried rock here and sawed, polished, and sold dressed stone to the value of $100,000 under the impression that this stone was marble. The so-called marble, however, was magnesite. The Keystone deposit is high on the mountain side and consists of beds pitching at an angle of 45° into the mountain. The magnesite outcrops in large ledges for nearly a quarter of a mile along the upper slope of a ridge, and the beds are from 10 to 30 feet thick and have a total thickness of at least 100 feet. The magnesite partly replaces a lens of dolomite and beds of dolomite are interspersed with it. That the magnesite is of commercial quality can not be determined by visual examination, but if the rock assumed to be of shipping grade proves to be so, there is 1,000,000 tons or more of readily recoverable magnesite in this deposit. It is overlain by quartzite and rests on shale which is cut by igneous intrusives. A shear zone in the magnesite contains a body of brucite exposed by quarrying for 75 feet and having an extreme width of 20 feet. The commercially valuable magnesite is mostly a coarse-grained black and white mixture. This deposit has not been worked since early in 1917 because the Finch quarry is several miles nearer the railroad. A branch railroad from Valley to Deer Creek, built late in 1917, passes within 1½ miles of the Keystone quarry and will make it much more accessible.

AMERICAN MINERAL PRODUCTION CO.

Early in 1917 the American Mineral Production Co., of Chicago, acquired three magnesite deposits west of Valley and began energetic development of them. This company was confronted by many difficulties, but nevertheless it shipped a considerable quantity of crude and calcined magnesite during the year.

Allen and Moss deposit.—The American Mineral Production Co. made most of its output from the Allen and Moss quarries, which are nearest to the main-line railroad. These quarries are 7 miles northwest of Valley on the western side of Browns Lake, and one-half and three-fourths of a mile south of the Finch quarry. The Moss quarry is at the south end and the Allen quarry near the north end of a magnesite lens about a quarter of a mile long. The magnesite beds are between quartzite above and shale and slate below and, with the inclosing strata, dip at a high angle. The lens attains a thickness of 200 feet, but is not all commercial ore. Close under the magnesite there is a fine-grained green igneous rock of a diabasic character, and a few hundred feet stratigraphically above it there is a great thickness of metadiabase or greenstone. One or the other of these may have caused the replacement of original dolomite by magnesite. Crude magnesite was shipped from these quarries in lump, being hauled by wagon and autotruck to Valley, the office and shipping point of this company.

An opening was cleared in the woods on the hill west of Browns Lake and four vertical brick kilns about 20 feet high and 6 feet in diameter were built for calcining magnesite. Rock from the Allen quarry was delivered to the top of these kilns over a trestle by gravity cable cars. Originally the kilns were oil burning, which necessitated transporting oil casks from the railroad over 7 miles of mountain road to the kilns. In August, 1917, the kilns were rearranged to burn wood, which was cut on the property.

Woodbury deposit.—The earliest output of calcined magnesite made by the American Mineral Production Co. was from the Woodbury quarry, which is 1½ miles southwest of the Allen quarry and 6 miles from Valley. Besides several prospect pits from which a few tons of magnesite were taken, there is a quarry with a 65-foot floor and 40-foot face in steeply dipping massive beds of coarsely crystalline black and white magnesite. The ore was found after considerable development and experimenting to be high in silica and mixed with dolomite, and operations here were abandoned.

The first kiln erected was a vertical steel cylinder 3 feet in diameter and 16 feet high, lined with fire brick and fired with oil. Later a brick kiln 20 feet high and 6 feet inside diameter was built and also fired with oil. These kilns were idle after the middle of the year.

Red marble deposit.—Red magnesite along the crest of a ridge in secs. 24 and 25, T. 31 N., R. 38 E. was prospected several years ago under the belief that it was marble. This deposit, which is 900 feet above Deer Creek and 12 miles west of Valley in a tract of timber, was acquired by the American Mineral Production Co., but any considerable shipment of ore from it has awaited the building of an aerial tram down the mountain and of a branch railroad. The deposit is about a quarter of a mile long and 200 to 300 feet thick, but how much of it is commercial ore has not been fully determined. Indications are that 1,000,000 tons or more of salable material may be taken within 50 feet of the surface. The beds dip at about 45° and extend to an unknown depth. The small quantity of ore taken from this deposit was shipped crude and at a cost of $4.50 a ton for hauling to the railroad by team. Geologic relations are the same here as at the other deposits.

VALLEY MAGNESITE CO.

Double Eagle deposit.—Halfway between the Keystone and Red Marble deposits is the Double Eagle magnesite deposit of the Valley Magnesite Co. It is between the forks of Deer Creek, near the top of a high ridge, and 800 feet above the proposed railroad terminus on the creek bottom three-quarters of a mile away. This deposit is reached from Deer Creek by a road up the mountain northeast from the ascent to the Red Marble. It was discovered and developed by Prof. F. M. Handy, of the State College, at Pullman, Wash., who was a pioneer in the Stevens County field. After prospecting the outcrop, which is about 1,000 feet long, a quarry was opened and kilns were built several hundred feet lower, where water was available. Shipments of both crude and calcined magnesite were made in the latter part of the year, with a charge of $4.50 a ton for hauling by wagon or autotruck over a rough road 12 miles to Valley. The magnesite in this deposit is mostly black and white and shows many variations from fine to coarse grained, mottled, and banded, with coarse black magnesite crystals on bedding and joint planes. If all the material that appeared on brief examination to be magnesite is of commercial grade, there are at least several hundred thousand tons in the deposit.

U. S. MAGNESITE CO.

The southernmost magnesite deposit known in Stevens County is 18 miles west of Springdale, in sec. 10, T. 30 N., R. 38 E. It is 1½ miles from the road to Hunter and 6 miles from the end of a lumber railroad, on a timbered mountain side. The deposit as uncovered is about 150 feet long and 100 feet wide, but is of low grade. A quarry was opened and a small output was shipped to Spokane in the summer of 1917, on the basis of analysis which seemed promising. The ore delivered to the kiln, however, was so high in silica and lime that it was thrown on the dump, and all work on this deposit was discontinued in August.

The country rock below this deposit is dark to light green slate, and that above it probably is quartzite. No rock was found in place above the magnesite, but float quartzite was seen. Some of the magnesite in this deposit is dark and coarsely crystalline, but not so black as that at the Keystone, and some is lighter colored with many white magnesite veinlets.

CALCINING PLANTS.

As mentioned in the foregoing paragraphs, the calcining plants operated by the magnesite producers in Stevens County in 1917 were as follows: Northwest Magnesite Co., 3 rotary kilns 7½ feet in diameter and 125 feet long, at Chewelah; American Mineral Production Co., 4 vertical kilns about 6 feet in diameter and 20 feet high, at the Allen quarry, and 1 vertical brick kiln 6 by 20 feet and 1 vertical steel kiln 3 by 16 feet, at the Woodbury quarry, west of Valley; Valley Magnesite Co., 3 vertical brick kilns, 20 feet high, 10 to 14 tons daily capacity each, at the Double Eagle quarry, 12 miles west of Valley.

DERIVED PRODUCTS.

Magnesite is ordinarily marketed either crude or calcined, and a number of derived and more or less manufactured products are made wholly or in part from it.

CRUDE.

Magnesite as mined, in its crude or natural form, is essentially carbonate of magnesium with some impurities. As such it may be considered a source either of magnesia (magnesium oxide) or of carbon dioxide gas, these being produced by its decomposition by extreme heat or calcining.

CALCINED.

Calcined magnesite consists essentially of magnesia (magnesium oxide). By different degrees of calcination of the raw magnesite two forms of magnesia are made, which have quite different properties, namely, the caustic calcined magnesite and the dead-burned magnesite. In making caustic calcined magnesite most of the carbon dioxide is driven off, but from 3 to 8 per cent is intentionally left in the residue. In this form magnesia is susceptible to reaction with water and with carbon dioxide of the air, and it readily combines with certain other reagents, such as magnesium chloride; it is upon this latter reaction that its important use in magnesia cement is based. When calcined at a much higher temperature, driving off essentially all moisture and combined carbon dioxide, the product is dead-burned magnesite, a very dense, fire resistant, and chemically inactive substance. The dead-burned magnesite is used for making refractory materials, including magnesite brick and grain magnesite.

OTHER DERIVED PRODUCTS.

Metallic magnesium has been made recently in the United States from magnesite and from magnesium chloride derived from bitterns. Light magnesia or magnesia alba, a basic carbonate, is made from magnesite by chemical precipitation. Calcined magnesite is converted into magnesium bisulphite for use in the manufacture of paper. Various salts, such as epsom salts (magnesium sulphate) and magnesium chloride, are derived from magnesite and from other magnesian rocks, as dolomite.

METALLIC MAGNESIUM.

The manufacture of metallic magnesium is now a well-established industry in this country, and the price has fallen to a point near that which prevailed before the war. The average price fell from $4.13 a pound in 1916 to $2.02 a pound in 1917. The price early in 1916 reached $5 a pound but late in 1917 it fell to $1.85. The production in 1917 was 115,813 pounds, valued at $233,626. This output was made by the Rumford Metal Co., Rumford, Me.; Norton Laboratories (Inc.), Lockport, N. Y.; American Magnesium Corporation, Niagara Falls, N. Y.; and Dow Chemical Co., Midland, Mich.

Magnesium is prepared in its metallic form by electrolytic means. It is used in alloys with aluminum, calcium, copper, iron, nickel, and silicon. Magnesium alloys for use in airplanes are a particularly important application of the metal. Metallic magnesium in the form of wire, ribbon, or powder is used for flash light in photographic work.

LIGHT CARBONATE OR MAGNESIA ALBA.

The basic carbonate known as magnesia alba is usually prepared by chemical precipitation from solution of the commercial sulphate or of the chloride with sodium carbonate. Its manufacture from dolomite in Pennsylvania is a well-established industry. It is also manufactured by chemical treatment of magnesite. Magnesia alba is used in fire-retarding paint and as a nonconductor of heat in coverings for steam pipes and in other heat insulators, where it is commonly mixed with asbestos fiber. It has other uses, including medicinal and toilet, which are fairly well known, as in face powder. The light carbonate is said to make an excellent absorbent in the manufacture of dynamite.

MAGNESIUM CHLORIDE.

Magnesium chloride is made in this country by solution of magnesite with hydrochloric acid, by reaction of serpentine with spent liquors containing hydrochloric acid, and as a by-product from bitterns of the salt refiners. Its principal use is for making oxychloride or Sorel cement and for dressing cotton goods. Some of the refined salt is used in chemical laboratories for drying, as it absorbs water rapidly.

MAGNESIUM SULPHATE.

Probably the greater part of the magnesium sulphate or epsom salts used in this country prior to 1914 was imported and was a by-product of the German potash industry. Much of this purified salt is used in the drug trade or in the manufacture of laxative mineral waters. Milk of magnesia is a well-known magnesia product, an aqueous suspension of magnesium hydroxide, made with the aid of magnesium sulphate and sodium hydroxide. Magnesium sulphate also has important uses in the textile industries and is used to a certain extent in tanning leather.

Natural deposits of magnesium sulphate in this country, which could not be developed in competition with the imported material, are being utilized now that the imports are cut off. Magnesium sulphate is manufactured also by treating magnesite or dolomite with sulphuric acid.

USES.

REFRACTORY MATERIAL.

The most important application of magnesite is its use for refractory purposes. In the dead-burned form, either granular or made into brick, it is used as a refractory lining for open-hearth furnaces and converters in the steel industry, in copper converters, reverberatories, settlers, and electric and other melting, heating, and welding furnaces. Magnesite brick are used for lining rotary kilns in Portland cement manufacture. Magnesite brick are made in California, but most of the refractory products from magnesite, including brick, shapes, and grain magnesite, are made in the Eastern and Central States.

OXYCHLORIDE OR SOREL CEMENT.

The use of magnesite for the manufacture of the cement known as oxychloride or Sorel cement is based on the fact that a finely ground calcined magnesite when wet with a solution of magnesium chloride of a certain strength will solidify or set as an exceedingly strong and hard mass. This mixture is generally modified by the addition of various filler materials, such as wood flour, cork, talc, silica, asbestos, clay, marble dust, and sand, beside coloring matter. The cement thus produced is sold under several trade names, commonly referred to as sanitary flooring. When well laid, magnesite cement has some decided advantages over other cements for use as flooring. It produces a smooth, even floor, which may be laid in large areas without cracking. It takes color advantageously and is susceptible of good polish by oiling or waxing. It is laid in a plastic state on wood, steel, or concrete. Its surface seems to have a resilience not given by ordinary cement, and it does not pulverize or grind to dust.

The use of magnesite cement in floors and as stucco or wall and outside plaster is gaining in importance in this country. Not only is it used for floors in office buildings and hospitals, but also in residences, railroad cars, and ships. It is reported that magnesia cement has been used by the Germans for gun emplacements because it sets quickly and attains great strength much sooner than Portland cement.

MANUFACTURE OF PAPER.

The principal use of California magnesite for many years was in the manufacture of wood-pulp paper on the Pacific coast. Magnesia, in the form of the bisulphite, is said to have a more solvent action on the free resins of the wood than lime, and it also has an additional advantage in that the residues left in the paper stock are not afterwards injurious to sizing agents.

The process of making paper in which magnesite is used is known as the sulphite process. The wood (mostly from coniferous trees) is boiled with a disintegrating agent so that it breaks down into a mass of pulp, which is afterward rolled into paper. The disintegrating agent in the sulphite process is sulphurous acid, or common bisulphite of calcium or magnesium. Magnesium bisulphite is more stable and it dissolves the noncellulose matter more completely than calcium bisulphite. Sodium bisulphite gives a better product than either of the two mentioned, and strong liquors can be made from it, but it is too expensive for general use.

Only a small part of California's annual output of magnesite is now used in making paper, but the demand for refractory and plastic purposes has caused a greatly increased production.

CARBON DIOXIDE.

Reducing raw magnesite to magnesia reduces the weight by approximately one-half by driving off the carbon dioxide. Calcining is therefore commonly done at the mine in order to lessen shipping cost on the product. Facilities for saving the gas are not provided and it is wasted in the air. The use of magnesite for the manufacture of carbon dioxide is dependent on the ability to make use of the resulting magnesia, and as the apparatus designed to save the gas does not usually burn the magnesite to the proper degree for caustic magnesia, carbon dioxide is commonly derived from other sources. The manufacture of carbon dioxide from magnesite consists in roasting the magnesium carbonate and recovering, purifying, and compressing the carbon-dioxide gas. The gas is liquefied and stored in steel cylinders for shipment. It is used in refrigeration and in making "soda water" and other carbonated beverages.

MAGNESIA PAINT.

Paint made of ground calcined magnesite and magnesium chloride dissolved in water has fire-resisting qualities. Inflammable materials coated with it may be burned by the direct application of heat and flame, but the destruction is retarded and confined. This property of magnesite is of use not only in its application to theater curtains and clothing for special purposes, but to fabrics for other purposes and in the construction of fire-resistant buildings.

MISCELLANEOUS APPLICATIONS.

Magnesite has numerous miscellaneous applications in both crude and calcined form, among which may be mentioned its use as a nonconductor of heat in pipe and furnace coverings, where it is commonly mixed with 15 per cent of asbestos fiber. It is said to be used to prevent scale in boilers in which sulphurous waters are used, and it has been utilized with some success as a binder for briquetting coal. Its use in the composition of some automobile tires is reported.

TALC AND SOAPSTONE.

By J. S. Diller.[1]

TALC.

PRODUCTION.

The mineral talc is remarkable for its softness, unctuous feel, and stability, properties which render it useful for many purposes. In its natural state it appears in the so-called French chalk used by tailors and in crayons. In ground form it is most commonly seen in lubricating and toilet powders, although its most extensive application is as a filler in the manufacture of paper. Much is used in rubber and certain kinds of paints. Some of that mined in Virginia has been successfully used as foundry facing instead of graphite. Its high insulating qualities gain for it a large application in electric insulation.

The sales of talc in 1917 amounted to 198,613 tons, valued at $1,889,672, a gain, as compared with 1916, of nearly 3 per cent in quantity and of more than 7 per cent in value. Thirty-seven producers reported to the Geological Survey, of whom 7 were in California, 6 in Georgia, 1 each in Maryland, Massachusetts, and New Jersey, 4 in New York, 6 in North Carolina, 2 in Pennsylvania, 5 in Vermont, and 4 in Virginia.

Heretofore New York has always been the premier State in the quantity and value of the talc production of the United States, but in 1917 it gave way in quantity to Vermont, although on account of the fibrous character and consequent higher grade of the New York product for making paper, its total value is still $256,312 greater than that of Vermont.

The most striking feature in the production of talc for 1917, as compared with that of 1916, is the increase in quantity of 28 per cent in Vermont, with large reserves, and the decrease of nearly 20 per cent in New York.

The highest average priced talc, as shown in the accompanying table, including that which was cut for gas tips, pencils, and insulators, was sold from Georgia, North Carolina, and Vermont, and the highest prices ranged from $50 to $200 a ton. The lowest-priced material was sold as rough talc (crude) at prices ranging from $3 to $8 a ton, or on an average of $5.58 a ton. Its value was greatly increased by grinding and ranged, when ground, according to quality, from $5 to $20 a ton, although the general average was only $9.11 a ton.

[1] The statistical data for this report were prepared by Miss H. M. Gaylord, of the U. S. Geological Survey.

Talc sold in the United States, 1916 and 1917.

State.	1916		1917		
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Average price per ton.
California	630	$10,694	4,152	$74,000	$17.82
Georgia	3,080	88,364	3,819	94,314	24.70
New York	93,236	961,510	74,671	881,462	11.80
North Carolina	1,787	41,824	2,175	41,766	19.20
Vermont	73,215	501,175	93,960	625,150	6.65
Virginia	8,798	73,622	6,432	85,856	13.35
Maryland, Massachusetts, New Jersey, and Pennsylvania	12,563	85,653	13,404	87,124	6.50
	193,309	1,762,842	198,613	1,889,672	9.51

Classification of talc sold in the United States, 1916 and 1917.

Condition in which marketed.	1916		1917		
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Average price per ton.
Rough (crude)	11,299	$106,928	12,269	$68,440	$5.58
Manufactured into pencils and blanks [a]	828	102,674	5,781	176,404	30.51
Ground [b]	181,182	1,553,240	180,563	1,644,828	9.11
	193,309	1,762,842	198,613	1,889,672	9.51

[a] Includes slate pencils and metal workers' crayons and blanks used in making acetylene burners and other objects.

[b] For foundry facings, filler for paper, paint, and rubber goods, toilet powder, foot ease, lubricators for dressing skins and leather, etc.

The most notable feature of the second table is that the output of talc for manufacture into pencils and blanks was about seven times as large in 1917 as in 1916. The gain for the year was chiefly in manufactured form and in the crude form. There was a slight decline in the ground form and this seems remarkable in consideration of the large demand for ground talc used in the manufacture of paper as a substitute for English chalk, which has advanced in price.

IMPORTS.

The quantity of talc imported for consumption in 1917 was less than one-tenth of the domestic production, but a larger proportion of it than of the domestic production is of high grade. More than half of the talc imported comes from Canada and is of a grade that commands a higher price than the talc from the principal domestic sources.

Talc imported for consumption in the United States, 1916 and 1917.[a]

Kind.	1916			1917		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
Crude and unground steatite and French chalk [b]	2,027	$12,645	$6.24	2,452	$10,710	$4.37
Ground talc, or steatite cut, powdered, washed, or pulverized [c]	16,855	218,230	12.95	16,157	258,787	16.02
	18,882	230,875	12.34	18,609	269,497	14.48

[a] Statistics compiled from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.
[b] Duty free.
[c] 15 per cent duty.

General imports of talc, ground or manufactured, into the United States, 1916 and 1917.[a]

Country.	1916			1917		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
Austria-Hungary						
British South Africa	10	$124	$12.40			
Canada	5,964	75,029	12.58	10,287	$145,404	$14.13
England	1	38	38.00	55	869	15.80
France	3,570	20,791	5.82	1,512	11,024	7.29
French Africa				33	678	20.55
Germany						
Italy	7,105	121,254	17.07	4,167	98,064	23.53
Jamaica				66	1,220	18.48
Japan				10	184	18.40
Spain	11	400	36.36	1	11	11.00
Sweden	22	544	24.73			
	16,683	218,180	13.08	16,131	257,454	15.96

[a] Statistics compiled from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Although the quantity of imports in 1917 as compared with 1916, decreased about 1.5 per cent, there was an increase in value of more than 16 per cent. Italy has been our chief source of talc for toilet powder, and the high-grade material for cutting has come from Sweden, Spain, and from India through England. It is said that the resources of this grade in India are large.

SOAPSTONE.

Although the name "soapstone" is sometimes improperly applied to talc on account of its soapy feel, it is generally used correctly to designate a massive rock that is composed largely of talc. In its most valued form the grains of talc interlock and thus preclude a decided schistose or gneissoid structure, which would render it fissile and weak for structural purposes. The most important application of soapstone, depending on its resistance to heat, acids, and electricity, is in the manufacture of laundry tubs, laboratory table tops, tanks, sinks, fume hoods, switchboards, and in general insulation, besides many smaller uses growing out of its slow radiation of heat. The entire output in 1917, 20,235 tons, came from three mines in Virginia, and more than 75 per cent of it was sold in manufactured form, especially for laundry tubs and laboratory tables, but much is also sold in form of slabs for manufacture and a smaller quantity in the rough.

The soapstone of the Virginia belt is derived from the alteration of a large body of basic intrusive rock, extending northeastward through Nelson, Albemarle, and Orange counties, and affording a large reserve of soapstone for future years. Soapstone occurs also in Vermont, but the deposit has not been worked in recent years because of the larger slabs that can be obtained from the Virginia quarries.

GYPSUM.

By R. W. Stone.[1]

PRODUCTION.

The quantity of crude gypsum mined in the United States in 1917 was slightly less than that mined in 1916, owing largely to a reduction in building operations in the last quarter of the year. The output nevertheless exceeded that of any year previous to 1916.

Crude gypsum mined in the United States, 1908–1917, in short tons.

1908	1,721,829	1912	2,500,757	1916	2,757,730
1909	2,252,785	1913	2,599,508	1917	2,696,226
1910	2,379,057	1914	2,476,465		
1911	2,323,970	1915	2,447,611		

On the other hand, the total value of the crude and calcined gypsum produced in the United States in 1917 far surpassed that of any other year. In 1916, for the first time, the total value of gypsum products of the United States in a single year exceeded $7,000,000, but in 1917 they exceeded $11,000,000. The increase in 1917 was $3,157,420, or 40 per cent over the total value in 1916, as compared with an increase of $3,000,000 in the 10 years from 1907 to 1916.

Total value of crude and calcined gypsum, 1908–1917.

1908	$4,075,824	1912	$6,563,908	1916	$7,959,032
1909	5,906,738	1913	6,774,822	1917	11,116,452
1910	6,523,029	1914	6,895,989		
1911	6,462,035	1915	6,596,893		

The increase in value was due to increased cost of production, including higher wages and higher cost of all supplies. As a whole, the gypsum business was in excellent condition during the first eight months of 1917 but declined notably in the last quarter of the year. Gypsum was produced in 18 States and in Alaska. In 1917, as in former years, New York was the largest producer of raw gypsum, Iowa ranked second, and Michigan third. Sales are credited to Illinois, Minnesota, Washington, and Wisconsin, which are not producers of raw gypsum but in which there are mixing plants and warehouses that prepare plasters for the market. The plant in Washington calcines as well as mixes plaster. In eight States and in Alaska the output was less in 1917 than in 1916. The decrease in output at the one gypsum mine in Alaska is understood to have been due to the flooding of the mine. In California, Nevada, and Oklahoma the decrease was only nominal, but in Iowa, Michigan, New Mexico, Ohio, and Utah the decrease ranged from 5 to 25 per cent.

[1] The statistical tables in this report are the work of Miss L. M. Jones, statistical clerk, with the exception of those relating to imports and exports, which were compiled from the records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey.

Gypsum produced and marketed in the United States, 1916 and 1917.

State.	Number of mills reporting.	Total quantity mined (short tons).	Sold without calcining.				Sold as calcined plaster.		Total value.
			Ground for land plaster.		For Portland cement, paint, and other purposes.				
			Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	
1916.									
Alaska, Arizona, Colorado, Illinois,[a] Minnesota,[a] Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Virginia, Washington,[a] Wisconsin [a]	17	394,315	40,349	$85,606	69,511	$136,919	238,877	$1,129,775	$1,352,300
California	4	32,575	(b)	(b)	b17,863	b 34,431	12,385	74,630	109,061
Iowa	5	522,293	12,923	18,428	47,923	40,869	373,416	1,437,498	1,496,795
Kansas	4	78,257	(b)	(b)	b17,993	b 18,644	48,442	304,141	322,785
Michigan	8	457,375	9,072	16,658	71,226	74,315	292,109	975,626	1,066,599
New York	8	579,827	7,169	18,710	188,077	273,322	311,264	1,167,555	1,459,587
Ohio	4	286,678	4,309	8,046	7,306	10,637	247,802	909,176	927,859
Oklahoma	5	161,661	(b)	(b)	b 40,018	b 37,065	95,991	392,285	429,350
Texas	5	197,785			(c)	(c)	c 163,444	c 653,288	653,288
Wyoming	5	46,964					35,464	141,408	141,408
United States	65	2,757,730	81,879	167,136	465,240	623,294	1,805,814	7,168,602	7,959,032
1917.									
Alaska, Arizona, Colorado, Illinois,[a] Minnesota,[a] Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Virginia, Washington,[a] Wisconsin [a]	15	400,681	48,174	133,930	68,680	148,686	222,723	1,347,044	1,629,660
California	3	30,552	(c)	(c)	(c)	(c)	c 28,978	c 96,718	96,718
Iowa	5	461,864	14,194	30,253	50,818	80,488	322,198	1,931,256	2,041,997
Kansas	4	79,331	(c)	(c)	(c)	(c)	c 75,910	424,611	424,611
Michigan	8	375,803	7,090	22,903	61,065	93,750	257,588	1,452,002	1,568,655
New York	6	606,268	5,298	20,235	218,094	400,836	295,646	1,872,347	2,293,418
Ohio	4	270,538	4,100	11,765	6,510	16,615	219,679	1,276,117	1,304,497
Oklahoma	4	158,017	(c)	(c)	(c)	(c)	c 134,962	c 562,767	562,767
Texas	5	257,328	(c)	(c)	(c)	(c)	c 220,983	c 996,262	996,262
Wyoming	5	55,844	(c)	(c)	(c)	(c)	c 38,695	197,867	197,867
United States	59	2,696,226	84,366	230,808	539,629	893,562	1,677,390	9,992,082	11,116,452

a No crude gypsum produced in the State. b Some land plaster included with gypsum sold for Portland cement, etc. c Some crude gypsum included with calcined plaster.

Gypsum produced and marketed in the United States, 1913–1917.

Year.	Sold without calcining.											
	For Portland cement.			As land plaster.			For other purposes.			Total.		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
1913	a 408,221	a $600,913	$1.47	54,815	$95,953	$1.75	100	$200	$2.00	463,136	$697,066	$1.51
1914	a 390,742	a 549,083	1.41	52,945	97,716	1.85	....	....	....	443,687	646,799	1.46
1915	a 406,393	a 528,161	1.30	69,256	122,714	1.77	....	....	....	475,649	650,875	1.37
1916	a 454,112	a 607,995	1.34	81,879	167,136	2.04	11,128	15,299	1.37	547,119	790,430	1.44
1917	a 526,881	a 867,123	1.65	84,366	230,808	2.74	12,748	26,439	2.07	623,995	1,124,370	1.80

Year.	Sold calcined.														
	As plaster of Paris, wall plaster, Keenes cement, etc.			For dental plaster.			To glass factories.			As boards, tile, and blocks, and for other purposes.			Total.		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
1913	1,680,157	$5,858,785	$3.49	861	$4,168	$4.84	10,942	$21,797	$1.99	81,889	$193,006	$2.36	1,773,849	$6,077,756	$3.43
1914	1,565,937	6,038,777	3.86	641	3,374	5.26	(b)	(b)	....	b 89,488	207,039	2.31	1,656,066	6,249,190	3.77
1915	1,520,308	5,776,826	3.80	534	2,376	4.45	11,861	26,620	2.25	81,017	140,196	1.73	1,613,720	5,946,018	3.68
1916	1,677,081	6,884,960	4.11	661	8,766	13.26	11,537	28,839	2.50	116,535	246,037	2.11	1,805,814	7,168,602	3.97
1917	1,531,535	8,873,176	5.79	991	7,672	7.74	13,808	72,558	5.25	131,056	1,038,676	7.93	1,677,390	9,992,082	5.96

a A small quantity of paint material included with gypsum sold for Portland cement.
b Some calcined gypsum sold to glass factories included under "As boards, tile, etc.

The average price per ton of crude gypsum sold for use as retarder in Portland cement increased from $1.34 in 1916 to $1.65 in 1917. A very large part of the gypsum sold for this purpose is produced in New York. More than one-third of the gypsum sold as land plaster was marketed by the plants in Virginia, and its average price of $2.74 a ton in 1917 was 70 cents higher than that in 1916. Most of the 12,748 tons sold without calcining "for other purposes" is gypsum shipped to manufacturers of gypsum products, and no information is available as to its form when finally placed on the market.

The higher cost of manufacturing due to higher wages and to higher price of fuel and of all other supplies is reflected in the average price per ton of all gypsum sold calcined, which increased from $3.97 in 1916 to $5.96 in 1917, or 50 per cent. The average price of wall plaster and plaster of Paris, including Keenes cement, was $5.79 in 1917 as compared with $4.11 in 1916, an increase in price per ton of 41 per cent, which largely accounts for the increase of more than $3,000,000 in total value, although the quantity sold was less than in 1916.

Keenes cement was made in Kansas, Texas, and Utah, and the average price per ton varied but little among the producers. As the quantity of Keenes cement produced annually is less than 20,000 tons, the inclusion of this high-priced material with wall plaster and plaster of Paris does not change the average price per ton for these common plasters more than 1 or 2 cents.

In 1916 dental plaster was reported as produced in six States and at prices ranging from $6 to $23.50 a ton, with an average price of $13.26 a ton. In 1917 dental plaster was produced in the same six States, but the average price per ton was $7.74. This striking fluctuation in price was due to the fact that the lower-priced product greatly predominated in 1917, thus decreasing the average price. Prices reported in 1917 ranged from $6 to $25 a ton.

Practically all the calcined gypsum reported sold to plate-glass factories was produced in Michigan and Ohio. The increase in average price per ton from $2.50 to $5.25, or more than 100 per cent, is the highest percentage of increase recorded.

Plaster board, tile, and blocks were made in 1917 at 19 plants in 12 States, and the gypsum plaster entering into the products amounted to 125,511 tons, valued at $1,022,425. The average price of $8.15 a ton represents a very large increase over the price in 1916.

BUSINESS CHANGES.

The Rex Plaster Co., of Los Angeles, Cal., surrendered leases, sold its property at the end of 1917, and went out of business. The property of the National Plaster Co., Carlsbad, N. Mex., was taken over November 1, 1917, by the Globe Plaster & Mining Co., which began to operate the plant in January, 1918. The Thos. Millen Co., Jamesville, N. Y., relinquished its gypsum property July 1, 1917, to the Alpha Portland Cement Co., which continued the production of crude gypsum.

NEW DEVELOPMENTS.

The United States Gypsum Co. did a considerable amount of development work at a gypsum deposit 10 miles east of Lewistown, Mont., during 1917, and in the spring began operating a new plant at Piedmont, S. Dak. At this new plant both light and dark plaster are produced. Gypsite is dug with horse scrapers, and rock gypsum is taken from a quarry and also mined underground. The mill machinery is driven by electricity, and all the equipment is of the highest efficiency.

The Dakota Plaster Co., whose plant at Black Hawk, S. Dak., was burned in 1916, put a new mill into operation at the same location in 1917.

MINE AND MILL DATA.

There were 66 active gypsum mines, quarries, and pits in the United States and Alaska, which supplied 59 domestic mills in 1917. Two mills sold ground gypsum only, 27 sold only calcined material, and 30 sold both calcined and uncalcined gypsum. Of the 59 mills, 41 used rock gypsum, 8 used gypsite, and the others used both gypsum and gypsite, except 1 plant which reported the use of selenite crystals.

Practically all the mills are equipped with kettles for calcining. The fuel used was coal at 39 plants, oil at 12 plants, wood at 1 plant, coal and oil at 4 plants, and coal and coke at 1 plant.

Four plants reported the manufacture of Keenes cement and 19 plants reported making gypsum blocks or boards.

Domestic gypsum was calcined in 1917 at plants in the following places:

Arizona: Douglas.
California: Amboy, Los Angeles.
Colorado: Loveland, Portland.
Iowa: Fort Dodge.
Kansas: Blue Rapids, Medicine Lodge.
Michigan: Alabaster, Grand Rapids, Grandville.
Montana: Hanover.
Nevada: Arden, Moundhouse.
New Mexico: Acme.
New York: Akron, Garbutt, Oakfield.
Ohio: Castalia, Gypsum, Port Clinton.
Oklahoma: Acme, Eldorado, Okeene, Southard.
Oregon: Gypsum.
South Dakota: Black Hawk, Piedmont.
Texas: Acme, Plasterco.
Utah: Nephi, Sigurd.
Virginia: North Holston, Plasterco.
Washington: Tacoma (using Alaska gypsum).
Wyoming: Kane, Laramie, Red Buttes, Stucco.

Imported gypsum from Nova Scotia was calcined in 1917 at New Haven in Connecticut, at Brooklyn, New Brighton, Newburgh, and New York City in New York State, and at Chester in Pennsylvania.

IMPORTS.

Gypsum imported into the United States comes almost exclusively from Nova Scotia and New Brunswick. As the principal quarries are on the Bay of Fundy, which is closed to navigation by ice during part of the winter, the rock is shipped by boat in the open season and stored at the plants in stock piles calculated to last through the winter and spring. Several barges towed by steam tugs, one motor barge, and a few schooners (with and without auxiliary power) are regularly engaged in the coastwise traffic. Shipments can be made all the way by rail, or from the quarries to Halifax by rail and thence to this country by boat, but this is not customary because of the higher cost and the difficulty of getting freight cars delivered to the plants in and around New York City. A tow of barges coming loaded and returning empty can make the round trip between the Bay of Fundy and New York in 12 days.

Domestic calcining plants using Canadian gypsum are located around New York City, at Newburgh on the Hudson, at New Haven, Conn., and at Chester, Pa. Their output is very largely mixed wall plaster, molding, casting, and finishing plaster, and to a less degree plaster board and block and dental plaster. A small quantity is ground and sold without calcining for use in paint and paper mills and as terra alba.

The pure white alabaster from New Brunswick and Nova Scotia makes a particularly white, even-textured, smooth-working plaster and is in demand especially for the finish coat on walls, for making moldings and cornices, for molds used in making pottery, and for dental plaster. It is understood that there is no gypsum in the United States east of Mississippi River that is equal to the best grade from New Brunswick and Nova Scotia for pottery molds, dental work, and ornamental casting. The plaster made from these Canadian gypsums has an extensive use in potteries because it is a more uniform absorber of moisture and because the molds last longer than those made from most of the domestic gypsum. Molds of imported gypsum are not stronger, but pinholes do not form in them so soon as in molds made from most of the domestic gypsum. Recently molding plaster made from gypsum quarried at Southard, Okla., has won part of the pottery market in Ohio and other States in competition with the imported plaster.

Dental plaster made from Canadian gypsum has fine texture, uniform set, and smooth working qualities, and supplies a considerable part of the demand in this country.

On account of severe curtailment of building operations in 1917, high ocean freight rates, and transfer of the gypsum fleet to coastwise transportation of coal, the quantity of gypsum imported in 1917 was less than in 1916. The proportionate value of imports to domestic production is small and decreasing. It has fallen from one-seventeenth in 1915 to one twenty-second in 1916, and to about one twenty-seventh in 1917.

Gypsum imported and entered for consumption in the United States, 1912–1917.[a]

Year.	Unground.		Ground or calcined.		Value of manufactured plaster of Paris.	Total value.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.		
1912	412,697	$430,183	3,702	$19,709	$38,589	$488,481
1913	447,383	473,594	4,542	31,277	52,051	556,922
1914	369,214	392,118	3,559	27,931	24,792	444,841
1915	336,856	356,791	5,749	22,873	10,095	389,759
1916	254,131	275,043	11,706	72,345	9,085	356,473
1917	240,269	265,504	16,533	109,732	5,955	381,191

[a] Figures compiled from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

EXPORTS.

Exports of gypsum have not been reported previously. Figures are available for exports of gypsum plaster board and plaster of Paris in 1916 and the first half of 1917. Since June, 1917, these articles have not been reported separately but listed under the head "All other," although the value of exported plaster of Paris in the first six months of 1917 was 54 per cent greater than for the whole of 1916. Data in the following table are from the Bureau of Foreign and Domestic Commerce, Department of Commerce:

Value of plaster of Paris and plaster or wall board exported, 1916 and 1917.

Country.	Plaster of Paris.		Plaster or wall board.	
	1916	1917	1916	1917
Europe:				
Denmark		$16		
France	$50			$68
Italy		2		5
Norway				550
Russia	3			
Spain		2	$63	632
United Kingdom:				
England	141	81	30,094	7,765
Scotland	260			
North America:				
Bermuda	8	3	125	
British Honduras	17	9		41
Canada	5,700	3,700	5,485	28,316
Central America:				
Costa Rica	40		15	
Guatemala	125	548		9
Honduras	54	24		4
Nicaragua	44	2		
Panama	186	299	9	26
Salvador	14	2	82	
Mexico	88	409	328	487
Newfoundland	482	35		471
West Indies:				
Barbados	10			
Jamaica	84	63	38	
Trinidad and Tobago	24	80		66
Other British	42	14	103	
Cuba	3,394	11,225	13,782	2,424
Virgin Islands	49	50	500	
Dominican Republic	47	522	20	
Dutch West Indies		3		
Haiti	14	311	144	163
South America:				
Argentina	434	280	2,622	12,813
Brazil	469	1,577	50	864
Chile	45	45	10,617	6,386
Colombia	126	157	141	
Ecuador	1		32	
Guiana:				
British	43	41		
Dutch		2		
Peru	3	104		
Uruguay	58	8		1,046
Venezuela	80	86	46	
Asia:				
China	172	29		257
East Indies:				
British India	4			5,282
Other British East Indies			92	145
Dutch East Indies	248			
Hongkong		98		
Japan	167	55	1,294	
Australia	31		26,249	36,696
New Zealand	78	66	6,996	88
French Oceania		23		
Philippine Islands		102		
Africa:				
British Africa:				
South	241	80	6,447	1,419
West			133	95
Egypt			2,998	
	13,076	20,153	108,505	106,118

It is interesting to note that the increase in value of exports of plaster of Paris to Cuba in the first half of 1917 over the whole year 1916 is greater than the increase in value of exports of the same material to all other countries for the same period. Cuba, Canada, and Brazil take the bulk of the exported plaster. Cuba does not produce gypsum, and although Canada is the world's third largest producer, nevertheless she imports gypsum products. Gypsum plants in central New York are nearer to Ottawa and Montreal than are any of the Canadian plants.

England, Canada, Cuba, Argentina, Chile, and Australia have been the largest buyers of gypsum plaster board.

PRODUCTION IN CANADA.[1]

Gypsum produced and marketed in Canada, 1916 and 1917.

Year.	Quantity (short tons).	Value.
1916	342,915	$738,593
1917	339,418	887,170

The total quantity of gypsum rock quarried in Canada in 1917 was 365,959 short tons, of which 97,667 tons was calcined. The shipments of all grades amounted to 339,418 tons, valued at $887,170, and included lump 226,846 tons, valued at $251,960; crushed 32,305 tons, valued at $51,869; fine ground, 4,843 tons, valued at $19,222; and calcined 75,424 tons, valued at $564,119.

USES.

IN WAR.

Although gypsum is not classed as a war mineral it is used in many ways by both Army and Navy and by other organizations directly connected with the prosecution of the war. Its largest application is for building material, but no less interesting is its use in various ways for the comfort and convenience of the combatants themselves. Few of the uses are distinctively military, practically all of them being civilian as well.

In the last few months thousands of tons of gypsum plaster have been used in making roofs for naval gun shops, warehouses, and other Government buildings, besides the gypsum wall plaster for interior finish. Hundreds of thousands of gypsum plaster boards are used instead of lath and plaster for the interiors of temporary buildings erected by the Government for offices, hospitals, shops, warehouses, and barracks, and gypsum block in large quantities goes into the construction of buildings of a more permanent character. Portland cement, which is used in permanent fortifications, dry docks, gun emplacements, and for many other purposes in military construction, contains a small percentage of gypsum which plays an impotrant part in regulating the setting of the cement.

Models of battlefields and trenches used for instruction in military schools are made of plaster of Paris. Carborundum wheels used for shaping parts of automobile and airplane engines and for grinding rifles, bayonets, and shrapnel are molded and vitrified in gypsum, and chemical stoneware specially designed for the manufacture of

[1] Preliminary report on the mineral production of Canada during the calendar year 1917, Canada, Dept. Mines, Mines Branch.

explosives is cast in gypsum plaster molds, as are also porcelain closets and other sanitary ware and the crockery used in cantonment mess halls.

Plaster of Paris is used by surgeons for casts around broken limbs and in orthopedic surgery, either in bulk or by means of open-mesh bandages filled with plaster; likewise specially prepared gypsum plaster is used by dental surgeons in taking impressions and making models for replacing teeth and for concealing faces disfigured in battle. Many of the buttons on military clothes are now made of gypsum composition.

ROOF DECKS.

A recent development in roof building is the application of gypsum in long-span beams and deck slabs. Gypsum tile 3 inches thick and 30 inches long, reinforced with metal, have been used for 10 years or more for the roof decks of laundries, foundries, textile mills, and other buildings where condensation of moisture on the underside of a cool roof deck causes considerable trouble. As gypsum has low heat conductivity its use in the roof deck prevents condensation or drip and stops heat losses through the roof in winter.

In 1916 a long-span beam in T and ⌶ section and as much as 10 feet in length was introduced and used. In 1917 an improved long-span gypsum tile with channel (⊓) section was introduced, gained favor, and is being used on factory roofs of large area and on large Government buildings, including naval gun shops, ammunition warehouses, and docks. The tile are made with reinforcing metal fabric on the broad face and reinforcing rods looped at the ends embedded in the sides. The tile are 15 to 22 inches wide, 6 to 10 feet long, 4 to 7 inches thick, and weigh 16 to 20 pounds per square foot. They require less supporting steel than concrete roof decks, and are quickly put in place at a low cost of erection. Common practice is to mold 6-foot tile at the mill, and to mold longer tile where the building is to be erected. For field molding, however, an order of at least 50,000 square feet may be required.

Another type of gypsum roof deck is that which is cast in place, in the same manner as concrete. To make such a roof requires a form of matched boards dressed smooth and oiled. For T-beam structure, lengths of dressed 2 by 4 inch stock may be nailed flatwise on the tight floor of the mold. These are to core out the spaces between the T-beam stems. These cores should be dressed, given strong draft on ends and sides, and finished like a foundry mold pattern. A roof cast in place is best poured in strips about 3 feet wide. One side of the strip must be bulkheaded and to the proper height, so that a screed moved along it will true the gypsum to the proper surface. Metal reinforcing rods may be placed in each T-beam stem and a 3-foot strip of wire mesh over the top. The finished deck is monolithic and can be covered with any type of roofing.

PLASTER BOARD.

Plaster board consists of a thin sheet or sheets of gypsum plaster fabricated between sheets of tough, fibrous binding material. A type of board in common use consists of two layers of felt with one layer of plaster between. Other boards consist of three or four layers of felt or paper with alternate layers of gypsum. The boards are made one-fourth, three-eighths, and one-half inch in thickness. In order to meet standard 16-inch spacing of joists and stubs, plaster boards are usually 32 by 36 inches. They are made in other sizes, however, to meet special requirements. They are now made 4 feet wide and 10 feet long to facilitate rapid covering of large areas and to compete in size with lighter but inflammable wood composition boards.

Plaster boards are used for lathing in place of wood or metal lath on surfaces that are to be plastered and where high fire-resistant construction is desired, and they are used in place of lath and plaster. Those used for lathing are surfaced with felt or with chip paper made from waste and news paper, which is gray because of the ink on the raw material. This gives an excellent bonding surface for gypsum plaster. Board used for a finished wall without a coat of plaster may be surfaced with wood-pulp paper, which has some finish. These boards are nailed direct to studding and joists and may be finished with thin wooden strips over the joints. Toward the end of 1917 large quantities of gypsum plaster board were used in the interior of temporary office and other buildings erected by the Government at Washington and elsewhere. This use increased early in 1918.

BLOCKS AND TILE.

Blocks and tile made of gypsum plaster are used for partitions, roofing, flooring, and furring. They are usually made 30 inches long, 12 inches wide, and 2 to 8 inches thick, either solid or hollow. They are used in the highest type of fireproof building for dividing and corridor partitions, in elevator and stairway inclosures, and in roof and floor decks. They are light in weight, can be cut with a handsaw, and, when plastered with gypsum, make partitions of high heat-resistant value.

In arid climates precast gypsum plaster blocks may be used for exterior walls and are strong enough to support the weight of two-story structures. The fact that they are used in certain parts of Wyoming, Utah, and Arizona with success suggests the possibility of using blocks molded from gypsum plaster for the walls of temporary hospitals, warehouses, and other low buildings in which there will be no great weight or jar from machinery. These blocks should be strong enough to sustain the relatively small load imposed upon them and if properly waterproofed, should resist the weather for a number of years or for the duration of the war, even in the moist climate of the Eastern and Central States. Where concrete aggregate is scarce or very expensive and gypsum is obtainable in quantity, gypsum block and tile might well be used for the walls and roofs of temporary buildings of low and light construction.

SURGICAL PLASTER.

Plaster of Paris is used by surgeons for casts around broken limbs and in other similar supports—a special use which does not take a large quantity of plaster annually but for which there is no equally available and suitable substitute. The qualities that make the plaster valuable are that it is plastic, sets quickly, and makes a strong support. Furthermore, the cast is a nonconductor of heat and is not affected by moisture.

Plaster of Paris is applied in orthopedic surgery by means of bandages. Open-mesh bandages of various widths are passed through a tray containing dry orthopedic plaster, which is made of fine and coarse particles to insure uniform filling of the meshes. The plaster is mixed over and through the bandage, which is then wound tight in advance of use. Before use the rolls are soaked in water for about two minutes; then the surgeon unrolls the plaster bandage and winds it firmly about the fractured, sprained, or deformed part, intermixing additional wet plaster where necessary. The result is a close-knit, tough, strong splint.

Plaster of Paris for the use of dental surgeons is prepared in several grades. An extremely fine-grained plaster to which an accelerator has been added is used for taking impressions in the mouth. This is known as impression plaster. Quick set and reproduction of fine details are the qualities demanded in such work. Plaster for making dental casts and models is not so fine grained as the finest impression plaster and sets slower and harder.

BUTTONS.

A new development in the use of gypsum is as a substitute for horn and hard rubber. A number of small articles in common use are now made with raw gypsum as the principal constituent of their composition. Among these are buttons. Finely ground raw gypsum mixed with shellac, rosin, flock, and coloring matter is molded hot in an automatic press into buttons of various sizes and shapes. The composition takes sharp impression and smooth finish and is not easily broken. The Government has ordered millions of gypsum buttons for use on military uniforms. Other articles made of the same composition are checkers, poker chips, and music-roll flanges.

MISCELLANEOUS USES.

Strong gypsum plaster is used in shaping novaculite grinding stones. Fragments of novaculite are set in plaster, making a block 2 or 3 feet across, and are then cut by gangsaws. Gypsum plaster is used by some copper smelters in the United States as a binder for concentrates and flue dust. It is mixed with the flue dust and sacked. The plaster sets, making the contents of the sack a solid block, which is sent to the furnace for recovering the values originally carried away in the flue dust.

A patent has been issued for cleaning wool with overburned gypsum. Calcined gypsum with the addition of coloring matter and glue is used for tinting walls. It needs only the addition of water to be ready for use. The common blackboard crayon known as chalk is made of finely pulverized raw gypsum to which a binder has been added; in colored crayons a pigment has also been added. Gypsum is used as a filler in the composition of some rubber goods, including certain kinds of automobile tires.

Other uses of gypsum, including land plaster and wall plasters, are described by the writer in a recent publication on gypsum products,[1] issued by the Bureau of Mines, Department of the Interior. That publication may be obtained free on application to the Director, Bureau of Mines, Washington, D. C.

[1] Stone, R. W., Gypsum products, their preparation and use: Bur. Mines Tech. Paper 155, pp. 66, 1917.

GRAPHITE.

By Henry G. Ferguson.

INTRODUCTION.

The peculiar physical properties of graphite—infusibility, chemical inertness, high conductivity, extreme softness, and low specific gravity—fit it for many uses, such as the manufacture of crucibles and other refractory products, lubricants, lead pencils, paint, foundry facings, as a preparation to loosen boiler scale, as polish for gunpowder, and for various applications in electrical work.

Natural graphite may be either crystalline or amorphous. The term crystalline or flake graphite is commonly understood to mean graphite in crystals large enough to be visible to the naked eye; much of the so-called amorphous graphite shows a crystalline structure under the microscope. Crystalline graphite occurs either in veins, as in the Ceylon deposits, or as flakes disseminated through the country rock, as in most of the crystalline graphite deposits of the United States. Most deposits of amorphous graphite are the result of the alteration of coal beds by the intrusion of igneous rocks. Amorphous graphite is also made artificially by means of the electric furnace.

USES OF GRAPHITE.

By far the most important use of graphite is in the manufacture of crucibles, and for this reason graphite is a mineral resource of vital importance in time of war, and American producers of flake graphite have greatly increased their output. The makers of crucibles have also greatly increased their production during the last two years. Graphite for making crucibles must be of great purity. Its content of graphitic carbon should exceed 85 per cent and should preferably be as high as 90 per cent, and it must be practically free from mica, pyrite, and iron oxide. A small amount of quartz is not injurious. Graphite for making crucibles should also be coarse enough for the interlocking fragments to be easily bound together by the clay with which it is mixed. It should preferably contain a large proportion of flakes about 1 millimeter in diameter and should all remain on a 100-mesh sieve.

Most makers of crucibles prefer to use Ceylon graphite mixed with 10 to 25 per cent American flake, in part because the more nearly cubical fragments of Ceylon graphite have a much smaller surface area in proportion to their volume than the thin flakes of the domestic graphite and hence require proportionately less clay as a binder. Ceylon graphite is also more nearly free from undesirable impurities such as mica and pyrite. It is possible, however, to use domestic flake graphite alone with good success in crucible manufacture. In recent commercial tests of crucibles made with Alabama flake graphite and domestic clay three No. 80 crucibles, tested in copper melting, gave 21 heats each, and a fourth 42 heats. There is, however, no immediate prospect of a sufficiently increased domestic production to supply the needs of crucible manufacturers, and graphite must still be imported from Ceylon and Madagascar, but it is believed that the percentage of domestic material used could be increased. The only American graphite resembling the Ceylon material is produced in small amount in Montana.

The difficulties encountered since 1914 in finding satisfactory supplies of clay have now been largely overcome, and the crucibles made with domestic clays are of much better grade than formerly. A part of the great demand for crucibles has been due to the fact that crucibles made with domestic clays did not stand as many heats as those made with the Bavarian clay and consequently a larger number were required to accomplish the same work. According to McNaughton,[1] the results attained in the early attempts to use domestic clays were very unsatisfactory. In certain tests only 4 or 5 heats were secured with crucibles of average size, as against 25 to 30 heats before the war. At present from 15 to 25 heats is the range of average service. The cost of the domestic clay, however, is more than double that of the German clay used prior to the war.

Graphite for other uses does not require the same grade of material as for crucibles, and for most purposes amorphous graphite can be used with as good effect as the crystalline variety. Graphite for foundry facings, commonly known as "silver lead," is of varying degrees of purity, according to the work required. Ceylon dust was formerly used to a considerable extent for this work, but the present high prices, due to the high freight rates, have greatly decreased its use. Next to crucibles, foundry facings probably absorb more graphite than any other single use.

Lubricating graphite must be of a high degree of purity and absolutely free from gritty substances, such as quartz. As size of grain is not essential, either amorphous or crystalline graphite may be used.

For pencils either amorphous graphite alone or a blend of amorphous and fine-grained crystalline graphite is employed. The graphite is mixed with clay in varying proportions, according to the hardness desired. In order that the product shall be uniform, very pure graphite is required.

For other uses, such as fillers for dry batteries, facings for molds, polish for explosives, paints, boiler mixture, and many similar requirements, either crystalline or amorphous graphite may be used, and the degree of purity essential varies according to the nature of the use.

[1] McNaughton, M., The crucible situation: Metal Industry, vol. 15, pp. 431–432, 1917.

DOMESTIC PRODUCTION.

CRYSTALLINE GRAPHITE.

The increase in metal manufacture incident to the progress of the war has brought a greatly increased demand for crucible graphite, and the amount of graphite suitable for crucible use, both domestic and imported, consumed during the year was approximately 30,000 short tons, as against 13,500 short tons in 1913. The domestic production has responded to the greater demand and during the last three years has shown a steady increase.

The actual mine production during 1917 has shown a notable gain. The total production, including stocks on hand at the mines, was approximately 14,000,000 pounds as against about 10,900,000 pounds in 1916. The figures for sales, however, which are used as the basis of the following tables, show a slight decrease. This is due principally to the facts that owing to the freight congestion the Alabama producers have had great difficulty in shipping their product and that many new companies have been unable to begin production owing to delay in procuring the necessary equipment. During the last three months of 1917 shipments of crystalline graphite from the Alabama field were only about 25 per cent of the capacity of the mills. The extremely severe winter also curtailed production, both in Alabama and in New York. In Pennsylvania the sharp decrease compared with 1916 is due to the remodeling of several of the larger plants. Many of the mills had large stocks on hand at the end of the year, but as the Survey's figures of production are based on sales, the amount of these stocks is not included in the total for the year.

Estimates furnished by the producers of crystalline graphite show that out of the total sales of 10,584,080 pounds, 6,816,913 pounds, valued at $982,336, or about 64 per cent by weight and 90 per cent by value of the total, was flake graphite containing from 80 to 90 per cent graphitic carbon, in large part suitable for crucible use. The remainder, 3,767,167 pounds, valued at $112,062, was dust or low-grade flake probably averaging under 50 per cent graphitic carbon. The proportion of flake produced is higher than in previous years, owing in part to improved milling methods, whereby a larger proportion of the graphite was saved as flake, and in part to the fact that because of the freight embargo during the later part of the year such shipments as the Alabama producers were able to make consisted mainly of the better-grade material.

As usual, the greater part of the domestic crystalline graphite was produced in Alabama, New York, and Pennsylvania. The production of these States was all of the variety known in the trade as flake graphite, which occurs as small flakes forming 3 to 10 per cent, by weight, of crystalline schists. In addition, crystalline graphite, resembling in a general way the Ceylon graphite, was produced in Montana, and a small quantity of flake graphite was mined in California and Texas. The quantity of crystalline graphite in 1917 was slightly less than the sales for the preceding year, but the value showed an increase of 20 per cent over 1916. The number of producers of crystalline graphite was 14 in Alabama, 1 in Alaska, 1 in

California, 1 in Montana, 4 in New York, 5 in Pennsylvania, and 1 in Texas.

Crystalline graphite sold in the United States, 1916 and 1917.

	1916		1917			
					Total.	
	Quantity (pounds).	Value.	No. 1 and No. 2 flake (pounds).	Other grades (pounds).	Quantity (pounds).	Value.
Alabama	5,226,940	$492,407	4,295,233	1,927,862	6,223,095	$719,575
New York	(a)	(a)	1,656,897	1,284,143	2,941,040	261,548
Pennsylvania	1,095,716	103,377	549,783	255,162	804,945	77,475
Other States b	4,609,333	318,964	315,000	300,000	615,000	35,800
	10,931,989	914,748	6,816,913	3,767,167	10,584,080	1,094,398

a Included in "Other States."
b 1916: California, Montana, New York, and Texas; 1917: Alaska, California, Montana, and Texas.

AMORPHOUS GRAPHITE.

The production of amorphous graphite during 1917 was 8,301 tons, valued at $73,481, as compared with 2,622 tons, valued at $20,723 in 1916. As amorphous graphite is not suitable for use in crucible manufacture, war conditions have not increased the demand for it to so marked a degree as for crystalline graphite. Moreover, the production of flake graphite for crucible use yields a large amount of dust as a by-product, and this dust is available for practically all uses to which amorphous graphite can be put.

The better grades of amorphous graphite are imported from Mexico and Chosen, and the imports, like those of crystalline graphite, greatly exceed the domestic production. Artificial amorphous graphite is also a competitor of the natural product.

Amorphous graphite was produced by 6 mines in 1917, as against 5 in 1916. The producing States were Colorado, Michigan, Nevada, and Rhode Island. On account of the small number of producers, figures showing the production by States can not be published without disclosing individual returns.

ARTIFICIAL GRAPHITE.

Graphite is manufactured chiefly by the International Acheson Graphite Co., which utilizes electric power generated at Niagara Falls. The output has increased greatly in recent years and now forms an important element in the country's graphite supply. The bulk graphite is made either from anthracite or from petroleum coke and is utilized mainly in lubricants and paints and for foundry facings, boiler-scale preventives, and battery fillers.

Besides the graphite products that enter into competition with natural graphite, there are a large number for which artificial graphite is particularly adapted. Chief among these is graphite electrodes, the demand for which has greatly increased during the last three years on account of the remarkable growth in certain electrochemical industries.

The table on page 110, showing the increase in the manufacture of electric-furnace steel, indicates the increase in the demand for graphite electrodes. It is stated that the production of electric-furnace steel in this country is now about eight times that of crucible steel and one-eighth that of Bessemer steel,[1] and that in 1917 there were 223 electric steel furnaces in the United States, compared with 136 in 1916.[2]

IMPORTS.

The following table shows the imports of graphite into this country since 1913. As the war has disarranged the usual trade routes and as the statistics of the Bureau of Foreign and Domestic Commerce necessarily show only the country from which shipments were made, it is necessary to draw some inferences as to the country of origin. Graphite entered in the import statistics as coming from France is probably all of Madagascar origin, and all graphite imported from Great Britain has been assigned to Ceylon. Similarly shipments from Japanese ports are assumed to represent Chosen graphite as the Japanese graphite production is of minor importance. The imports from Canada in 1914 and 1915 were in excess of the Canadian production for these years, so it is probable that these imports include a certain amount of Ceylon material.

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[1] Iron Age, vol. 99, pp. 1132–1133, 1917.
[2] Idem, vol. 101, p. 113, 1918.

Graphite imported into the United States, 1913–1917.[a]

Country exporting.	Probable country of origin.	Quantity (short tons).					Value.				
		1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Other British East Indies	Ceylon	16,996	8,374	12,275	24,411	24,304	$1,674,764	$920,147	$1,564,917	$5,846,515	$7,075,143
England	do		381	2,216	561	6		42,446	261,321	166,847	1,566
British India	do		127		1,260	265		9,815		343,170	102,499
Total, Ceylon		16,996	8,882	14,491	26,232	24,575	1,674,764	972,408	1,826,238	6,356,532	7,179,208
Netherlands	(?)			36					2,811		
Dutch East Indies	(?)				169					21,484	
Madagascar	Madagascar		155	36				18,426	2,831		
France	do		194	1,432	1,631	4,393		20,278	181,236	241,863	1,057,081
Total, Madagascar			349	1,468	1,631	4,393		38,704	184,067	241,863	1,057,081
Canada	Canada	1,662	1,806	2,995	4,127	3,476	98,665	92,536	116,407	314,177	349,034
Brazil	Brazil				1	18				75	4,380
Mexico	Mexico	4,435	4,259	1,680	5,331	7,570	198,000	190,075	75,000	238,000	285,568
Chosen	Chosen				337	137				10,534	5,483
Japan	do	4,170	6,327	2,373	5,038	2,314	58,199	96,433	35,292	93,085	77,652
Japanese China	do					11					423
Total, Chosen		4,170	6,327	2,373	5,375	2,462	58,199	96,433	35,292	103,619	83,558
Italy	Italy	236	254	27	151	115	4,061	3,203	994	4,133	3,092
Austria	Bohemia	660	78				9,957	1,258			
Germany	Bavaria	90					4,034				
Other countries		630	47	5			62,111	3,644	354		67
Grand total		28,879	22,002	23,075	43,017	42,609	2,109,791	1,398,261	2,241,163	7,279,883	8,961,988

[a] Compiled from reports of the Department of Commerce.

After the outbreak of the European war and before the entrance of the United States, guaranties were required by the British and French Governments of importers and users of Ceylon and Madagascar graphite, in order to prevent its falling into enemy possession. At present all graphite imports must be consigned to the Plumbago-Graphite Association, a voluntary association of importers, which supervises the imports and exacts similar guaranties.[1]

The necessity of conserving shipping requires that imports shall be reduced as far as possible without seriously affecting industry, and therefore, under the President's proclamation of February 16, 1918, licenses from the War Trade Board are now required for all imports. Graphite is among the list of restricted commodities announced by the War Trade Board on March 23, 1918. Imports of graphite are prohibited between April 15 and July 1, 1918, and 5,000 long tons allowed during the remainder of the year.

TOTAL SALES AND IMPORTS.

Domestic natural graphite sold, 1912–1917.

Year.	Amorphous.		Crystalline.		Total.	
	Quantity (short tons).	Value.	Quantity (pounds).	Value.	Quantity (short tons).	Value.
1912	2,063	$32,894	3,543,771	$187,689	3,835	$220,583
1913	2,243	39,428	5,064,727	254,328	4,775	293,756
1914	1,725	38,750	5,220,539	285,368	4,335	324,118
1915	1,181	12,358	7,074,370	417,273	4,718	429,631
1916	2,622	20,723	10,931,989	914,748	8,088	935,471
1917	8,301	73,481	10,584,080	1,094,398	13,593	1,167,879

Graphite imported for consumption in the United States, 1912–1917.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1912	25,643	$1,709,337	1915	23,075	$2,241,163
1913	28,879	2,109,791	1916	42,930	7,279,884
1914	21,990	1,398,209	1917	42,577	8,961,988

EXPORTS.

The United States imports so much graphite that exports are comparatively unimportant. From 1914 to 1916 there was a considerable increase in the exports of manufactured graphite articles and a marked falling off in the exports of unmanufactured graphite. During 1917, however, exports of unmanufactured graphite increased greatly, while exports of graphite manufactures declined.

[1] Plumbago-Graphite Assoc. Bull. 1, New York, 1917. Copies may be obtained from J. M. Naylor, secretary, care of Henry W. Peabody & Co., 17 State Street, New York.

Exports of graphite, 1912–1917.

	Unmanufactured graphite.		Manufactures of graphite.
	Quantity (pounds).	Value.	
1912	4,640,802	$383,458	$177,082
1913	5,383,981	391,906	238,302
1914	3,920,693	277,386	215,878
1915	1,057,764	52,583	536,572
1916	1,595,608	98,118	1,339,259
1917	5,146,816	349,563	891,687

Exports of unmanufactured graphite in 1915 went principally to England, France, Canada, Denmark, and Holland; in 1916 to England, Canada, France, Spain, and Japan; and in 1917 to England, France, Canada, and Italy. Graphite manufactures in 1915 were exported principally to England, France, Canada, Switzerland, and Denmark; and in 1916 to Canada, England, France, Portugal, and Italy.

Under the President's proclamation of August 27, 1917, and supplementary lists published by the War Trade Board, graphite crucibles, graphite electrodes, graphite, flake graphite, and plumbago (Ceylon graphite) are placed on the list of "commodities whose conservation is necessary on account of the limited supply and the needs of the United States in its successful prosecution of the war." Consequently these articles may not be exported, except by special license from the War Trade Board.[1]

MARKETS AND PRICES.

Domestic flake graphite brought slightly higher prices in 1917 than in 1916. The prices received at the mines for the best grades ranged from 12 to 18 cents a pound for No. 1 flake, according to its grade; from 6 to 10 cents a pound for Nos. 2 and 3; and from half a cent to 5 cents a pound for dust. Flake graphite containing 90 per cent or more of graphitic carbon sold for considerably higher prices than the usual product containing 85 per cent carbon or less. Prices reported by purchasers were, in general, from 12 to 17 cents a pound for No. 1 flake and occasionally prices as high as 20 cents a pound for special lots, 9½ to 12 cents for No. 2, and 1 cent to 9 cents for lower grades. Ceylon graphite was hard to obtain during the summer, and domestic flake was consequently in great demand, but in September large quantities of Ceylon graphite became available and the manufacturers no longer required the domestic product. This new supply, coupled with the difficulty of rail shipments, due to the freight embargoes, seriously affected the domestic industry.

The prices paid at the mines for the highest-grade domestic graphite have been as follows: 1911 and 1912, 6 to 7 cents a pound; 1913, 6 to 8 cents; 1914, 6½ to 8 cents; 1915, 7 to 10 cents; 1916, 10 to 16 cents; 1917, 12 to 18 cents.

[1] War Trade Board Bull. 1, 1917.

Ceylon graphite of the better grades is more largely used by crucible makers than domestic flake graphite and even in normal times commands a higher price. During the last three years the tremendous increase in crucible manufacture has caused a demand for the Ceylon product greatly in excess of the available supply and the price has constantly increased. The sharp increase of price for all grades of Ceylon graphite in 1916 over that for previous years was due in part to the fact that a much larger proportion of the highest-grade product was imported. During 1917 the prices of Ceylon graphite in the eastern market were approximately as follows: Lump, 27 to 30 cents a pound; chip, 19 to 24 cents; dust, 7 to 14 cents, according to grade. These prices show only a slight increase over those for 1916.

Madagascar graphite is a flake graphite similar to the crystalline graphite produced in this country, but the flakes are larger and thicker. The prices during 1917 ranged from 11 to 14 cents a pound, or slightly lower than those for domestic graphite. The Mining Journal (London) since June 9, 1917, has given weekly quotations for Madagascar graphite based on 80 and 85 per cent carbon with an allowance of 15 francs per metric ton per unit of variation. These quotations showed a range in prices (f. o. b. Tamatave) of 900 to 950 francs per metric ton for 85 per cent material. During the later part of the year the price quoted was 1,250 francs f. o. b. Marseille for 80 per cent material, or about 10 cents a pound at prevailing exchange rates, and 900 francs f. o. b. Tamatave for 85 per cent, in each case with an allowance of 15 francs per unit of carbon variation. The average value of material imported into this country, as shown by the import figures of the Bureau of Foreign and Domestic Commerce, is 12.3 cents a pound.

The following table shows the average prices of Ceylon and Madagascar graphite imported into this country, compiled from the records of the Bureau of Foreign and Domestic Commerce, and the average prices of all grades of domestic crystalline graphite, including both dust and flake, as reported by the producers. The sharp increase in the price of Ceylon graphite in 1916 appears to be due to the diminished import of lower-grade material as well as to enhanced prices for the better grades:

Average price of crystalline graphite, in cents a pound, 1912–1917.

	Ceylon.	Madagascar.	Domestic.		Ceylon	Madagascar.	Domestic
1912	4.1	....	4.2	1915	6.3	6.3	5.9
1913	4.9	....	5.0	1916	12.0	7.4	8.4
1914	5.5	5.5	5.5	1917	14.6	12.3	10.3

Domestic amorphous graphite brought widely varying prices, according to the grade of the material mined. Although the demand was generally good, the prices do not appear to have increased greatly during the year.

Chosen amorphous graphite, which before the war sold at about $22 a ton, during 1917 brought from $45 to $60 a ton. The amount available was not as large as in former years, and the Chosen material appears to be in large measure supplanted by Mexican, domestic, and artificial amorphous graphite.

In order to assist producers in marketing their product, the Geological Survey has prepared a list of firms known to be purchasers of domestic graphite. This list will be mailed free on request to the Director, United States Geological Survey.

WORLD'S PRODUCTION.

The following table shows the world's production of graphite by countries since 1913, so far as statistics are available. Tables of production for 1912 and earlier years have been published in the reports on graphite for 1906 to 1915, inclusive. The production of the leading graphite-producing countries from 1907 to 1917 is shown graphically in figure 2.

World's graphite production, 1913–1917.

	1913		1914		1915		1916		1917	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
United States [a]	4,775	$293,756	4,335	$324,118	4,718	$429,631	8,088	$935,471	13,593	$1,167,879
Canada	2,162	90,282	1,647	107,203	2,635	124,233	3,971	285,362	3,714	402,892
Mexico [b]	4,435	198,000	4,259	190,075	1,680	75,000	5,331	238,000	7,570	285,568
Germany	13,263	63,308	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Austria	54,501	412,745	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Spain	....	....	....	....	33	[d] 2,000	1,364	[d] 79,000	(c)	(c)
France	1,191	3,441	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Sweden	97	2,831	62	1,813	87	(c)	214	(c)	(c)	(c)
Italy	12,282	65,790	9,441	[d] 50,000	6,793	[d] 33,000	9,017	(c)	(c)	(c)
Japan	773	116,389 (Japan and Chosen)	632	[d] 156,000 (Japan and Chosen)	734	(c)	1,261	25,903	(c)	(c)
Chosen	10,264		[b] 12,000		[b] 7,767	101,041	[b] 18,704	[d] 243,000	(c)	(c)
India	....	....	....	....	78	769	1,476	7,304	(c)	(c)
Ceylon [b]	28,540	2,935,529	15,929	1,142,000	24,436	2,569,434	37,420	7,298,128	(c)	(c)
Madagascar	6,958	[d] 423,000	8,540	[d] 536,000	13,060	[d] 686,000	28,080	[d] 2,213,000	[d] 38,500	(c)
South Africa	39	6,117	(c)	(c)	46	5,856	67	8,657	(c)	(c)
Australia	....	....	38	4,718	77	144	(c)	(c)	(c)	(c)
	139,283	4,611,188								

[a] Sales at mines. [b] Export figures. [c] Data not available. [d] Estimated.

The production in Madagascar shows a most remarkable growth, and, according to available descriptions,[1] the deposits of that island are capable of immense expansion. The graphite occurs in graphitic schists, which are said to carry as much as 60 per cent of graphite. These schists crop out over a large area in the eastern part of the island, and although at present they are developed only in the neighborhood of the principal transportation routes, the available reserves appear to be enormous. Cheap native labor and abundant water power are available. In normal times the total cost of production and freight, c. i. f. London, is between $82 and $92 per metric ton.[2] The Madagascar graphite goes chiefly to France and England, though during 1917 a greatly increased amount was imported into this country. The following summary of trade conditions with

[1] Shelley, J. W., Graphite in Madagascar: Min. Mag., vol. 14, pp. 324–330, 1916.
[2] Idem, p. 327.

respect to Madagascar graphite is based on reports submitted to the Bureau of Foreign and Domestic Commerce by the American consul at Tananarivo, Madagascar, James G. Carter, who was largely instrumental in starting the direct exportation of Madagascar graphite to the United States.[1]

For some time prior to the beginning of the war the graphite situation of Madagascar for various reasons had become somewhat demoralized. It was, therefore, desired by the colonial government that an attempt be made to interest American importers in Madagascar graphite as a probable means of relief. A beginning was made, and several direct shipments went forward

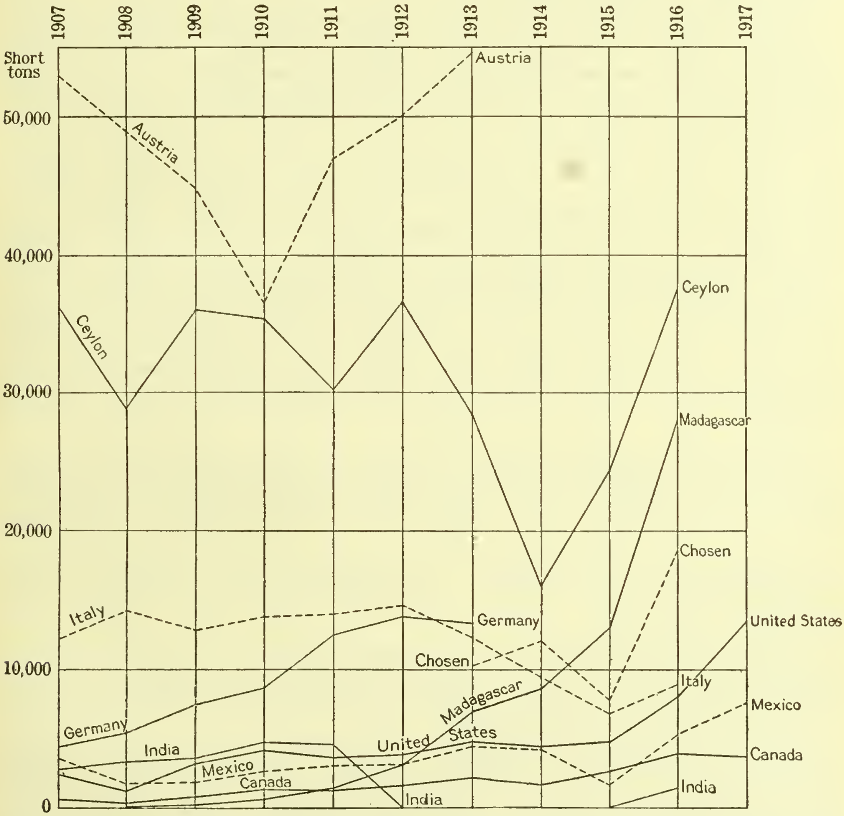

FIGURE 2.—Diagram showing production of graphite in principal countries in 1907–1917. Full lines indicate that bulk of the production is crystalline graphite; dotted lines, amorphous.

prior to the war and a few shipments after the war. In October, 1914, however, a decree was issued by the Madagascar authorities prohibiting the exportation of graphite from the colony except for France, England, Russia, and Belgium. This decree was issued notwithstanding the fact that there did not appear at that time to be any serious demand from Europe for the large stock of from about 8,000 to 10,000 tons of graphite estimated to be on hand in the island. This remained the situation until February, 1916, when the French Ministry of Colonies decreed that all graphite shipped from Madagascar should be billed to Marseille, and that only after the needs of France had been supplied would authorization be given for shipment of this mineral from Marseille to any foreign country.

[1] Commerce Repts., Mar. 1, 1918, p. 788.

In October of the same year there was published in the official journal of Madagascar a notice stating that according to new instructions from the Ministry of Colonies, issued in agreement with the Chief Staff of Munitions, the regulations governing the exportation of graphite from the colony were changed so as to permit the surplus of the local production to be exported to the United States via Marseille. At the same time it was stated that graphite for England might be shipped direct under certain conditions. In view of the present tonnage situation, the State Department was requested to endeavor to obtain the consent of the French authorities to the direct exportation of graphite from Madagascar to the United States and has now been advised that the French Ministry of Armaments is disposed to grant a favorable hearing to applications for such shipments.

The figures for Ceylon given in the accompanying table, represent exports, which though probably agreeing closely with production, vary somewhat according to the shipping available. It is possible that the great increase in exports in 1916 represents in part the shipment of accumulated stocks. American crucible manufacturers prefer the Ceylon graphite to other grades, and a large percentage of the total Ceylon exports, 70 per cent in 1916 as against 46 per cent in 1912, came to the United States. The Ceylon graphite industry does not appear to have increased sufficiently to meet the great demand due to the war, but the production in Madagascar has trebled in three years. The State of Travancore, in Southern India, formerly produced graphite similar to the Ceylon material, but with increasing depth the mines became unprofitable, and no graphite has been produced from them since 1913. The later output from India has come from the State of Rajputana, in the central part of the peninsula.

The Canadian graphite is chiefly of the flake variety and similar to that of the United States, but most of the deposits produce only half as much flake as dust. The production has shown a steady increase during recent years. The bulk of the Canadian production comes from the Province of Ontario, and it is stated that about one-third of the product is flake.[1] A small amount of graphite is also produced in Quebec. During 1917 a little high-grade graphite was mined on Baffin Island.[2]

A small amount of crystalline graphite is imported into the United States from Brazil, but no data are available with regard to the location and output of the deposits.

The German graphite deposits are situated in the Passau district, in Bavaria, close to the Austrian frontier. The graphite is of the flake variety and occurs in decomposed schist. The deposits have been mined for centuries, and the graphite was formerly used very largely in the manufacture of crucibles. For several years prior to the war, however, large amounts of Ceylon graphite were employed in German crucible manufacture. Since the war began Ceylon graphite has been largely excluded from Germany, and it has been necessary to use the Bavarian graphite for crucibles. No figures for production have been published since 1913, but it is supposed that since Germany has been cut off from foreign sources of supply her own production has been greatly increased.

[1] Gibson, T. W., Graphite in Ontario in 1917: Eng. and Min. Jour., vol. 105, p. 151, 1918.

[2] McLeish, John, Preliminary report on the mineral production of Canada during 1917, p. 16, Ottawa Dept. Mines, 1918.

In normal times Austria is the leading graphite-producing country. The producing regions, in the order of their importance, are Bohemia, Styria, Moravia, and Lower Austria. The Austrian graphite is fine grained and would be classified in this country as amorphous. It was formerly exported in large quantities for use in pencil manufacture. No figures of production have been available since 1913.

Since the exclusion of Austrian graphite from outside markets Mexico, Chosen, and Italy have been the principal sources of the world's supply of amorphous graphite. The figures for the Mexican production given in the foregoing table are those for imports into the United States, but they represent the production fairly accurately, as the mines are operated by American companies and the product is refined in this country. Mexican production was low in 1915, owing to the disturbed condition of the country, but has since shown a steady increase. The mines are in the southern part of the State of Sonora, near the Southern Pacific Railroad.

The Chosen output has increased greatly in recent years. A large part of it formerly came to this country, but shipping difficulties and high freight rates have reduced the amount imported, and its place in the American market has been largely filled by Mexican, domestic, and artificial amorphous graphite. A small amount of crystalline graphite is also produced in Chosen. It is believed that at present Great Britain is the largest importer of Chosen graphite.

The production of amorphous graphite in Italy has decreased since the war began. Formerly a considerable amount was imported from Italy into this country, but these imports are now reduced to almost nothing, and Italian graphite is exported largely to England and France. About two-thirds of the output comes from the Pinerolo district and the remainder from the Bormida district.

FUTURE OF THE DOMESTIC GRAPHITE INDUSTRY.

Even at the present war prices the miners of this country who are working deposits of disseminated flake graphite must depend on their No. 1 and No. 2 flake for their profit. The dust and lower-grade flake produced are merely by-products and are salable only at a very low price. The object of the operators is consequently to produce as large a proportion of flake as possible. The usual process of finishing involves grinding in burr mills in order to break the small particles of quartz and allow them to be separated out by screening. This process necessarily breaks the flake and increases the amount of dust. Developments in graphite milling practice during 1917 give promise of a largely increased production of flake of better grade. Among the new methods is oil flotation, particularly in the Alabama field, where several companies are using it with marked success. If flake graphite holds its present prices, profits can be made by a mill of almost any type, but at the prices that prevailed in time of peace only the most efficiently managed mills can hope to survive. Madagascar's output is increasing rapidly, and after the war domestic producers will have to meet competition from this island as well as from Ceylon. If Madagascar graphite can in normal times be put on the London market at a cost of approximately 4 cents a pound,[1] the price at New York would not be much higher, and it can readily be seen how formidable a competition will have to be met by the domestic producers when the shipping situation becomes normal again and how essential it is that the methods of mining and milling should be brought to as high a degree of efficiency as possible. The Ceylon graphite is considered by American manufacturers to be better suited to the manufacture of crucibles and will probably continue to command a higher price than the domestic. The costs of mining in Ceylon have advanced considerably in recent years, however, since deep mining has become necessary, and it is probable that unlike Madagascar, which is a new field, Ceylon will not increase her production greatly. Moreover, it is probable that the greater use of the electric furnace in metallurgic operations will somewhat retard the demand for graphite crucibles. The following table shows the notable development in electric-furnace steel during the last few years, while the production of crucible steel has remained about stationary.

Steel ingots and castings, produced in the United States, 1908-1916, by processes,[a] in gross tons.

	Crucible.	Electric.		Crucible.	Electric.
1908	63,631		1913	121,226	30,180
1909	107,355	13,762	1914	89,869	24,009
1910	122,303	52,141	1915	113,782	69,412
1911	97,653	29,105	1916	129,692	168,918
1912	121,517	18,309			

[a] Am. Iron and Steel Inst. Ann. Rept. for 1916, p. 24, New York, 1917.

Under conditions such as prevailed in the summer of 1917 nearly any grade of flake graphite is salable, and there are no definite standards governing specifications. Consequently, other things being equal, the buyer will prefer the imported graphite, for which there are fairly well recognized standards. It would seem advisable for the domestic producers, now that their product is in good demand, either to adopt standards for different grades of flakes, in order that when imported graphite comes on the market more freely they may be better able to meet the competition, or so to regulate their milling methods that they may be able to prepare special grades based on the purchaser's specifications. It is probably impossible to standardize grades for the whole country, owing to the different methods of treatment necessary for different types of ore, but where conditions are essentially the same over a large area, as in the Alabama field, cooperation among the producers might result in the establishment of two or three standard grades, based on the percentage of graphitic carbon and size of flake, with a guaranteed minimum of silica and iron. This would give the producers a far stronger position in the market and make the crucible manufacturers more ready to use domestic flake.

Graphite for other uses, such as for lubricants, pencils, foundry facings, and paints, will probably continue to be in good demand, but unless the deposits are large and cheaply mined, the prices of the

[1] Shelley, J. W., Graphite in Madagascar: Min. Mag., vol. 14, p. 327, 1916.

grades required for these uses do not make them profitable to the producer. Here again the expected competition after the war of the graphite dust from Madagascar and Ceylon and amorphous graphite from Mexico and Chosen, as well as artificial amorphous graphite, will be difficult to meet. Better milling methods, resulting in a higher graphite content of the dust produced, will aid the situation greatly. For instance, dust as ordinarily produced at flake graphite mines carries about 40 per cent carbon and is sold at less than 1 cent a pound, but this same dust when refined to a degree of purity suitable for use as a filler for dry batteries commands many times this figure.

Perhaps it may be found feasible to manufacture many graphite products in the vicinity of the mines. In this connection an article by Bartley[1] is worthy of attention.

AVAILABLE SUPPLY FOR 1918.

It is estimated that with the increased requirements in manufacture of munitions and in kindred industries about 25,000 tons of graphite suitable for manufacture of crucibles will be needed in 1918. If freight conditions and demand for the product favor the production of domestic graphite, about 8,000 tons of flake, exclusive of dust, can be produced in this country. This will mean an increase of about 160 per cent over the production in 1917 and is largely in excess of the amount of domestic material usually required by crucible manufacturers. Unless they should use a larger proportion of the domestic product than formerly, many mills may have difficulty in disposing of their product. If the freight situation should revert to the conditions prevailing in the autumn of 1917, and imported graphite enters the market in as large amounts as during the latter part of 1917 and the first few months of 1918, the demand will be small and the domestic production of No. 1 and No. 2 flake will hardly exceed 2,500 tons.[2] If the domestic production could be stimulated to its maximum capacity, reasonable assurance of a steady market given, and encouragement offered for the establishment and operation of new plants, a production as high as 10,000 tons might be reached. In any case it is evident that the country is not yet independent with respect to graphite suitable for manufacture of crucibles, and the deficiency must be supplied from Ceylon and Madagascar.

The situation is more favorable with respect to noncrucible graphite. The requirements for 1918 will be about 30,000 tons, which may be supplied from domestic sources, both natural and artificial, and from Mexico.

REVIEW BY STATES.

ALABAMA.

The Alabama graphite mines in 1917 furnished approximately 59 per cent of the quantity and 66 per cent of the value of the domestic crystalline graphite sold—an increase of 19 per cent in quantity and

[1] Bartley, Johnathan, Can profits be made in graphite?: Iron Age, July 8, 1915, p. 86.
[2] Reports received up to the end of April, 1918, indicate a monthly flake production of about 250 tons. The principal reasons for this small production are lack of demand on the part of the crucible manufacturers and shortage of labor.

46 per cent in value over 1916, and 3 times the quantity and 8 times the value of Alabama's output in 1913. Sales were reported by 14 companies in 1917, and 25 others have begun operations since the beginning of 1918 or expect to begin in the near future. Work has been most active in the Ashland district in Clay County. The producing companies number 11 in Clay County, 2 in Coosa County, and 1 in Chilton County. In spite of the great increase in the number of companies only a comparatively small portion of the graphite-bearing area is yet under development, and for the most part the operations confined to localities near the power lines of the Alabama Power Co.

The embargo on freight shipments during the later part of 1917 seriously affected the Alabama production, and many of the mines were unable to make shipments to the northern markets. During the last quarter of the year the production was only about 25 per cent of the maximum capacity of the mills. The principal reason for the shortage was the freight embargo, but the shortage of labor and the severe winter were also important factors.

The Alabama flake graphite from different mines varies greatly in purity, and lack of standardization hinders the full development of the deposits. A few companies produce a No. 1 flake containing 90 per cent carbon, others maintain an 85 per cent standard, and some market flake averaging only about 80 per cent.

The following analyses, furnished through the courtesy of one company, show the content of the average grade of the Alabama product. No. 1 represents samples from 5 tons and No. 2 from 3 tons of flake.

Analyses of Alabama flake graphite.

	1	2
Volatile matter	2.00	1.08
Carbon (graphitic)	84.00	84.72
Ash	14.00	14.20
	100.00	100.00
Iron	.97	
Sulphur	.08	

Ash analysis of sample 2.

	Ash.	Percentage for entire product.
Fe_2O_3	8.32	1.18
Al_2O_3	22.94	3.26
SiO_2	64.27	9.13
CaO	Trace.	Trace.
MgO	1.43	.20
S	.32	.05
Alkalies	2.78	.39
	100.06	14.21

The ash analysis indicates that the principal foreign impurity in the finished product is silica, with a little clayey matter, very little mica, and almost no pyrite.

The organization of the Graphite Producers Association of Alabama (A. B. Conklin, secretary, Ashland, Ala.) has been of great assistance to the industry, as it enables the graphite producers of the State to take united action in matters affecting the mining industry, such as the railroad embargo. The association is preparing to obtain a better standardization of the Alabama flake.

The following Alabama companies either reported sales during 1917 or expected to begin operations during the early part of 1918:

Graphite producers in Alabama.

Company.	Location of plant.
CHILTON COUNTY.	
Flaketown Graphite Co., Mountain Creek	Mountain Creek.
CLAY COUNTY.	
Acme Graphite Co., Ashland	Ashland.
Alabama Graphite Co., Ashland	Do.
C. B. Allen Graphite Co., Ashland	Do.
American Graphite Co., Gadsden	Do.
Ashland Graphite Co., Ashland	Do.
Atlas Graphite Co., Ashland	Do.
Axton Noe Graphite Co., Ashland	Do.
Clay County Graphite Co. (Inc.), Ashland	Do.
Crystalline Flake Graphite Co., Birmingham	Do.
Empire Graphite Co., Ashland	Do.
Griesemer Graphite Co., Ashland	Do.
Hood Graves Graphite Co., Alexander City	Do.
Jefferson Graphite Co., Birmingham	Do.
May Bros. Graphite Co., Ashland	Do.
National Flake Graphite Co., Ashland	Do.
Republic Graphite Co., Ashland	Do.
Southern Graphite Co., Ashland	Do.
Superior Flake Graphite Co., Ashland	Do.
Crucible Flake Graphite Co., 50 Broad Street, New York, N. Y	Do.
Carbon Mountain Graphite Co., Lineville	Graphite.
Liberty Graphite Co., Birmingham	Lineville.
Jennings Graphite Co., Lineville	Do.
Morris Graphite Co., Lineville	Do.
King Graphite Co., Lineville	Do.
Lineville Graphite Co., Lineville	Do.
Peerless Flake Graphite Co., Lineville	Do.
Eagle Graphite Co., Ashland	Quenelda.
Norway Graphite Milling Co., Clairmont Springs	Do.
Quenelda Graphite Co., Quenelda	Do.
COOSA COUNTY.	
Ceylon Co., Birmingham	Hollins.
Duro Graphite Co., Sylacauga	Sylacauga.
Graphite Co. of America, Good Water	Good Water.
Good Water Graphite Co., Good Water	Do.
Parkdale Graphite Products Co., Talladega	Parkdale.

ALASKA.

The deposits of crystalline graphite in the Port Clarence mining district, Seward Peninsula, Alaska, were recently visited by G. L. Harrington, of the United States Geological Survey, and the following description is condensed from his manuscript report, not yet published:

Development work has been chiefly confined to deposits on the north side of the Kigluaik or Sawtooth Range, west of Cobblestone River. Most of the work has been limited to two groups of claims, those of the Alaska Graphite Mining Co. and the Uncle Sam Alaska Mining Syndicate. The former group lies about 4 miles east of Graphite Bay, an arm of Imuruk Basin, and 2 miles west of Cobblestone River. The latter is 2 miles south of Graphite Bay and about 2 miles west of the camp of the Alaska Graphite Mining Co.

Graphite lenses are found along a steep slope for several miles west of Cobblestone River. Development work has been limited to outcrops which lie between altitudes of 500 and 1,000 feet, although there are said to be other lenses higher up the slope. The lenses of graphite occur in association with quartz schists carrying biotite, and garnetiferous schists carrying some calcite are also locally present. Some of the quartz schists have the appearance of beds of metamorphosed sandstone. Tourmaline was noted in small grains in the graphite at one locality. Granitic rocks appear to make up a portion of the core of the range. The general trend of the schists in which the graphite occurs is a little north of west, and the dip 60°–75° N. Locally there are two or three series of graphite lenses which are parallel in strike and dip, but without further very detailed studies it can not be stated whether they represent more than one horizon which may have been repeated by faulting or close folding.

The topographic situation and nearness to water transportation has favored development work at these deposits rather than at those which are said to occur for several miles to the east, extending along the front of the range beyond Cobblestone River and appearing on the hill slopes or in the stream valleys which are incised into the range.

The first claims were staked in 1900, but in the succeeding years little except assessment work has been done until recently. Small shipments have been made from time to time for mill tests or as sample shipments, but no steady production has been maintained. About 120 tons was shipped by the Uncle Sam Alaska Graphite Mining Syndicate in 1912,[1] but no shipment has been made by this company since, though assessment work has been done on the nine claims of the group. As the lenses dip with the slope of the hillside, but more steeply, little work has been necessary to prove the existence of the graphite bodies, and the assessment work has therefore taken the form of open cuts from each of which a few sacks of graphite have been removed, so that there is now sacked and ready for shipping a considerable amount of hand-sorted graphite. Some of this will require resacking before shipping. Two short tunnels have been driven on claims of this group. The development work to date has shown the existence of a number of lenses of graphite, which may be continuous, but their size and continuity have not been proved.

The property now being worked by the Alaska Graphite Co. consists of five claims that were staked in 1905 and three claims that were staked by N. Tweet in 1915 or 1916. In 1907 about 35 tons of graphite was picked from the talus on the steep hillside and shipped. Other smaller shipments followed in succeeding years. Several tons of graphite was mined in 1916 but not shipped. In 1917 a large part of the time of the seven men employed was consumed in making and repairing the road to Graphite Bay, but a considerable quantity of hand-picked graphite was mined from an open cut and with that mined the previous year was shipped to San Francisco. Most of the graphite produced in 1916 and 1917 came from an open pit about 100 yards west of Glacier Creek, the first stream west of Cobblestone River. The lens on which the mining was done had an exposed width of 4 to 6 feet of graphite with only thin seams of quartz and schist. It appears in the bottom of the cut for a length of 30 feet, and the footwall has a height of about 20 feet. Graphite appears at one end of the cut, indicating that it has a greater horizontal dimension than that given, and its vertical dimension has not been determined. On the east side of Glacier Creek there is a lens or series of closely spaced lenses of graphite having a total exposed vertical height of 400 feet or more. A few small open cuts afford some indications of the thickness of these lenses, which is comparable to that in the pit now being worked. An 8-inch hydraulic pipe 400 feet long serves to convey the graphite from the pit to the loading station, 150 feet lower. Hand sorting is done at the pit, and there is several tons of low-grade graphite on the dump. The product is transported from the mine to Graphite Bay by trucks drawn by a gasoline caterpillar tractor. At Graphite Bay it is loaded on scows, on which it is towed to Teller, where it is transferred to ocean steamers. In addition to the open pit near Glacier Creek there are a number of short tunnels and open cuts about a quarter or half a mile west of Glacier Creek, from which there has been some production in previous years. On the steep hillside between the pit and the bunkhouse there are a number of exposures of graphite, but little development work has been done to afford an indication of the size of the bodies. Some of them, so far

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[1] Mertie, J. B., jr., U. S. Geol. Survey Bull. 662, p. 449, 1917.

as can be told on a surface partly obscured by talus, are at least 100 by 50 feet, with a thickness of a foot or more.

There appears to be an opportunity for production of a large quantity of graphite from these deposits. Transportation problems are relatively simple. If the output were sufficient to justify it, aerial trams could be constructed, possibly of a gravity type, from one if not from both properties. For a smaller output good roads for team or power haulage could be easily made, the power required for hauling loads being small on account of the generally uniform downhill slope to the shipping point. Graphite Bay affords a good shallow-water harbor, numerous small coves and islands giving protection from storms.

If a mill were erected at either property hydroelectric installation would probably prove the more economical for summer operations, power being derived from some of the small streams which cross the claims. For winter operations other power would be necessary.

MONTANA.

The Crystal Graphite Co., which is operating a deposit of vein graphite about 16 miles from Dillon, Mont., made a marked increase in production during 1917. Numerous small veins have been developed, ranging in thickness from a knife edge to a maximum of 16 inches. For the most part these veins follow a principal zone of fracture that strikes in a westerly direction and dips sharply to the north. Small veins intersect this lode at all angles, and several have been worked to short distances from the main vein. Veins over 2 or 3 inches in width are worked, and the workings along the numerous branching veins are very irregular. So far as could be observed, the principal enlargements occur at intersections of veins. In the eastern part of the workings there has been faulting since the deposition of the graphite, and graphite has been dragged into the fault planes, giving them the appearance of graphitic veins.

The veins consist of practically pure graphite, with here and there a very small amount of quartz. In a few places stains of iron oxide, indicating the oxidization of pyrite, were observed. Most of the veins show bladed graphite crystals normal to the vein walls. More rarely the graphite consists of fibrous graphite similar to the best grades of Ceylon graphite. As predicted by Bastin,[1] development in depth has yielded graphite which more nearly resembles the Ceylon product in its greater luster and less friable character than the material mined nearer the surface.

The mine is developed by three levels—an adit level and two lower levels 75 and 100 feet below the adit—and two shafts, one from the surface 50 feet above the adit level and the other from the adit level. The maximum horizontal extent of the workings is about 150 feet along the strike of the principal vein system. The graphite is hand sorted at the mine into two grades and shipped to Bethlehem, Pa., for refining.

The following publications describe the deposit in greater detail:

Winchell, A. N., Graphite near Dillon, Mont.: U. S. Geol. Survey Bull. 470, pp. 528–532, 1911.

Winchell, A. N., A theory for the origin of graphite as exemplified in the graphite deposits near Dillon, Mont.: Econ. Geology, vol. 6, pp. 218–230, 1911.

Bastin, E. S., The graphite deposits of Ceylon, a review of present knowledge, with a description of a similar deposit near Dillon, Mont.: Econ. Geology, vol. 7, pp. 419–430, 1912.

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[1] Bastin, E. S., U. S. Geol. Survey Mineral Resources, 1913, pt. 2, p. 203, 1914.

Bastin, E. S., The production of graphite in 1913: U. S. Geol. Survey Mineral Resources, 1913, pt. 2, pp. 202–204, 1914.
Winchell, A. N., Mining districts of Dillon quadrangle, Mont., and adjacent areas: U. S. Geol. Survey Bull. 574, 1914.

Other graphite deposits in Montana were prospected during 1917. These consist of flake graphite disseminated in graphite schist and are said to carry a comparatively high percentage of graphitic carbon. The deposits now being developed lie in the Tobacco Root Mountains, near Virginia City, Madison County, and in the southern part of Beaverhead County, near the Idaho line.

NEW YORK.

The following summary of developments in the New York graphite industry during 1917 has been kindly furnished by Mr. D. H. Newland, assistant State geologist, Albany, N. Y.:

One new producer, Hooper Bros., entered the list in 1917. The mine of this firm is on South Bay, an arm of Lake Champlain, west of Whitehall. Active operations were begun in June and have been carried on continuously since. The other active producers were the American mine of the Joseph Dixon Crucible Co. at Graphite, and the property of the Graphite Products Corporation at Kings, north of Saratoga Springs. The latter company added to its mill and mining plant so as to increase the capacity about 50 per cent. The company has also undertaken the refining of its product, having installed machinery for that purpose in the old mill located on the property. Hooper Bros. shipped their product as mill concentrates, but will undertake to refine graphite hereafter in a plant at Whitehall. There were no new developments in the American mine. The old Empire mine, northwest of Saratoga Springs, was taken over by the Flake Graphite Co. and some work was done with the view of reopening the property. Plans were considered also for the development of the Faxon property, which adjoins the American mine on the south and east.

The production of graphite in New York for the last quarter of 1917 amounted to approximately 57 per cent of the maximum capacity of the mills. The principal part of the shortage was due to the excessively cold winter.

NORTH CAROLINA.

Graphite mining in North Carolina has up to this time been marked by successive attempts closely followed by failures. The occurrence of graphite has been made the subject of gross misrepresentation on the part of certain promoters. So far as known to the Geological Survey no graphite was produced in North Carolina in 1917.

PENNSYLVANIA.

The production of graphite in Pennsylvania showed a decrease in 1917 from 1916, owing principally to the fact that one of the 1916 producers did not operate during the year and that the plants of two others were closed during a part of the year to permit extensive alterations. The labor shortage also affected the Pennsylvania production to a considerable extent. Shipments during the last quarter of 1917 amounted to only 21 per cent of the capacity of the plants.

The following Pennsylvania companies reported production in 1917:

Graphite Products Co., Uwchland, Pa., with mines at Byers.
T. D. Just & Co., Philadelphia, with mines at Byers and Chester Springs.
Harry Schmehl, Chester Springs.
Standard Carbon Co., Philadelphia with mines at Pikeland.
Tonkin Graphite Co., Byers.

OTHER STATES.

Small amounts of crystalline graphite were produced during 1917 in California and Texas. In California the only production reported was that of the California Graphite Co. from its mine at Saugus, Los Angeles County. Other deposits in Los Angeles and San Diego counties are being prospected.

Several companies have recently been organized to develop the graphite deposits of Llano and Burnet counties, Tex. Of these the Dixie Graphite Co., of Llano, reported production in 1917.

The most important developments in the production of amorphous graphite in 1917 were in Colorado, where Woodruff & Woodruff made large shipments from their mine near Pitkin, in Gunnison County. The property adjoining the Woodruff mine has been leased by L. M. Nance, who expects to begin production during 1918. The Federal Graphite Co. also mined amorphous graphite from its mine at Turret, Chaffee County.

The Detroit Graphite Co. continued to mine amorphous graphite for its own use in paint manufacture from its mine at L'Anse, Baraga County, Mich. Amorphous graphite for use in making paint was also mined by the Carson Black Lead Co. near Carson, Nev.

In Rhode Island amorphous graphite for foundry facings was produced from mines near Providence.

LITERATURE.

The best general publications, in English, on graphite deposits and the mining, concentration, and manufacture of graphite are the following:

Cirkel, Fritz, Graphite; its properties, occurrence, refining, and uses: Canada Dept. Mines, Ottawa, 1907.

Miller, B. L., Graphite deposits of Pennsylvania: Pennsylvania Top. and Geol. Survey Comm. Rept. 6, 1912.

A select bibliography of papers relating to graphite was published in the Survey report on graphite for 1914,[1] and a more extended bibliography will be published in the forthcoming bulletin on the graphite deposits of the United States.[2] The following list includes the more important publications that have appeared since the 1914 report:

1. Ashley, G. H., Rhode Island coal: U. S. Geol. Survey Bull. 615, 1915. Graphite deposits, pp. 18–20, 33, 57. Description, with analysis, of Fenner's Ledge deposit.

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[1] Bastin, E. S., U. S. Geol. Survey, Mineral Resources, 1914, pt. 2, pp. 167–174, 1915.
[2] Bastin, E. S., Graphite deposits of the United States: U. S. Geol. Survey Bull. 679 (in preparation).

2. Bartley, Jonathan, Can profits be made in graphite? Iron Age, July 8, 1915, p. 86. Advocates having the mines manufacture their own product instead of selling it in the raw state.

3. Bastin, E. S., Graphite: U. S. Geol. Survey Mineral Resources, 1915, pt. 2, pp. 81–93, 1916. Description of California deposits.

4. Bastin, E. S., Graphite deposits of the United States: U. S. Geol. Survey Bull. 679 (in preparation).

5. Bayley, W. S., Salisbury, R. D., and Kümmel, H. B., U. S. Geol. Survey Geol. Atlas, Raritan (N. J.) folio (No. 191), 1914.

6. Bierbaum, C. H., Graphite as a lubricant: Machinery, vol. 22, pp. 887–888, 1916.

7. Bierbaum, C. H., Graphite and its compounds for lubricating purposes: Am. Soc. Mech. Eng. Jour., vol. 39, pp. 751–756, 1917. Abstract in Chem. Abstracts, vol. 11, p. 3098, 1917. A study of the action of graphite suspended in oil. Believes it advisable that the graphite particles should not be too fine. The carbon content of graphite is not an indication of its lubricating value, as in some varieties the percentage of nongraphitic carbon is very high.

8. Bleininger, A. V., Notes on the crucible situation: Metal Industry, vol. 16, pp. 15–16, 1918. Short discussion of different types of graphite, and detailed study of properties of clays necessary for manufacture of crucibles.

9. Bleininger, A. V., and Schurecht, H. G., Properties of some European plastic fire clays: Bur. Standards Tech. Paper 79, 1916. Characteristics of clays suitable for manufacture of crucibles.

10. Brooks, L. W., Graphite: Min. and Sci. Press, Sept. 15, 1917, p. 391. Describes uses of graphite for pencils, crucibles, facings, lubrication, electrotyping, and paints.

11. Carter, F. W., Use of graphite in the lubrication of cylinders: Power, vol. 43, pp. 47–48, 1916. Describes tests showing that a decided saving is effected by the use of oil containing graphite.

12. Dammer, B., and Tietze, O., Die Nutzbaren Mineralien, Stuttgart, 1913. Graphite, vol. 1, pp. 57–85. Review of graphite occurrences, particularly European deposits, and notes on uses and trade conditions.

13. Donath, E., and Lang, A., Ueber die Untersuchung und Wertbestimmung des Graphits: Montanische Rundschau, vol. 7, pp. 653–658, 683–687, 1915; Stahl und Eisen, vol. 34, pp. 1757–1761, 1848–1852, 1914. An investigation of the quality and value of various kinds and grades of graphite. Methods for the determination of nongraphitic forms of carbon, such as gas carbon, coke, lampblack, coal, and charcoal when used as adulterants of graphite. English abstract: Chem. Abstracts, vol. 9, pp. 1158–1159, 1915.

14. Donath, E., and Lang, A., Zur Untersuchung des Graphits: Montanische Rundschau, vol. 7, pp. 767–779, 1915. Characteristics of different varieties of graphite, particularly with reference to their heat-resisting qualities.

15. Dunstan, B., Graphite: Queensland Govt. Min. Jour., pp. 454–460, 1917. Gives tables of production and exports for graphite-producing countries, analyses of graphite and graphite ores from several localities, and notes on graphite deposits in Queensland.

16. Emerson, B. K., Geology of Massachusetts and Rhode Island: U. S. Geol. Survey Bull. 597, 1917. Note on the occurrence of graphite at Sturbridge, Mass., p. 71.

17. Ferguson, H. G., Our mineral supplies—graphite: U. S. Geol. Survey Bull. 666-L, 1917. Short summary of available domestic graphite supplies.

18. Ferguson, H. G., Graphite: U. S. Geol. Survey Mineral Resources, 1916, pt. 2, pp. 43–59, 1917. Mines of Clay and Coosa counties, Ala., described in detail.

19. Herr, Irving, Clay County graphite district of Alabama: Eng. and Min. Jour., vol. 103, pp. 693–697, 1917.

20. Jones, R. W., Graphite industry in New York: Eng. and Min. Jour., vol. 102, p. 773, Oct. 28, 1916.

21. McNaughton, M. The crucible situation: Am. Inst. Metals Jour., vol. 11, pp. 208–212, 1917. Difficulties overcome by crucible makers in the use of domestic clay and shortage of Ceylon graphite.

22. May, J. W., Llano County graphite, its formation and uses: Texas Mineral Resources, September, 1917, p. 4. Burnet and Llano counties contain large deposits of graphite. The statement made in regard to analysis by the Geological Survey is erroneous.

23. Merrill, F. J. H., Mines and mineral resources of Los Angeles County, Orange County, Riverside County, Cal., pp. 41–44, California State Mining Bur., 1917. Contains a description of the workings of the California Graphite Co., and mentions various undeveloped deposits.

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25. Miller, B. L., Mineral Industry, vol. 24, pp. 356–364, 1916. Article on the graphite crucible industry in 1915.

26. Miller, B. L., Mineral Industry, vol. 25, pp. 369–380, 1917. Description of Alabama deposits, by W. F. Prouty.

27. Moffit, P. H., Geology of the Nome and Grand Central quadrangles, Alaska: U. S. Geol. Survey Bull. 533, 1914. Graphite deposits described, pp. 135–136.

28. Paige, Sidney, U. S. Geol. Survey Geol. Atlas, Llano-Burnet (Tex.) folio (No. 183), 1912.

29. Pratt, J. H., Alabama graphite deposits: Manufacturers' Record, Mar. 22, 1917, p. 58. Gives figures for capacity of the mills in operation at the time.

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32. Prouty, W. F., Geology and distribution of graphite in Alabama: Alabama Geol. Survey Bull. 19, 1917.

33. Searle, A. B., Refractory materials, their manufacture and uses, London, Charles Griffin & Co., 1917. Deals with the uses of graphite in the manufacture of crucibles and other refractory products.

34. Shelley, J. W., Graphite in Madagascar: Min. Mag., vol. 14, pp. 324–330, 1916. Describes the deposits and the methods of mining and dressing and gives an outline of labor conditions and of the mining laws. Costs of mining are estimated at £9 a ton, and total costs c. i. f. London between £17 and £19. "There are such vast resources available in Madagascar that even if production in other parts of the world were to fail, they would be quite equal to any demand made upon them."

35. Thomas, P. W., Making anthracite culm pile pay a big dividend: Black Diamond, Oct. 17, 1914, p. 302. Describes the use of waste of anthracite mines in the manufacture of artificial graphite.

36. Tone, F. J., Electric-furnace development at Niagara Falls: Min. World, May 13, 1916.

37. Wiard, E. S., Grading of graphite, gunpowder, and malt: Met. and Chem. Eng., vol. 16, pp. 654–655, June, 1917. Grades of graphite required for crucibles, pencils, and other purposes.

38. Winchell, A. N., Mining districts of the Dillon quadrangle, Mont. and adjacent areas: U. S. Geol. Survey, Bull. 574, 1914. Graphite, pp. 105–110.

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SLATE.

By G. F. Loughlin.[1]

PRODUCTION.

GENERAL STATISTICS.

The total value of the domestic slate sold in 1917—$5,749,966—was an increase of nearly 8 per cent over that for 1916, which was an equal increase over the value in 1915. This increase, as shown in the following table, was common to all the slate products recorded but was most marked in slate for "other uses." The increase in value, however, is in marked contrast to the prevailing decrease in quantity of the different products sold and only indicates the degree to which prices have been advanced to offset increased cost of production.

Slate sold in the United States, 1908–1917.

Year.	Roofing slate.			Mill stock.			Other uses (value).	Total value.
	Number of squares (100 sq. ft.).	Value.	Average price per square.	Quantity (square feet).	Value.	Average price per square foot.		
1908	1,333,171	$5,186,167	$3.89	4,793,812	$793,304	$0.165	$337,346	$6,316,817
1909	1,133,713	4,394,597	3.87	5,112,894	876,089	.171	170,732	5,441,418
1910	1,260,621	4,844,664	3.84	5,181,498	999,098	.192	392,997	6,236,759
1911	1,124,677	4,348,571	3.87	5,744,577	1,027,605	.178	351,843	5,728,019
1912	1,197,288	4,636,185	3.87	5,765,273	1,013,220	.176	393,913	6,043,318
1913	1,113,944	4,461,062	4.00	6,312,011	1,233,838	.195	480,576	6,175,476
1914	1,019,553	4,160,832	4.08	5,361,925	977,930	.182	568,025	5,706,787
1915	967,880	3,746,334	3.87	4,576,112	819,672	.179	392,909	4,958,915
1916	835,873	3,408,934	4.08	5,782,842	1,177,260	.20	[a] 752,643	5,338,837
1917	703,667	3,411,740	4.85	5,478,151	1,277,249	.23	[a] 1,060,977	5,749,966
Percentage of increase or decrease	−15.8	+0.08	....	−5.3	+8.5	....	+40.7	+7.7

[a] Includes, in 1916, 4,990,007 school slates, valued at $52,561, and 3,182,159 square feet of blackboard material, valued at $403,502; in 1917, 4,378,490 school slates, valued at $48,828, and 2,650,563 square feet of blackboard material, valued at $413,163.

Roofing slate, with a decrease in quantity of nearly 16 per cent, continued the decline which has been continuous since 1912 and general since the record year, 1902, as shown in the accompanying diagram (fig. 3). The quantity sold in 1917, 703,667 squares, was

[1] All the tables in this report have been compiled by Miss A. T. Coons, of the United States Geological Survey, from figures reported by the producers to the United States Geological Survey.

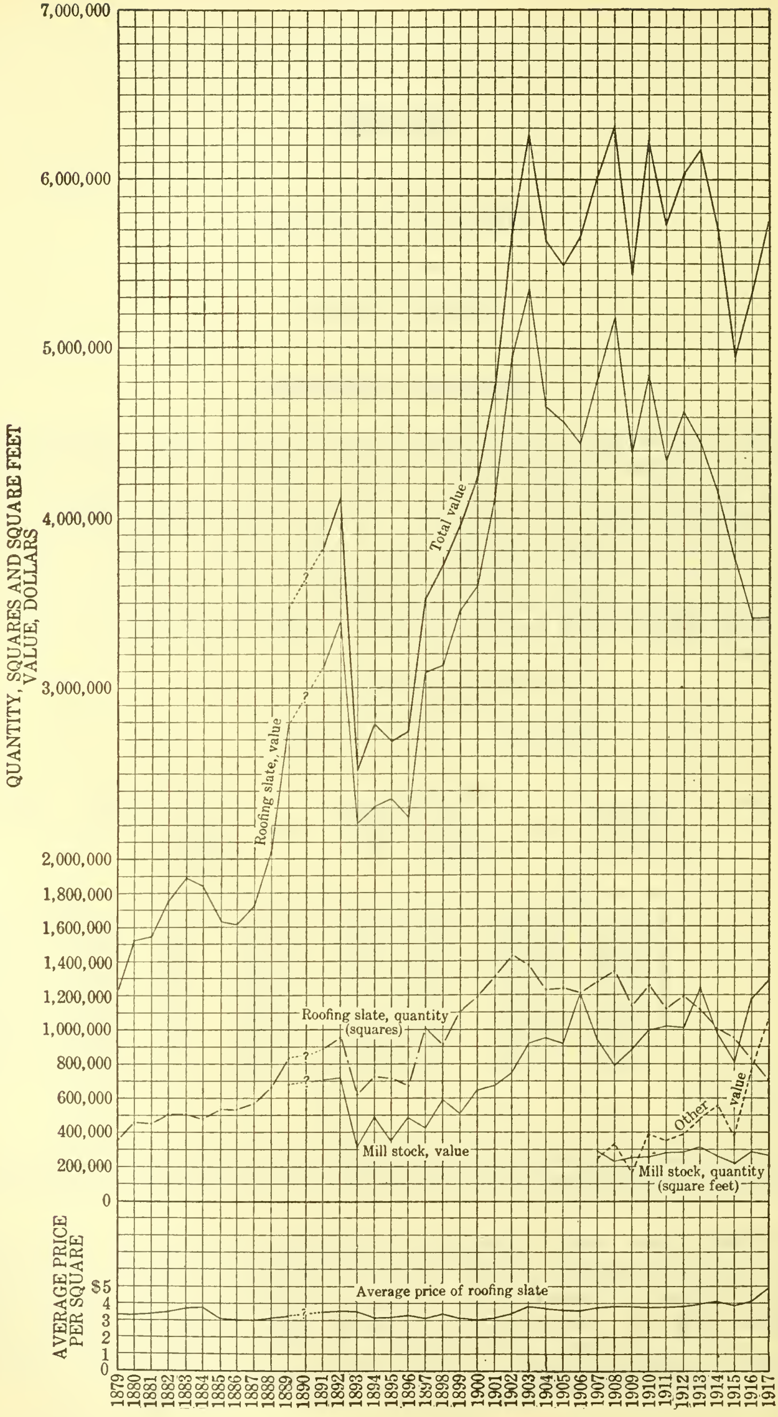

FIGURE 3.—Diagram showing production of slate in the United States from 1879 to 1917, inclusive Number of square feet of mill stock is divided by 20 to show proper relation to roofing slate.

the smallest since 1896. The value of roofing slate, however, after a general decline since 1903, showed a very slight gain (0.08 per cent) in 1917, owing to the advance in average price per square from $4.08 to $4.85, the highest price ever recorded; but the total value in 1917 failed to equal that of any other year since 1898 except 1916.

By reference to the table on page 126, it will be seen that there is considerable difference in the average price in different States, the average for the country being nearest that of Pennsylvania, the largest producer. In Vermont and New York, particularly, a considerable demand for "architectural" slate as well as for ordinary or "commercial" slate has been supplied. "Architectural" slate includes material of unusual thicknesses, ranging from three-sixteenths of an inch to 2 inches, the price increasing with thickness. The average price of "architectural" slate reported by one company was nearly $9 a square, whereas that of its "commercial" slate was less than $5. Slate 1 inch thick, according to another company was sold for $32 and slate 1½ inches thick for $50 a square.

The demand for roofing slate in 1917, as indicated by the foregoing figures, was generally poor, although a few companies report it to have been good. Some reported a good demand during the first six or seven months of the year. Quarrying and shipping were adversely affected by shortage of labor and fuel, railroad embargoes, and increased cost of operation, wages at some quarries increasing 15 to 20 per cent and cost of explosives as much as 150 per cent. The average general cost, according to several producers, advanced 40 to 50 per cent. Selling prices, however, increased only 10 to 25 per cent, the average for the country being 19 per cent. Prices in some districts, particularly Pennsylvania, were held low by local competition. This condition may be modified to a considerable extent by the establishment of selling companies, which buy the output of local producers and devote great and much needed energy to the regaining of the market in the building industry that roofing slate deserves. The Vendor Slate Co., of Bangor, Pa., was organized in the summer of 1917 to handle the output of several quarries in the Bangor district.

Prices early in 1918 have increased further.[1] Advances of approximately $1 a square are announced by some of the producers in Pennsylvania, and of 35 cents on certain sizes of sea-green slate and $1 on all sizes of clear red and mottled red slate in the Vermont-New York district. Quotations on Maine slate have been entirely withdrawn, and prices are made only on application. It is also reported that the demand for both "commercial" and "architectural" slate has been very poor, some producers stating that sales are less than 50 per cent of normal. This great decrease in demand is common to other building materials that have not been extensively employed in rapid construction work resulting from the war.

Mill stock, or slate for structural and sanitary purposes, after a great gain in 1916, showed a comparatively small decrease, 5 per cent, in quantity in 1917. The quantity in 1917, however, as shown in figure 1, was about half way between the maximum and minimum figures recorded since 1907. The value in 1917, however, increased 8.5 per cent, owing to a rise of 3 cents a square foot in average price,

[1] Stone, February, 1918, p. 85.

and both the value and average price were the highest value ever recorded for mill stock. Of the mill stock sold in 1917, 4,744,104 square feet, valued at $1,201,027, was manufactured, and 734,047 square feet, valued at $76,222, was rough stone. Compared with 1916, manufactured stock decreased 4.5 per cent in quantity and increased 8.5 per cent in value and rough stock decreased 8.6 per cent in quantity and increased 7.5 per cent in value.

Slate for other uses continued in 1917 the large increase in value. It exceeded 1916 by nearly 41 per cent, and for the first time exceeded $1,000,000. The sales of blackboards decreased nearly 17 per cent in quantity, but increased over 2 per cent in value; those of school slates decreased 12 per cent in quantity and 7 per cent in value. Both of these products were sold only from Pennsylvania.

It was suggested in the report for 1916 that owing to the increased cost of paper, the return to the use of school slates, with due sanitary precautions, was worthy of consideration. The probability that during 1918 the imports of clay suitable for use in paper making will be greatly curtailed, owing to scarcity of ships, adds weight to this suggestion.

The remainder of slate sold for other purposes includes billiard-table tops, tombstones, "inlaid slate," and ground slate for roofing, and small quantities of slate for special structural purposes.

There appears to have been a growing demand in some places, particularly in Massachusetts, for slate tombstones, although a small number have been sold for many years. Tombstones of Welsh slate were extensively used from colonial times until the second quarter of the nineteenth century, when they were followed by marble. The present local increase in use has been attributed by some to a reaction in taste to avoid the glaring white of some marbles and granites. The slate most used for tombstones at present is black slate from the Monson, Me., district, although black slate from Slatington, Pa., and green slate from Fairhaven, Vt., have also been reported as sold in 1917.

The manufacture of ground slate for roofing increased and a new plant was erected for this purpose by the Sheldon Slate Products Co. of Granville, N. Y. The output will be red slate, and another plant may be erected by the same company for the manufacture of ground green slate. It is said [1] that Hugh G. Williams, of Granville, was the first to erect a mill for this purpose. The material is run through crushers, rollers, and screens, until granules of the desired size are obtained. Besides the production of slate granules for the coating of asphalt shingles, the fine material passing the screens is ground to flour, which has proved of value in the manufacturing of linoleum, paint, and wall finishes.

Suggestions have been made from time to time for the disposal of slate waste, and the "inlaid slate" and ground slate just mentioned are practical results of attempts to utilize slate formerly wasted. In view of the present necessity of curtailment of building materials, whose manufacture requires the utilization of large quantities of fuel, the suggestion is now warranted that the cutting of slate on the waste dumps into small blocks of uniform size for the building of foundations and partition walls for dwellings, factories, and other structures

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[1] The Reporter, Sept. 26, 1917.

is worthy of consideration. The power required to saw these blocks probably represents a small part of the fuel needed in the manufacture of artificial building materials and their utilization would at the same time aid in relieving the shortage of buildings in manufacturing centers near the slate districts that have been congested as a result of war activities.

Sales, according to the two following tables, were reported in 1917 from all the States in which slate was sold in 1916 and in addition a small quantity was reported from Tennessee. The two leading States, Pennsylvania and Vermont, showed respective increases of nearly 6 and 16 per cent in total value of slate sold in 1917, following respective increases of 3 and 30 per cent in 1916. New York with increase of $33,862, or 159 per cent, was the only other State to show increase in 1917. This followed a decrease of 83 per cent in 1916. Virginia and Maryland showed respective decreases in 1917 of 18 and 5 per cent, following decreases in 1916 of 21 per cent each. Of the States included in "undistributed," Maine decreased nearly 6 per cent, New Jersey 8 per cent, Utah 65 per cent, and California 82 per cent.

Slate sold in the United States, 1913–1917, by States.

State.	1913	1914	1915	1916	1917	Percentage of increase or decrease, 1917.
California	....	....	....	(a)	(a)	....
Georgia	(a)	....	....	....	....	....
Maine	$323,998	$277,419	(a)	(a)	(a)	....
Maryland	83,993	77,391	$91,277	$71,737	$67,938	− 5.3
New Jersey	(a)	(a)	(a)	(a)	(a)	....
New York	144,882	112,776	127,603	21,345	55,207	+158.6
Pennsylvania	3,733,581	3,609,959	3,044,269	3,124,743	3,306,704	+ 5.8
Tennessee	....	....	....	....	(a)	....
Utah	....	(a)	(a)	(a)	(a)	....
Vermont	1,697,820	1,414,247	1,234,891	1,607,901	1,858,307	+ 15.6
Virginia	175,830	204,139	210,612	165,483	135,380	− 18.2
Undistributed	[b] 15,372	[c] 10,856	[d] 250,263	[e] 347,628	[f] 326,430	....
	6,175,476	5,706,787	4,958,915	5,338,837	5,749,966	+ 7.7

[a] Included in "Undistributed."
[b] Includes Georgia and New Jersey.
[c] Includes New Jersey and Utah.
[d] Includes Maine, New Jersey, and Utah.
[e] Includes California, Maine, New Jersey, and Utah.
[f] Includes California, Maine, New Jersey, Tennessee, and Utah.

Slate sold in the United States in 1916 and 1917, by States and uses.

State.	Number of operators.	Roofing slate.			Mill stock.[a]						Other.	Total value.
					Manufactured.		Rough.		Total.			
		Number of squares (100 square feet).	Value.	Average price per square.	Quantity (square feet).	Value.	Quantity (square feet).	Value.	Quantity (square feet).	Value.		
1916.												
California	1			$8.96								(b)
Maine	3	10,263	$75,563	7.36								(b)
Maryland	3	11,777	70,404	5.98							$1,333	$71,737
New Jersey	1			3.50								(b)
New York	9	2,727	21,345	7.83								21,345
Pennsylvania	81	531,342	2,056,324	3.87	3,397,404	$576,030	633,377	$43,457	4,030,781	$619,487	c448,932	3,124,743
Utah	1											(b)
Vermont	39	242,723	1,015,661	4.18	968,152	263,765	180,567	27,476	1,148,719	291,241	300,999	1,607,901
Virginia	8	36,007	165,483	4.60								165,483
Undistributed d		1,034	4,154		602,342	266,532			603,342	266,532	1,379	347,628
	146	835,873	3,408,934	4.08	4,968,898	1,106,327	813,944	70,933	5,782,842	1,177,260	752,643	5,338,837
1917.												
California	1			8.16								(b)
Maine	3	5,153	37,423	7.26								(b)
Maryland	4	9,909	66,462	6.71							1,476	67,938
New Jersey	1			5.00								(b)
New York	9	3,069	27,511	8.96							27,696	55,207
Pennsylvania	72	457,393	2,110,044	4.61	3,400,402	660,224	571,150	49,868	3,971,552	710,092	e486,568	3,306,704
Tennessee	1			6.00								(b)
Utah	1											(b)
Vermont	38	201,487	1,031,525	5.12	779,174	255,541	162,897	26,354	942,071	281,895	544,887	1,858,307
Virginia	6	25,997	135,380	5.21								135,380
Undistributed d		659	3,395		564,528	285,262			564,528	285,262	350	326,430
	136	703,667	3,411,740	4.85	4,744,104	1,201,027	734,047	76,222	5,478,151	1,277,249	1,060,977	5,749,966

[a] Mill stock is classed as rough or manufactured according to the condition in which it is sold by the quarrymen; whether as rough blocks to slate mills or in finished or partly finished condition from the producers' mills at the quarries.

[b] Included in "Undistributed."

[c] Composed of 4,990,007 school slates, valued at $42,561; 3,182,159 square feet of blackboard material, valued at $403,502; and slates used for structural and other purposes, valued at $2,869.

[d] Includes in 1916, California, Maine, New Jersey, and Utah; in 1917, California, Maine, New Jersey, Tennessee, and Utah.

[e] Composed of 4,378,490 school slates, valued at $48,828; 2,650,563 square feet of blackboard material, valued at $413,163; 84,966 square feet of billiard board slate, valued at $20,527, and slate for other uses, valued at $4,050.

The number of active producers continued its steady decrease of recent years, 136 companies reporting sales in 1917 compared with 146 in 1916 and 150 in 1915. The decrease was mainly in Pennsylvania, where there were 9 less operators in 1917 than in 1916. Vermont showed 1 less and Virginia 2 less than in 1916. Maryland and Tennessee each showed an increase of 1. New York was the only State to show increase in the quantity of roofing slate sold in 1917, but Pennsylvania and Vermont also showed increase in value. Pennsylvania was the only State to show increase in quantity of manufactured mill stock, none showing increase in quantity of rough or total stock. Pennsylvania and the States included in "undistributed" showed increase in value of mill stock. All but the States included in "undistributed" showed increase in value of slate for other uses.

COLORED SLATES.

Sales of colored slates as a whole in the Vermont-New York region, after a steady decline in value during 1914, 1915, and 1916, showed a considerable increase in 1917. The figures shown in the following table do not include crushed or ground slate.

Colored slates sold in New York and Vermont in 1909 and 1914-1917.

Year.	Red.	Green.			Purple.	Purple and green, mottled, variegated.	Total.
		Sea-green.	Unfading green.	Green.			
1909	$37,789	$758,372	$183,135	$246,612	$145,041	$143,430	$1,814,379
1914	36,256	789,055	81,884	190,265	121,935	307,628	1,527,023
1915	28,223	672,917	71,765	191,573	88,987	303,199	1,356,664
1916	16,039	529,875	51,328	122,487	265,523	328,154	1,313,406
1917	[a] 18,796	350,762	77,805	232,469	216,454	474,055	1,370,341

[a] Value of 1,719 squares of roofing slate.

The gain in 1917 was due to increase in the output of variegated slate, which reached its maximum value, and of green slate. The increase in the output of these slates together exceeded the considerable decrease in sea-green and purple slate. The value of purple slate, however, in spite of its decline in 1917, was much greater than in any other year except 1916. Red slate made a small increase over its minimum value of 1916. Sea-green slate, however, attained its minimum value in 1917. The increase in total value may have been due in part to a greater demand for architectural roofing slate, the largest sizes of which were sold for as much as $50 a square.

SLATE INDUSTRY BY STATES.

Slate deposits in Arizona, Arkansas, Colorado, and Georgia continued inactive in 1917, although plans for development work in Arkansas were being considered. Distance from transportation lines was stated to be the chief obstacle to successful operation.

CALIFORNIA.

No quarrying for slate was done in California in 1917. Small sales were reported from stocks.

MAINE.

The demand for slate from the Maine quarries, according to one producer, was good until September, and prices as a whole increased, although the average price of roofing slate decreased slightly. The general increase in price, however, was not in proportion to the great increase in cost of labor and supplies, and one company was further hampered by the collapse of quarry walls. Difficulties in making shipments were particularly great during the last part of the year because of fuel shortage and railroad embargoes.

The decrease of nearly 50 per cent in quantity of roofing slate was due to more than one cause. Competition with lower-priced slates of other States no doubt was effective, but another important reason given by one company was that the demand for electrical slate, directly or indirectly for war purposes, had so increased that that company in the winter of 1917–18 had come to devote its entire energy to the output of this product. Maine slate, as shown by tests [1] and by actual experience, is especially suited for electrical work.

MARYLAND.

Although four companies in Maryland reported production in 1917, compared with three in 1916, the quantity of roofing slate declined. The value also declined in spite of an increase of 73 cents in average price. No special comments on business conditions were made by producers.

NEW JERSEY.

There was no quarrying of slate in New Jersey during 1917, owing to the high cost of operation, but sales of roofing slate were made from stock on hand.

NEW YORK.

The demand for slate from quarries in New York increased materially in 1917. It was particularly good for black and purple slates in graded sizes and thicknesses. In spite of the increase in value of green slates, except the sea-green, in the Vermont-New York region, one producer of black and green slates in New York reported that there was no demand for green slate and that he was forced to suspend operations as the cost of quarrying black slate alone was prohibitive. The average price of all slate sold from quarries in New York in 1917 was $8.96 a square. Red slate, however, averaged $10.93 a square and black slate $12.70, the output consisting mainly of "architectural" slate. These prices represented increases of as much as 10 per cent compared with those in 1916, but wages increased 15 to 20 per cent and explosives as much as 150 per cent, and labor was difficult to obtain.

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[1] Dale, T. N., Slate in the United States: U. S. Geol. Survey Bull. 586, p. 191, and table opposite p. 188, 1914.

PENNSYLVANIA.

The value of Pennsylvania's sales of slate, after increasing 3 per cent in 1916, increased nearly 6 per cent more in 1917. It amounted to 57.5 per cent of the total value of the slate output of the country in 1917, compared with 58.5 per cent in 1916. Roofing slate, in spite of a decrease of 14 per cent in quantity, increased 7 per cent in value and 74 cents in average price per square in 1917. The increase in price was mainly due to the "soft vein" slate, as increase in price of "hard vein" slate was reported to have been not more than 25 cents a square. An additional large increase in price during 1918 has been predicted. Pennsylvania slate represented 65 per cent of the total quantity and nearly 62 per cent of the total value of all roofing slate sold in the country, compared with 64 per cent and 60 per cent, respectively, in 1916 and 59 and 57 per cent, respectively, in 1915. The total quantity of mill stock for structural and sanitary purposes decreased 1.4 per cent in quantity, although that of manufactured mill stock increased slightly. The values of both manufactured and rough mill stock increased, however, the total increase being about 15 per cent. The total quantity of Pennsylvania's mill stock amounted to 72 per cent and the value to 56 per cent of the country's total in 1917, compared with 69 and 52 per cent, respectively, in 1916 and 78 and 62 per cent, respectively, in 1915. The quantities of black-boards and school slates both decreased in 1917, although the value of the former increased. The discrepancy in values between the figures of production of school slates, as shown on page 130 and the figures of exports on page 137, is due to the fact that the figures of production are chiefly the value of slate sold to mills for working up into school slates, whereas the exports represent the value of the finished product.

"Other" slate, as shown on page 130, was mainly for billiard tables, but also included "inlaid slate" and ground slate, the latter in part for mineral paint. A mill was in process of construction to work up slate waste at the Old Peach Bottom quarry at Peach Bottom, Lancaster County.

About 86 per cent of the total quantity of slate sold in Pennsylvania in 1917, as shown in the table on page 130, was produced in Northampton County, compared with 82 per cent in 1916, nearly all the remainder being quarried in Lehigh County.

Slate sold in Pennsylvania in 1916 and 1917.

County.	Number of operators.	Roofing slate.			Millstock.								Other (value).	Total value.
		Number of squares (100 square feet).	Value.	Price per square.	Manufactured.		Rough.		Blackboards.		School slates.			
					Quantity (square feet).	Value.	Quantity (square feet).	Value.	Quantity (square feet).	Value.	Quantity (number).	Value.		
1916.														
Lancaster	1	3,903	$20,780	6.00										$20,780
York ("Peachbottom slate")	3			5.23										
Lehigh	24	98,471	367,806	3.74	421,600	$46,845	132,012	$13,265	706,046	$76,147	2,674,642	$33,495	$1,995	529,553
Northampton	53	428,968	1,667,738	3.89	2,975,804	529,185	501,365	30,192	2,476,113	327,355	2,315,365	19,066	874	2,574,410
	81	531,342	2,056,324	3.87	3,397,404	576,030	633,377	43,457	3,182,159	403,502	4,990,007	52,561	2,869	3,124,743
1917.														
Lehigh	22	60,044	280,088	4.66	181,610	26,825	118,352	18,195	674,298	80,778	2,264,515	28,012	1,477	435,375
Northampton	49	397,349	1,829,956	4.60	3,218,792	633,399	452,798	31,673	1,976,265	332,385	2,113,975	20,816	a 23,100	2,871,329
York	1			5.50										
	72	457,393	2,110,044	4.61	3,400,402	660,224	571,150	49,868	2,650,563	413,163	4,378,490	48,828	24,577	3,306,704

a Includes 84,966 square feet of billiard table material, valued at $20,527.

The number of active producers in Pennsylvania in 1917 was 72, 9 less than in 1916 and 1915. Twenty of these commented on trade conditions in 1916, and the great majority reported the demand much poorer and costs of operation much higher than in 1916. Labor conditions were said to be the greatest drawback. Some of the companies ceased operations during 1917 to wait until conditions should improve. A few producers, however, benefited from the building activity incident to war industries in neighboring cities and were optimistic regarding 1918. One producer of "hard vein" slate stated that although this product has heretofore been sold mainly to customers within the State there were indications that it would soon reach a more extensive market. "Hard vein" slate does not possess the smooth cleavage surface of the "soft vein," but has proved itself a most durable roofing material. The "soft vein" is mainly used for roofing, but is especially suitable for blackboards and school slates because of its soft character, comparatively dull luster, and highly developed cleavage.

The principal event of general interest in the Pennsylvania slate district in 1917 was the establishment in August of that year of the Vendor Slate Co., with headquarters in Bangor, Pa. This company has become the exclusive selling agent of about thirty companies quarrying roofing slate. These quarry companies now sell to the Vendor Slate Co. and it is therefore probable that a part of the quantity reported by these companies late in 1917 was not used for building in that year. It is expected that this new plan of marketing roofing slate will avoid unnecessary and ruinous competition, which has been a great drawback to the slate industry in Pennsylvania, will reduce costs of marketing, will more thoroughly standardize the output, and thus improve the general quality of the slate marketed. It is also planned to conduct a much needed publicity campaign in behalf of roofing slate, a product that has heretofore been almost totally without advertising either in the trade, technical, or popular journals of the country.

It is also planned to organize two other selling agencies—the Structural Slate Co., Pen Argyl, Pa., to handle the output of structural, electrical, and similar slate products; and the Natural Slate Blackboard Co., Pen Argyl, Pa., to handle blackboards exclusively.

UTAH.

A small quantity of slate "waste" was sold in Utah during 1917, as in previous years, for use in manufacture of asphaltic roofing material.

VERMONT.

Vermont, the second in rank of the slate-producing States, showed an increase in total value of nearly 16 per cent in 1917, following an increase of 30 per cent in 1916. Whereas the increase in 1916, however, was due in part to production of "other slate" which had not been reported in former years, the increase in 1917 was due to increased activity of companies operating in both 1916 and 1917. As shown in the table on page 126, the quantity of roofing slate in Vermont decreased in 1917 but its value increased somewhat, whereas mill stock decreased in both quantity and value, the decrease in value approximately offsetting the increase in value of roofing slate. The net increase in total value was mainly due, therefore, to "other slate." The increase in value and average price of roofing slate was due, in part at least, to the demand for colored "architectural" slate of special sizes and thicknesses, slate 1 inch thick selling for $32 and slates 1½ inches thick for $50 a square f. o. b. quarry.

Several companies reported that busines in 1917 was very good until September, and then very dull, the dull period continuing into 1918. Prices advanced, as in other States, but not sufficiently to offset increase in cost of labor, fuel, and other supplies. Shortage of labor also retarded production during the period of good demand.

VIRGINIA.

Roofing slate in Virginia decreased 27 per cent in quantity and 18 per cent in value in 1917, following respective decreases of 27 and 21 per cent in 1916. The average price per square continued to increase—from $4.27 in 1915 to $4.60 in 1916 and to $5.21 in 1917. Only six companies were active in 1917 compared with eight in both 1916 and 1915. One company reported that it had suspended operations for an indefinite period owing to prohibitive cost of operation.

EXPORTS.

ROOFING SLATE.

The value of exports of roofing slate in 1917 was $27,113, a little less than in 1916. As selling prices were much higher in 1917, the quantity exported was probably considerably less than in 1916.

Roofing slate exported from the United States, 1913–1917.

1913	$226,413	1915	$46,137	1917	$27,113
1914	139,125	1916	27,630		

The following table, furnished by the Bureau of Foreign and Domestic Commerce, United States Department of Commerce, shows the countries to which roofing slate was exported.

Roofing slate exported from the United States, 1915, 1916 and 1917.

1915.

Canada	$31,101
Mexico	2,710
Central America:	
British Honduras	68
Costa Rica	833
Honduras	28
Nicaragua	27
Panama	559
South America:	
Brazil	75
British Guiana	208
Chile	239
Colombia	16
Trinidad	499
Venezuela	9
West Indies:	
Cuba	$2,740
Dominican Republic	333
Dutch West Indies	106
Europe:	
Italy	251
Scotland	940
British South Africa	2,288
Australia	2,621
New Zealand	486
	46,137

Roofing slate exported from the United States, 1915, 1916, and 1917—Continued.

1916.

Canada	$22,200
Central America:	
Honduras	91
Panama	145
South America:	
Colombia	342
Uruguay	78
West Indies:	
Cuba	57
Haiti	110
Bermuda	105
Jamaica	262
Trinidad and Tobago	2,603
Other British West Indies	58
Europe:	
Denmark	$800
France	14
Spain	7
Hongkong	442
Chosen	52
British India	46
French Oceania	5
British South Africa	73
Portuguese Africa	140
	27,630

1917.

Canada	$19,245
Mexico	93
Central America:	
Guatemala	14
Panama	2,774
South America:	
Brazil	70
Colombia	40
British Guiana	5
Venezuela	136
West Indies:	
Barbados	17
Jamaica	23
West Indies—Continued.	
Trinidad and Tobago	$111
Other British West Indies	1,446
Virgin Islands	103
Dutch East Indies	492
Europe:	
France	75
Australia	2,450
British South Africa	19
	27,113

Canada received the greater part of the exports of roofing slate in each of the three years represented in the preceding table. Total imports of slate into Canada, shown below, are of interest in comparison with exports from the United States to Canada in 1915 and 1916, figures for 1917 not being available.

Slate imported into Canada in 1915 and 1916.[a]

	1915	1916
Roofing slate	$34,528	[b] $21,335
School writing slate	38,874	35,887
Slate pencils	4,954	11,309
Slate of all kinds and manufactures of	30,320	28,245
	108,676	96,776

[a] McLeish, John, Preliminary report of the mineral production of Canada during the calendar year 1916 Canada Dept. Mines.
[b] Represents 4,412 squares.

Altogether slate valued at $51,941 was exported from the United States to Canada in 1917, compared with $33,282 in 1916, the value of other than roofing slate being shown on page 135. Canada's production of roofing slate in 1916 was 1,262 squares, valued at $6,223;[1] in 1917 it was 1,422 squares, valued at $7,789.[2]

[1] McLeish, John, op. cit.
[2] McLeish, John, Preliminary report of the mineral production of Canada during the calendar year 1917, Canada Dept. Mines.

OTHER SLATE.

The following figures of exports of slate for other purposes than roofing were compiled from information furnished directly to the United States Geological Survey by producers and manufacturers. These figures were collected for the first time in 1916. Those for 1917 are more complete, and show where possible the ports of shipment as well as the producing States.

Slate other than roofing exported in 1916, by countries.

To—	Quantity.	Value.	Producing State.
Canada:			
Electrical	....	$5,003	Maine.
Structural ... square feet	1,000	1,500	Pennsylvania.
Blackboards ... do	8,000	1,200	Do.
Electrical ... do	653	203	Vermont.
Billiard tables ... do	65	20	Do.
Electrical ... do	120	90	
School slates ... cases	643	3,066	Pennsylvania.
Newfoundland:			
Electrical ... square feet	200	150	
Mexico:			
Electrical ... do	480	360	
Central America:			
Unspecified:			
Electrical ... square feet	40	30	
Billiard tables ... slabs	75	875	Vermont and Pennsylvania.
Panama:			
Electrical ... square feet	840	630	
Slabs	....	1,000	Pennsylvania.
West Indies:			
Unspecified:			
Billiard tables ... slabs	120	1,400	Vermont and Pennsylvania.
Cuba:			
Sanitary slate ... square feet	2,531	676	Pennsylvania
School slates ... cases	332	1,463	Do.
Electrical ... square feet	3,200	2,400	
Porto Rico (San Juan):			
Blackboards and sanitary slate ... do	3,100	800	Do.
South America:			
Unspecified:			
School slates ... cases	2,208	9,955	Do.
Billiard tables ... slabs	195	2,315	Vermont and Pennsylvania.
West coast:			
Electrical ... square feet	900	675	
Argentina:			
Electrical ... do	300	225	
Brazil:			
Electrical ... do	240	180	
Colombia:			
Electrical ... do	200	180	
Venezuela:			
Electrical ... do	20	15	
Europe:			
Unspecified:			
Electrical ... do	1,020	765	
Great Britain:			
Electrical ... do	20	15	
France:			
Electrical ... do	620	465	
Greece:			
School slates ... cases	23	1,804	Pennsylvania.
Italy:			
Electrical ... square feet	960	720	
Spain:			
School slates ... cases	49	233	Do.
Denmark:			
Electrical	....	2,218	Maine.
Norway:			
Blackboards ... square feet	5,317	780	Pennsylvania.
Scandinavia:			
School slates ... cases	172	609	Do.
Russia:			
Electrical	....	107	Maine.
Do ... square feet	1,360	1,020	
Africa:			
Unspecified:			
School slates ... cases	393	1,921	Pennsylvania.
South Africa:			
Electrical ... square feet	100	75	

Slate other than roofing exported in 1916, by countries—Continued.

To—	Quantity.	Value.	Producing State.
Asia:			
China:			
Electrical ....square feet..	200	$150	
Central Asia (except China):			
Electrical ....do....	280	210	
Japan:			
Electrical ....do....	2,640	1,980	
India:			
School slates ....cases..	937	2,573	Pennsylvania.
Philippines:			
Electrical ....square feet..	160	120	
Billiard tables ....slabs..	15	175	Vermont and Pennsylvania.
Dutch East Indies:			
Electrical ....square feet..	20	15	
Australia:			
School slates ....cases..	355	1,536	Pennsylvania.
Electrical ....square feet..	2,200	1,650	
Unspecified:			
Blackboards	....	100	
		53,652	

Slate other than roofing exported in 1917, by countries.

	Quantity.	Value.	Producing State.	Port of shipment.
Canada:				
Electrical ....square feet..	1,200	$605	Vermont	Castleton, Vt.
Do ....do....	3,694	2,065	Maine	
Blackboards ....do....	42,440	8,500	Pennsylvania.....	Buffalo, N. Y.
Structural slate ....do....	3,000	600	.....do	Do.
School slates ....cases..	3,537	20,926	Pennsylvania.....	New York, N. Y.
Total .... {square feet.. / cases........	50,334 / 3,537	11,770 / 20,926		
		32,696		
Newfoundland:				
Electrical ....square feet..	20	17	Maine	
Mexico:				
Electrical ....square feet..	720	620	.....do	
Billiard tables ....do....	390	77	....	Do.
School slates ....cases..	15	82	Pennsylvania.....	Do.
Total .... {square feet.. / cases........	1,110 / 15	697 / 82		
		779		
Central America:				
Canal Zone:				
Billiard tables ....square feet..	897	206	....	Do.
Costa Rica:				
Electrical ....do....	20	17	Maine	
Panama:				
Blackboards ....do....	13,682	2,350	Pennsylvania.....	Do.
School slates ....cases..	18	95	.....do	Do.
Unspecified:				
School slates ....do....	795	5,250	.....do	Do.
Slate pencils ....do....	1,000	6,612	.....do	Do.
Total .... {square feet.. / cases........	14,599 / 1,813	14,530 / 11,957		
		26,487		
West Indies:				
Cuba:				
Structural ....square feet..	40	19	.....do	Do.
Electrical ....do....	4,460	3,791	Maine	
School slates ....cases..	64	368	Pennsylvania.....	
Haiti:				
Electrical ....square feet..	80	68	Maine	
Jamaica:				
School slates ....cases..	121	656	Pennsylvania.....	Do.

Slate other than roofing exported in 1917, by countries—Continued.

	Quantity.	Value.	Producing State.	Port of shipment.
West Indies—Continued.				
Porto Rico:				
Electrical..............square feet..	280	$238	Maine..............	
Structural....................do....	750	490	Pennsylvania.....	New York, N. Y.
Blackboards..................do....	3,934	1,040	.....do............	Do.
Unspecified:				
Electrical ....do....	120	102	Maine..............	
Billiard tables................do....	3,262	468	....	Do.
School slates................cases..	794	5,237	Pennsylvania.....	Do.
Total.................. square feet..	12,926	6,216		
Total.................. cases........	979	6,261		
		12,477		
South America:				
Argentina:				
Electrical..............square feet..	480	408	Maine..............	
British Guiana:				
Electrical....................do....	20	17	.....do............	
School slates................cases..	60	460	Pennsylvania.....	Do.
Brazil:				
Electrical..............square feet..	1,040	884	Maine..............	
Chile:				
Electrical....................do....	1,520	1 194	Vermont.......... / Maine..............	Do.
Structural....................do....	250	113	Pennsylvania.....	Do.
Ecuador:				
Electrical....................do....	20	20	Maine..............	
Peru:				
Electrical....................do....	480	408	.....do............	
Uruguay:				
Electrical....................do....	400	340	.....do............	
Venezuela:				
Electrical....................do....	240	204	.....do............	
Unspecified:				
Electrical....................do....	720	612	.....do............	
Billiard tables................do....	2,184	435	....	Do.
Blackboards..................do....	24	5	Pennsylvania.....	Do.
School slates................cases..	7,762	46,571	.....do............	Do.
Slate pencils..................do....	4,000	26,448	.....do............	Do.
Total.................. square feet..	7,378	4,640		
Total.................. cases........	11,822	73,479		
		78,119		
Europe:				
Denmark:				
Electrical..............square feet..	3,682	1,850	Maine..............	Do.
England:				
Electrical....................do....	40	34	....	
School slates................cases..	7	31	Pennsylvania.....	
France:				
Electrical..............square feet..	220	187	Maine..............	
Greece:				
Electrical....................do....	100	85	.....do............	
Holland:				
School slates................cases..	62	216	Pennsylvania.....	Do.
Italy:				
Electrical..............square feet..	480	408	Maine..............	
Norway:				
School slates................cases..	57	280	Pennsylvania.....	Do
Spain:				
Electrical..............square feet..	140	119	Maine..............	
School slates................cases..	20	122	Pennsylvania.....	Do.
Sweden:				
School slates..................do....	20	135	.....do............	Do.
Total.................. square feet..	4,662	2,683		
Total.................. cases........	166	784		
		3,467		
Africa:				
Electrical..............square feet..	220	187	Maine..............	
Blackboards..................do....	310	30	Pennsylvania.....	Do.
School slates................cases..	2,531	16,601	.....do............	Do.
Total.................. square feet..	530	217		
Total.................. cases........	2,531	16,601		
		16,818		

Slate other than roofing exported in 1917, by countries—Continued.

	Quantity.	Value.	Producing State.	Port of shipment.
Asia:				
China:				
Electrical .... square feet..	680	$578	Maine.............	
Billiard tables .... do....	39	11	....	New York, N.Y.
Chosen (Korea):				
Electrical .... do....	20	17	.....do............	
India:				
Electrical .... do....	700	595	Maine.............	
School slates .... cases..	1,815	6,468	Pennsylvania.....	Do.
Japan:				
Electrical .... square feet..	3,280	2,788	Maine.............	
Philippine Islands:				
Electrical .... do....	200	170	.....do............	
Russia:				
Electrical .... do....	320	272	.....do............	
Siam:				
Billiard tables .... do....	39	5	....	Do.
East Indies (British):				
School slates .... cases..	794	5,237	Pennsylvania.....	Do.
East Indies (Dutch):				
School slates .... do....	844	5,674	.....do............	Do.
Total .... square feet..	5,278	4,436		
Total .... cases........	3,453	17,379		
		21,815		
Oceania:				
Australia:				
Electrical .... square feet..	2,340	1,989	Maine.............	
School slates .... cases..	2,516	16,242	Pennsylvania.....	Do.
New Zealand:				
Electrical .... square feet..	40	34	Maine.............	
School slates .... cases..	57	234	Pennsylvania.....	Do.
Straits Settlements:				
School slates .... do....	793	5,237	.....do............	Do.
Tahiti:				
Electrical .... square feet..	120	102	Maine.............	
Tasmania:				
Electrical .... do....	40	34	.....do............	
Total .... square feet..	2,540	2,159		
Total .... cases........	3,366	21,713		
		23,872		
Grand total .... square feet..	99,377	35,408		
Grand total .... cases[a]......	27,682	169,182		
		204,590		

Slate other than roofing exported in 1917, by uses.

	Quantity.		Value.	
School slates .... cases [a]..	22,682		$136,122	
Slate pencils .... do....	5,000		33,060	
		27,682		$169,182
Electrical slate .... square feet..	28,136		21,059	
Blackboards .... do....	60,390		11,925	
Billiard tables .... do....	6,811		1,202	
Structural .... do....	4,040		1,222	
		99,377		35,408
				204,590

[a] Cases weigh from 130 to 165 pounds each; average is 135 pounds.

South America was by far the leading consumer of these exports in 1917, taking 38 per cent of the total value, a much larger proportion than in 1916. Canada, Oceania, Asia, Africa, Central America, and West Indies were next in order of value, and all showed marked increase over 1916. Europe ranked eighth, with a much smaller value than in 1916. The port of shipment for practically all the slate exports except those to Canada, was New York. No port of shipment is given for exports of slate from Maine.

Pennsylvania led in exports, which represented 89 per cent of the total value in 1917, compared with 53 per cent in 1916, and included all the products listed in the foregoing table except electrical slate. Nearly all of the electrical slate exported was produced in Maine, a small proportion coming from Vermont.

School slates exported, as shown in the foregoing summary, amounted to 22,682 cases, valued at $136,122, or nearly 67 per cent of the total value of slate, other than roofing, exported in 1917. Their value in 1916 was less than one-half of the total. Slate pencils ranked second in value, and electrical slate third, the value of the latter remaining close to its value in 1916 and representing the value of the slate before preparation.

IMPORTS.

Imports of slate for consumption in the United States continued to decrease in 1917 and represented less than half the value for 1916. The total values for the last four years have been $4,855 in 1914, $2,768 in 1915, $2,200 in 1916, and $1,024 in 1917. The value of imports in 1917 was distributed as follows among different ports of entry:

New York	$88
Philadelphia	36
St. Louis	60
Nebraska and Utah	2
Washington	503
Oregon	4
San Francisco	$7
Southern California	46
Hawaii	278
	1,024

No sources of these imports are stated.

FELDSPAR.

By Frank J. Katz.

INTRODUCTION.

The actively productive feldspar quarries in the United States are restricted to the eastern seaboard States and California. Important factors in the localization of feldspar mining in the New England, Middle Atlantic, and southern Appalachian States are the local abundance of feldspar deposits and the concentration of the ceramic industries about Trenton, N. J., Wilmington, Del., and East Liverpool, Ohio. Potteries in California account for the exploitation of feldspar deposits in that State.

The composition and properties of feldspar, the geology and mineralogy and the commercial availibility of feldspar deposits, the methods of mining and milling feldspar, and the feldspar localities in the United States have been briefly described and discussed in the volumes of Mineral Resources for 1915 and 1916. These subjects are more extensively treated in the following publications:

Bastin, E. S., Economic geology of the feldspar deposits of the United States: U. S. Geol. Survey Bull. 420, 1910.

——— Geology of the pegmatites and associated rocks of Maine: U. S. Geol. Survey Bull. 445, 1911.

De Schmidt, H. S., Feldspar in Canada, Canada Dept. Mines, Mines Branch, Ottawa, 1916. This recent illustrated publication describes deposits of feldspar in Canada, the United States, Australia, and European countries, and contains useful chapters on mining, preparation, and uses of feldspar, and a bibliography of feldspar technology.

Galpin, S. L., Feldspar and mica deposits of Georgia: Georgia Geol. Survey Bull. 30, 1915.

Watts, A. S., Mining and treatment of feldspar and kaolin in the southern Appalachian region: Bur. Mines Bull. 53, 1913.

——— Feldspars of New England and northern Appalachian States: Bur. Mines Bull. 92, 1916.

USES.

Feldspar is used principally in the manufacture of pottery, chinaware, porcelain, enamel ware, and enamel brick and tile. It is used in both the body and glaze of ceramic products. In the body it constitutes from 10 to 35 per cent, its value there being due to the fact that it melts during firing at a temperature below the fusing points of the other ingredients and forms a firm bond between their particles. In glazes and enamels it constitutes from 30 to 50 per cent.

Feldspar is used also as an abrasive, chiefly as a constituent of scouring soaps and window wash, for which purpose very clean feldspar is desired. Other uses of feldspar, which do not require high-grade material, are in the manufacture of emery and corundum wheels, where it serves as a binder; in the manufacture of glass; as poultry grit; as a constituent of roofing material; and for surfacing concrete work. Small quantities of the purest grades of potash feldspar are used in the manufacture of artificial teeth. Feldspar suitable for this purpose brings the highest prices—$6 to $8 a barrel of 350 pounds.

The use of ground feldspar as a fertilizer has been proposed, but the results of extensive tests by the United States Department of Agriculture prove that only under exceptional conditions is such use of value. Attempts to extract potash from feldspar are still in an experimental stage. A number of patents have been taken out on processes of extraction of potash from feldspar and other potash-bearing silicates. These are summarized in the report for 1917 and in other recent Survey reports on potash salts. Other experiments have been directed toward the treatment of feldspar or other potash-bearing silicate rock in such manner as to make its potash content readily soluble, the treated feldspar to be used as a fertilizer or an as ingredient of complete fertilizers. It is reported that some of the larger manufacturers of fertilizer met urgent needs for potash in 1915 and 1916 by treating feldspar with ground flourite and sulphuric acid. The less commendable procedure of adding untreated ground feldspar to commercial fertilizer is practiced to a slight extent.

FELDSPAR MILLS.

Exclusive of mills operated by feldspar consumers for grinding spar for their own use, there are mills in the Eastern States operated by the following firms, dealers in feldspar, at the places named: Maine Feldspar Co., Auburn and Topsham, Me.; Trenton Flint & Spar Co., Cathance, Me.; Louis W. Howe, South Glastonbury, Conn.; Bedford Mining Co., Bedford, N. Y.; Pennsylvania Feldspar Co., Barnard, N. Y., and Toughkenamon, Pa.; Brandywine Summit Kaolin & Feldspar Co., Brandywine Summit, Pa.; Eureka Flint & Spar Co., Trenton, N. J.; Golding Sons Co., Trenton, N. J., Wilmimgton, Del., and East Liverpool, Ohio; Potters Mining & Milling Co., East Liverpool, Ohio; Newell Mining & Pulverizing Co., Newell, W. Va.; Clinchfield Products Corporation, Erwin, Tenn.; and Rochester Feldspar Mills (Inc.), Rochester, N. Y.

MARKETED PRODUCTION.

The marketed production of domestic feldspar in 1917 was the largest ever recorded. It was an increase of nearly 7 per cent in quantity as compared with 1916, 35 per cent as compared with 1915, and 5 per cent as compared with 1914. As reported prior to 1916 the values of the yearly production have expressed the combined sales of crude and ground feldspar and have, therefore, shown wider fluctuation than the quantities because of changes from year to year in the proportions sold as crude or ground. The value of the combined production in 1913 was the largest in the decade, and the production in 1915 dropped almost to the low level of 1908 and 1909. The industry rallied markedly in 1916 and 1917, making productions substantially as large as in the best years. A fairer basis for comparison of the yearly production is given in the accompanying curve (fig. 4), which shows the annual output, in long tons, of crude feldspar for each of the last 11 years.

The average price for feldspar sold crude in 1917 was $3.40 a long ton, as compared with $3.34 in 1916 and $3.46 in 1915, the range in prices during 1917 reported to the United States Geological Survey being from $2 to $7 a long ton. The average price of ground feldspar in 1917 was $10.15 a short ton, compared with $9.30 in 1916 and $8.33 in 1915, the range in 1917 in prices reported to the Geological Survey being from $5.70 to $17 a ton.

Of the total marketed production as tabulated below about 70 per cent was sold crude and 30 per cent ground in 1917, compared with 63 per cent and 37 per cent, respectively, in 1916 and 69 per cent and 31 per cent in 1915. The tables, however, credit to North Carolina as crude production a certain quantity of feldspar ground in Tennessee before being sold, and considerable quantities of the crude output in Maine, Connecticut, New York, Pennsylvania, Maryland, and North Carolina were produced virtually on contract with the feldspar mills listed above, so that the proportion of feldspar ground before entering the market was materially greater than appears from the figures. In 1917 the total quantity marketed in ground form was approximately 75,000 short tons.

About 84 per cent of the output in 1917 was consumed in the manufacture of pottery, chinaware, porcelain, tile, and enamel ware; about 2 per cent, or between 2,500 and 3,000 tons, in the preparation of "ceramic binders" for emery wheels and the like; probably about one-half of 1 per cent, or less than a thousand tons, in the manufacture of chicken grits; about 2.5 per cent in manufacture of scouring soaps and for other abrasive purposes; further, about 5 per cent was used in the manufacture of cement for the purpose of enriching flue dusts from which potash was recovered; about 1 per cent was used directly as an ingredient of fertilizer; and about 7,000 tons, or nearly 6 per cent, was used in roofing and cement surfacing.

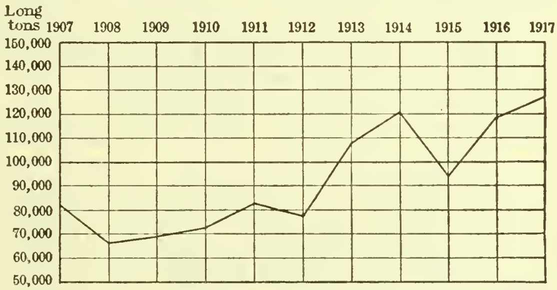

FIGURE 4.—Curve showing annual output of crude feldspar, 1907–1917, in long tons.

Crude and ground feldspar sold in 1916 and 1917.

State.	1916 Quantity (short tons).	1916 Value.	State.	1917 Quantity (short tons).	1917 Value
California	1,400	$6,550	California	7,874	$18,543
Connecticut	12,333	76,979	Connecticut[a]	11,710	77,432
Maine	28,006	235,922	Maine	35,527	291,252
Maryland	23,928	83,957	Maryland	15,779	56,958
New York	17,426	82,461	New York	13,462	62,003
North Carolina	34,670	77,446	North Carolina	47,559	131,442
Pennsylvania	7,342	56,323	Pennsylvania	10,013	91,208
Virginia, Georgia, New Hampshire, and Vermont	7,576	82,640		141,924	728,838
	132,681	702,278			

[a] Includes New Hampshire in 1917.

Quantity of feldspar sold in 1916 and 1917, and value at price for crude feldspar.

State.	1916		1917	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
California	1,250	$6,550	7,031	$18,137
Connecticut	11,012	49,554	[a]10,455	[a]43,160
Maine	25,006	75,018	31,720	131,994
Maryland	21,364	83,957	14,088	56,958
New York	15,559	66,340	12,019	44,290
North Carolina	30,955	77,446	42,463	131,442
Pennsylvania	6,555	25,899	8,939	48,786
Virginia, Georgia, New Hampshire,[a] and Vermont	6,764	19,925		
	118,465	404,689	126,715	474,767

[a] New Hampshire included with Connecticut in 1917.

FELDSPAR INDUSTRIES BY STATES.

The sales of feldspar in 1917 were reported from the following States, named in the order of their output: North Carolina, Maine, Maryland, New York, Connecticut, Pennsylvania, California, New Hampshire. Named in order of the value of the product sold they are: Maine, North Carolina, Pennsylvania, Connecticut, New York, Maryland, California, New Hampshire.

California.—Ten quarries operated by eight firms, one each in Tulare, San Bernardino, Monterey, and Los Angeles counties and four in Riverside County, Cal., reported production in 1917. The production was much the largest recorded for the State and amounted to 7,031 long tons of crude feldspar, valued at $18,137. Most of this was used for its potash content by the Riverside Portland Cement Co. This company uses feldspar as a raw ingredient in the manufacture of cement and recovers potash by precipitation of flue dusts from its cement kilns. The remainder of the California production was used by California pottery, porcelain, tile, and enameling works. Prices received for crude feldspar in California ranged from $2 to $7.80 a long ton f. o. b. quarries and averaged about $4.50 for pottery grades.

Connecticut.—Three companies in Connecticut reported production in 1917. Two operated in the Portland region in Hartford and Middlesex counties, and one at Willimantic in Windham County. The total production was less than in preceding years and together with a small production from New Hampshire amounted to 10,455 long tons of crude spar, valued at $43,160. A small part of the total output was sold for use as abrasive and in scouring soaps, and a little for manufacturing glass. The chief part was used in pottery and enameling works.

Prices ranged from $4 to $7 a long ton for crude spar f. o. b. quarries, and ground spar brought from $8.90 to $17 a short ton f. o. b. mills, according to color and purity. The L. W. Howe feldspar mill at South Glastonbury made its usual important output of high-grade feldspar.

Delaware.—There was no production from feldspar quarries in Delaware in 1917. Wilmington, Del., is a large feldspar market and a site of feldspar grinding mills.

Georgia.—No report of production in 1917 has been received from Georgia.

Maine.—Six operators reported production from nine or more quarries in Maine in 1917. These were in the Georgetown district and near Cathance and Topsham in Sagadahoc County and at Mount Apatite and near Auburn in Androscoggin County. The total output was 31,720 long tons of crude feldspar, valued at $131,994. This is more both in quantity and in value than the production of the preceding years. Maine ranked second in quantity and first in value among the producing States. The greater part of this production was made and sold ground by the Maine Feldspar Co., which operates mills at Topsham and Auburn, and by the Trenton Flint & Spar Co., whose mill is at Cathance.

Prices in Maine in 1917 ranged from $3 to $4.50 a long ton, but stood prevailingly about $4 for crude spar and from $11 to $11.30, averaging $11.05, for ground feldspar. The output was used almost entirely in ceramics, a considerable part in the preparation of ceramic binders for carborundum and corundum grinding wheels, and a little in abrasive soaps.

Maryland.—Seven operators reported production in Baltimore, Howard, and Carroll counties, Md., in 1917. The output amounted to 14,088 long tons, valued at $56,958. In addition there was a small undetermined quantity of soda spar produced in the Sylmar, Md., district, which is unavoidably included with the Pennsylvania output. Maryland ranked third in quantity and value of the production in 1917, which was considerably less than that for 1916. Prices for crude spar ranged from $3 to $4.50 a long ton and averaged $4.05 f. o. b. quarries.

New Hampshire.—Feldspar was produced in New Hampshire in 1917, at two localities—Grafton and Orange, in Grafton County. The product was used in the manufacture of scouring soaps.

New Jersey.—There are no productive feldspar deposits in New Jersey. Trenton is an important feldspar market, in which there are mills for grinding feldspar.

New York.—New York ranked fourth in quantity and fifth in value of the feldspar output in 1917. Four companies reported production, one in Franklin County, one in Essex County, which operated quarries and a mill for crushing and coarse grinding feldspar to be used in roofing and concrete facing, and two in Westchester County. Besides the mill mentioned there were two others in operation for fine grinding—one at Bedford in Westchester County, and one at Barnard, in Monroe County. It is reported that another mill has been erected near Rochester. The total production of the State for 1917 was 12,019 long tons of crude feldspar, valued at $44,290, which was considerably less than in preceding years. The larger part of this output was consumed as roofing, concrete facing, and chicken grits, the remainder in pottery and enamel ware. Crude pottery spar prices ranged from $3 to $4.50 a long ton and averaged $3.05. Ground spar was reported to have been sold for $7.04.

North Carolina.—North Carolina ranked first in quantity and second in value of the feldspar produced in 1917. The Geological Survey received reports of production from 24 quarry operations chiefly in the Spruce Pine district, in Mitchell, Avery, and Yancey counties. The total output was 42,463 long tons of crude spar, valued at $131,442. Prices ranged from $2.60 to $7 a ton, prevailingly about $4, and averaged $3.10. Much of the output was ground at Erwin, Tenn., and the remainder went chiefly to mills at East Liverpool, Ohio; and Trenton, N. J.

Pennsylvania.—Pennsylvania ranked sixth in quantity and fourth in value of feldspar produced in 1917. Production was reported by 10 operators who drew their supply from seven large and a number of small quarries in Delaware, Chester, and Lancaster counties. The total production was 8,939 long tons of crude spar, valued at $48,786 f. o. b. mines. A small part was crushed for chicken grits and most of the remainder was ground at Brandywine Summit and Toughkenamon. Prices for crude spar ranged from $2 for spar for grits to $6 for better grades of pottery spar; the average was $5.08. Ground spar sold from $7.20 to $12 a ton, and averaged $10.25. Pennsylvania spar was used chiefly for pottery and glass and in small part for abrasive soap as well as for chicken grits. The Brandywine Summit Kaolin & Feldspar Co. produces a considerable quantity of soda spar from mines in the Nottingham, Pa., and Sylmar, Md., region.

Vermont.—There was no production of feldspar in Vermont in 1917.

Virginia.—There was no production of feldspar in Virginia in 1917.

PRODUCTION IN OTHER COUNTRIES AND IMPORTS.

The following table gives such figures as are available on the production of feldspar in recent years in the United States and other countries. The United States imports nearly the whole of the Canadian production and none from other countries.

Feldspar sold in principal producing countries, 1912–1917.

Country.	1912		1913		1914	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
United States	86,572	$520,562	120,955	$776,551	135,419	$620,873
Belgium [a]		660	(b)	(b)	(b)	(b)
Canada [c]	13,733	30,916	15,935	56,841	18,060	70,824
Germany (Bavaria) [a]	7,348	49,581	(b)	(b)	(b)	(b)
Italy [d]	37,416	44,079	35,569	39,172	35,863	43,305
Madagascar [a]	451		(b)	(b)	(b)	(b)
Norway [e] [a]	43,919	146,325	(b)	(b)	(b)	(b)
Sweden [a]	37,814	88,682	(b)	(b)	[f] 22,941	(b)

Country.	1915		1916		1917	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
United States	105,118	$489,223	132,681	$702,278	141,924	$728,838
Belgium [a]	(b)	(b)	(b)	(b)	(b)	(b)
Canada [c]	15,455	59,124	19,488	71,407	11,493	54,555
Germany (Bavaria) [a]	(b)	(b)	(b)	(b)	(b)	(b)
Italy [d]	37,230	50,921	(b)	(b)	(b)	(b)
Madagascar [a]	(b)	(b)	(b)	(b)	(b)	(b)
Norway [e] [a]	(b)	(b)	(b)	(b)	(b)	(b)
Sweden [a]	[f] 13,240	(b)	[f] 14,022	(b)	(b)	(b)

[a] Statistics taken from Mines and quarries: General report and statistics, part 4, London.
[b] Statistics not available.
[c] Reports on mineral production of Canada, Canada Dept. Mines, 1917 figures preliminary and subject to revision.
[d] Includes quartz; statistics taken from Rivista del Servizio minerario, Rome.
[e] Export figures.
[f] Eng. and Min. Jour., May 18, 1918, quoting "official reports."

GEMS AND PRECIOUS STONES.

By Waldemar T. Schaller.[1]

PRODUCTION.

The value of the precious stones produced in 1917 ($131,012) is much smaller than that for either of the two preceding years and is only a little larger than that for 1914 ($124,651). In fact, except for 1914, the value for 1917 is smaller than that for any other year since 1897, when it was $130,675.

Value of precious stones produced in the United States, 1913–1917.

	1913	1914	1915	1916	1917
Beryl	$1,615	$2,395	$1,675	$2,031	$2,178
Copper ore gems	2,350	1,280	1,120	1,713	2,857
Corundum	238,835	61,032	88,214	99,180	54,204
Diamond	6,315	765	608	2,680	4,175
Feldspar	1,285	449	368	305	(a)
Garnet	4,285	1,760	4,523	1,542	624
Hematite	....	....	126	(a)	(a)
Jade	....	300	....	....	....
Opal	15,130	1,114	1,850	1,838	805
Peridot	375	100	(a)	455	(a)
Pyrite	50	....	1,042	2,075	(a)
Quartz	16,861	18,838	35,724	25,707	28,273
Rhodonite	165	1,050	85	(a)	(a)
Smithsonite	50	50	(a)	....	(a)
Spodumene	6,520	4,000	(a)	(a)	(a)
Thomsonite	....	21	(a)	47	(a)
Topaz	736	1,380	862	1,005	230
Tourmaline	7,630	7,980	10,969	50,807	12,452
Turquoise	8,075	13,370	11,691	21,811	14,171
Variscite	6,105	5,055	3,867	3,140	2,350
Vesuvianite	152	1,425	1,535	(a)	2,765
Miscellaneous gems	2,920	2,287	b 6,172	c 3,457	d 5,928
	319,454	124,651	170,431	217,793	131,012

a Small production included under "miscellaneous gems."
b Includes apatite, calamine, chloarstrolite, crocidolite, datolite, fossil coral, Iceland spar, kyanite, lazurite, obsidian, peridot, phenacite, rutile, smithsonite, spodumene (kunzite), staurolite, thomsonite, titanite, and zircon.
c Includes chlorastrolite, datolite, epidote, fossil coral, hematite, kyanite, lazulite, rhodonite, rutile, sepiolite, serpentine, spodumene, staurolite, and vesuvianite.
d Includes andalusite, chlorastrolite, datolite, epidote, feldspar, fossil coral, hematite, Iceland spar, lapis lazuli, obsidian, peridot, phenacite, pyrite, rhodonite, rutile, sepiolite, smithsonite, spodumene, staurolite, thomsonite, willemite, and zoisite.

The value given in the table largely represents the value of the rough material; the value of the cut and polished gems is several times greater. The completeness and accuracy of the statistics of production depend on the assistance rendered by the gem miners and dealers, and their help is greatly appreciated. The Geological Survey carries on a large correspondence concerning precious stones, and

[1] The table giving statistics of the value of the gems and precious stones produced in 1917 was compiled by Miss Blanche H. Stoddard.

the accurate information furnished by the individual producers enables the Survey to put intending purchasers of rough material directly in touch with them.

The principal precious stones produced in the United States during recent years are corundum, quartz, tourmaline, and turquoise. These four minerals yielded 83 per cent of the total value of precious stones produced in 1917—corundum was 41 per cent, quartz 22 per cent, turquoise 11 per cent, and tourmaline 9 per cent.

Montana continues to lead all other States in the value of precious stones produced, corundum being the chief gem mineral, others being moss agate and other quartz gems, Iceland spar, and garnet.

Nevada ranks second, with turquoise and moss agate as the leading precious stones produced. Other gem minerals mined are quartz and variscite.

California ranks third, with quartz, vesuvianite, tourmaline, and beryl as the chief gem minerals produced. Smaller quantities of andalusite, diamond, epidote, obsidian, opal, rhodonite, spodumene, topaz, turquoise, and pyrite were also mined.

Maine produced chiefly tourmaline, but also some beryl and quartz; Colorado produced turquoise, quartz, beryl, feldspar, opal, phenacite, topaz, and garnet; Arizona produced copper-ore gems, quartz, garnet, peridot, obsidian, quartz, and tourmaline; Arkansas, diamond, quartz, and smithsonite.

The rank of States in value of precious stones produced is as follows:

Value of precious stones produced in 1917, by States.

Montana	$59,130	Arkansas	$4,260
Nevada	17,851	Oregon	3,355
California	15,972	Other States [1]	5,550
Maine	10,870		
Colorado	7,205		131,012
Arizona	6,819		

IMPORTS.

The precious stones (excluding pearls) imported into the United States in 1917, as reported by the Bureau of Foreign and Domestic Commerce, were valued at $34,846,351. Pearls are omitted from the total value, as they are lustrous calcareous concretions with animal membrane between successive layers and are not a mineral but an animal product, being deposited in the shells of various mollusks. As pearls owe their beauty and value to the organic part of their composition, they do not come within the scope of this report. They are, however, among the most desired of gems, and their value is therefore given in a separate column in the table of imports.

The value of imported gems in 1917 was lower than in 1916, higher than in either 1915 or 1914, but lower than for any year from 1909 to 1913. The full recovery in the value of imported gem stones in 1916, as compared with the average annual value of the years 1909 to 1913, was not quite retained in 1917.

[1] Virginia, Utah, Texas, Massachusets, New Hampshire, Connecticut, Michigan, North Carolina, Pennsylvania, Minnesota, Idaho, Wyoming, New Mexico, New Jersey, South Carolina, and Washington.

Diamonds and other precious stones imported and entered for consumption in the United States, 1908–1917.

Year.	Diamonds.				Diamonds and other stones not set.	Total excluding pearls.	Pearls.
	Glazier's.	Dust and bort.	Rough or uncut.	Unset.			
1908	$650,713	$180,222	$1,636,798	$9,270,225	*a* $1,051,747	$12,789,705	$910,699
1909	758,865	50,265	8,471,192	27,361,799	*a* 3,570,540	40,212,661	24,848
1910	213,701	54,701	9,212,378	25,593,641	4,003,976	39,078,397	1,626,083
1911	199,930	110,434	9,654,219	25,676,302	3,795,175	39,436,060	1,384,376
1912	452,810	94,396	9,414,514	22,865,686	3,405,543	36,232,949	5,130,376
1913	471,712	100,704	12,268,513	24,812,604	2,775,811	40,429,374	5,002,624
1914	579,332	77,408	2,851,933	11,976,871	1,635,522	17,121,066	2,090,018
1915	366,793	75,944	7,020,646	13,177,919	*a* 1,078,391	21,719,693	4,513,909
1916	836,018	67,290	11,441,328	24,282,140	*a* 2,303,341	38,930,117	11,336,971
1917	1,098,102	349,746	13,092,855	18,421,838	*a* 1,883,810	34,846,351	4,947,509

a Including agates. Agates in 1915, $31,657; in 1916, $18,681; in 1917, $19,715.

GEM NAMES.

The following list of gem names has been compiled from the literature and from correspondence with the producers of precious stones in the United States. The list is in two parts. Part I gives the name of the gem followed by the name of the mineral species to which the gem belongs. Part II aims to give all the names of the mineral species followed by the names of the corresponding gems.

Many of the names have been coined by the dealers in particular minerals for the evident purpose of increasing their sales. Many people who buy cheap gem stones under fanciful names probably would not buy the stones if they were offered under their true mineralogic names. The list herewith will enable those who are interested to look up the true mineral species of the gems offered.

The use of the name of a valuable gem mineral combined with another modifying word instead of the true name of a mineral of less value—for example, "Alaska diamond" instead of quartz or "Arizona ruby" instead of garnet—is incorrect and should be avoided. The list does not contain all the names applied to gem minerals. Such self-evident names as "milky opal" and "blue beryl" are omitted. The object of the list is to show the mineral species forming the gem and not to list all possible names which have been used for gems.

A few names of substances not minerals but commonly used as gems have been included. Artificial products, however, many of them made of glass and fraudulently sold under mineral names—for example, glass sold as "fire agate"—have been excluded.

In offering this list the Geological Survey emphatically disclaims giving any official sanction to the local or trade names applied to varieties of well-known minerals used as gem stones. In fact, the Survey strongly condemns the practice and hopes that the publication of this list, which shows the true mineral species, will remove much of the mystery attached to these trade names and will act as a deterrent on their use in the future.

To those who have aided in the compilation of this list the Geological Survey expresses its appreciation. Additions and corrections will be gratefully received.

PART I.

A.

Achirite=dioptase from Siberia.
Achroite=colorless or white tourmaline.
Actinolite=green silicate of iron, calcium, and magnesium (amphibole).
Adamantine spar=hair-brown corundum.
Adelaide ruby=blood-red pyrope (garnet) from South Africa.
Adularia=orthoclase (feldspar).
Aeroides=pale sky-blue beryl.
Agalmatolite=compact mica (hydrous silicate of aluminum and potassium); also compact pyrophyllite (hydrous silicate of aluminum).
Agate=variegated chalcedony.
Agate jasper=intermediate between jasper and chalcedony with predominant translucent chalcedony; jasper with bands of chalcedony.
Agrite=brown, mottled, calcareous stone.
Alabandine ruby=red spinel of a violet tint.
Alabaster=white, fine-grained gypsum; also incorrectly applied to fine-grained and pure-white stalagmites of aragonite.
Alalite=diopside.
Alaska diamond=quartz.
Albite=silicate of aluminum and sodium (feldspar).
Albite moonstone=iridescent albite.
Alençon diamond=quartz crystal from Alençon, France.
Aleppo stone=eye agate.
Alexandrite=emerald-green to dark-green chrysoberyl which changes in color to a columbine-red by artificial light.
Allanite=black hydrous silicate of aluminum, magnesium, cerium, and iron and other elements.
Almandite (almandine)=columbine-red, or a deep crimson and violet garnet, silicate of aluminum and iron.
Almandine spinel=violet-red spinel
Alpine diamond=pyrite.
Amatrice=green, blue-green, and bluish variscite cut with its associated matrix.
Amazon stone=green microcline feldspar, silicate of aluminum and potassium
Amber=fossil resin.
Amber opal=opal colored brown by iron oxide.
Amberine=yellowish-green agate from the Death Valley region, Cal.
Ambroid=small pieces of inferior amber fused together.
American jade=californite (vesuvianite).
American ruby=blood-red garnet, mostly pyrope.
Amethiste basaltine=pale violet or reddish beryl.
Amethyst=purple and bluish-violet quartz, in crystals.
Amethystine quartz=quartz of an amethyst color, not necessarily in crystals.
Amphibole=group of minerals, silicates of aluminum, iron, calcium, magnesium, and other elements.
Anatase=oxide of titanium. Another name for octahedrite.
Ancona ruby=quartz.
Andalusite=silicate of aluminum; also trade name for brown tourmaline.
Andesine=silicate of aluminum, sodium, and calcium (feldspar).
Andradite=garnet, silicate of iron and calcium.
Anthracite=hard iron-black coal, harder than jet or cannel coal.
Apatite=phosphate of calcium, with fluorine.
Aphrizite=black tourmaline.
Apophyllite=hydrous silicate of calcium and potassium.
Apricotine=yellowish-red quartz pebbles from vicinity of Cape May, N. J.
Aquamarine=light bluish-green or sea-green beryl.
Aquamarine chrysolite=greenish-yellow beryl.
Aquamarine topaz=greenish topaz.
Aragonite=carbonate of calcium, in orthorhombic crystals.
Arizona ruby=deep-red pyrope (garnet) from Arizona and Utah.
Arizona spinel=deep-red pyrope (garnet) from Arizona and Utah. Same as Arizona ruby.
Arkansas diamond=diamond from Arkansas; also quartz crystals from Arkansas.
Arkansite=brilliant iron-black, opaque brookite, oxide of titanium.

Armenian stone=(in part)lapis lazuli.
Arrow points=Indian arrowheads mostly made of quartz, more rarely of obsidian or other fine-grained rock.
Asparagus stone=pale-yellow apatite.
Asteria=asteriated sapphire; also any gem showing a six-ray star when cut cabochon.
Asteriated topaz=asteriated oriental topaz (yellow corundum).
Australian sapphire=deep inky blue sapphire (corundum).
Automolite=dark-green to nearly black zinc spinel.
Aventurine=opaque yellow, brown, or red massive quartz containing inclusions of minute scales of some other mineral, such as mica or iron oxide.
Aventurine feldspar=sunstone.
Axstone=nephrite.
Axinite=hydrous borosilicate of aluminum, calcium, iron, and manganese.
Aztec stone=chalchihuitl.
Azure quartz=blue quartz.
Azure stone=lapis lazuli.
Azulite=pale-blue smithsonite.
Azurite=blue, hydrous carbonate of copper.
Azurite malachite=azurmalachite.
Azurmalachite=combination of the copper carbonates azurite (blue) and malachite (green) from the copper mines of Arizona.

B.

Baffa diamond=quartz crystal.
Bahias=diamonds from Bahia, Brazil.
Balas ruby=rose-red or pink spinel.
Barite=sulphate of barium.
Basanite=velvet black, flinty quartz.
Bastite=variety of bronzite.
Beckite=silicified coral shells or fossiliferous limestone replaced by silica.
Beekite=beckite.
Bemiscite=salmon-colored feldspar from Bemis, Maine.
Benitoite=blue silicate of barium and titanium.
Beryl=silicate of aluminum and beryllium with small amounts of other elements.
Beryllonite=phosphate of beryllium and sodium.
Bishop's stone=amethyst.
Bixbite=red and rose-colored beryl from Utah.
Black amber=jet.
Black lava glass=obsidian.
Black opal=opal in a dark matrix; also opal with vivid colors.
Blood agate=flesh-red, pink, or salmon-colored agate from Utah.
Blood jasper=bloodstone.
Bloodstone=massive dark-green jasper (plasma) with red or blood-colored spots; also hematite (German usage).
Blue chrysoprase=chalcedony stained blue with chrysocolla.
Blue john=dark-blue fluorite, tinged with violet.
Blue malachite=azurite.
Blue moonstone=blue chalcedony from the Death Valley region, Cal.
Blue rock=lapis lazuli from California.
Blue white=diamond of highest grade.
Bobrowska garnet=grossularite (garnet).
Bohemian diamond=rock crystal (quartz).
Bohemian garnet=dark blood-red pyrope (garnet).
Bohemian topaz=yellow quartz.
Bohemian ruby=red or rose quartz.
Bonamite=translucent apple-green smithsonite from New Mexico.
Bone turquoise=teeth of fossil animals (mammoths, mastodons, etc.) stained blue by phosphate of iron.
Bottle stone=moldavite.
Bowenite=unusually translucent serpentine of a cream color.
Brazilian aquamarine=greenish topaz.
Brazilian diamond=diamond from Brazil; also clear quartz from Brazil.
Brazilian emerald=green tourmaline.
Brazilian pebble=rock crystal (quartz).

Brazilian peridot=yellow-green tourmaline.
Brazilian ruby=rose-red or pink topaz, both naturally and artificially colored. Most of the pink or reddish topazes have been artificially colored by heating the dark-yellow ones.
Brazilian sapphire=light-blue or greenish topaz; also blue tourmaline.
Brazilian topaz=golden to reddish-yellow topaz; also smoky quartz artificially changed to yellow by heat.
Briançon diamond=quartz crystal from southeastern France, cut in Briançon.
Brighton emerald=green bottle glass purposely thrown on beach at Brighton, England.
Brilliant=diamond.
Bristol diamond=quartz crystal from Cornwall, England.
Bronzite=silicate of magnesium and iron; variety of enstatite.
Brookite=hair-brown, yellowish, reddish, or ruby-red, transparent to translucent oxide of titanium, in orthorhombic crystals.
Brown coal=brown or brownish-black coal, often retaining the original wood texture.
Brown jacinth=vesuvianite.
Brown spar=ankerite from Chester County, Pa.
Bull's-eye=labradorite with a dusky sheen.
Burma ruby=blood-red ruby (corundum).
Burmite=amber from Burma.
Burnt amethyst=purple amethyst changed to brownish-yellow by heat.
Burnt Brazilian topaz=burnt topaz.
Burnt topaz=yellow topaz from Brazil which has been changed to pink by heat.
Byssolite=fine greenish hair-like asbestos or actinolite, inclosed in quartz.
By-water=yellow-tinted diamond.

C.

Cabochon=any gem cut round, without facets.
Cacholong=opaque, porcelain-like, milky-white opal.
Cacholong opal=feebly translucent common opal.
Caesium beryl=beryl containing several per cent of caesium, one of the rarer alkalies. The beryl is generally colorless or pink.
Cairngorm=yellow to smoky-brown, gray, or black quartz.
Calamine=hydrous silicate of zinc. In England calamine is called smithsonite.
Calcite=carbonate of calcium in rhombohedral (hexagonal) crystals.
Calcomalachite=mixture of carbonate of calcium and malachite, from Arizona.
California cat's-eye=compact serpentine, sufficiently fibrous to show a silky luster and to yield a cat's-eye effect when cut cabochon, from Tulare Co., Cal.
California iris=kunzite (spodumene).
California jade=californite (vesuvianite).
California moonstone=white or gray chalcedony.
California onyx=dark-brown aragonite.
California ruby=garnet.
California tiger-eye=California cat's-eye.
Californite=compact, translucent, green vesuvianite.
Callainite=translucent green hydrous phosphate of aluminum (probably variscite).
Cameo=relief carving on a gem (the opposite of intaglio).
Canary=yellow diamond.
Canary beryl=greenish-yellow beryl.
Cancrinite=complex hydrous silicate of aluminum, calcium, and sodium, and the carbonate radicle.
Candle coal=cannel coal.
Cannel coal=dark grayish-black or brownish-black coal.
Cape chrysolite=green prehnite from South Africa.
Cape garnet=bright red-yellow almandite (garnet).
Cape May diamond=colorless and clear quartz crystal from Cape May, N. J.
Cape ruby=blood-red pyrope (garnet) from South Africa.
Cape=diamond having a yellowish tinge.
Carbonado=black diamond, not crystallized.
Carbuncle=clear deep-red almandite garnet; also any red, scarlet, or crimson garnet cut cabochon. The term is also improperly applied to any red stone especially if cut cabochon.

Carmazul=oxidized copper ore showing red, brown, blue, and green colors, from Lower California, Mexico; composed of jasper, chalcedony, quartz, hematite, chrysocolla, and malachite.
Carnelian=translucent red chalcedony.
Carnelian-onyx=agate with red and white bands.
Cassinite=pearly, bluish-green aventurine feldspar from Delaware County, Pa.
Cassiterite=oxide of tin.
Cat sapphire=dark-blue sapphire.
Catalinite=beach pebbles from Santa Catalina Island, Cal.
Catalina sardonyx=catalinite.
Catlinite=compact red clay.
Cat's-eye=any mineral having a changeable luster or showing opalescence without play of colors; also true cat's-eye (chatoyant chrysoberyl); also chatoyant quartz.
Celestial stone=turquoise.
Celestial precious stone=olivine from meteorite.
Cer-agate=chrome-yellow agate from Brazil.
Ceylon cat's-eye=chrysoberyl cat's-eye.
Ceylon chrysolite=yellowish-green or greenish-yellow tourmaline.
Ceylon hyacinth=garnet.
Ceylon opal=moonstone.
Ceylon peridot=honey-yellow or yellowish-green tourmaline.
Ceylon ruby=ruby from Ceylon; also deep-red almandine garnet from Ceylon; also any pale or pink ruby.
Ceylon sapphire=pale-blue sapphire (corundum).
Ceylonese zircon=fire-red cloudy zircon.
Ceylonite=black spinel.
Chalcedony=compact silica, transparent or translucent, with a waxy luster.
Chalcedony onyx=agate with white and pale bands.
Chalcedonyx=chalcedony with alternating stripes of gray and white.
Chalchihuitl=supposed to have been applied to blue, gray, or green calamine from Mexico, also to turquoise, emerald, prase, green jasper, and jadeite.
Chalchuite=green turquoise.
Changeant=labradorite.
Chert=compact silica, includes flint, hornstone, and jasper.
Chessy copper=azurite.
Chessylite=azurite.
Chesterlite=microcline feldspar from Chester County, Pa.
Chiastolite=variety of andalusite with crosslike marking.
Chinarump=petrified wood from Arizona.
Chlorastrolite=impure variety of prehnite or thomsonite.
Chloromelanite=dark-green to nearly black jadeite.
Chloropal= green opal from Silesia, Germany. Mineralogically, a hydrous silicate of iron.
Chlorophane=variety of fluorite which phosphoresces with a greenish light on being slightly heated as by friction or by the heat of the hand.
Chlorospinel=green spinel.
Chlorutahlite=utahlite (compact variscite).
Chondrodite=silicate of magnesium and iron, with fluorine.
Chrome garnet=uvarowite (garnet).
Chromic iron=chromite.
Chromite=oxide of chromium and iron.
Chrysoberyl=oxide of aluminum and beryllium.
Chrysoberyllus=greenish-yellow, honey-yellow, or wine-yellow beryl.
Chrysocarmen=very similar to carmazul.
Chrysocolla=green to blue hydrous silicate of copper.
Chrysolithus=pale yellowish-green beryl.
Chrysolite=olivine or peridot; also light-golden chrysoberyl (incorrect usage); also improperly applied to any light greenish-yellow to yellowish-green transparent gem.
Chrysoprase=apple-green, olive-green, or whitish-green, translucent chalcedony.
Cinnamon stone=essonite (garnet).
Citrine=golden-yellow quartz.
Cloudy chalcedony=chalcedony with dark cloudy spots in a light-gray transparent base.
Cobaltite=metallic sulphide and arsenide of cobalt and iron.

Cobra stone=chlorophane.
Colophonite=brownish-black and radite (garnet), characterized by a resinous luster; silicate of iron and calcium.
Colorado ruby=pyrope (garnet). Same as Arizona ruby.
Colorado topaz=topaz from Colorado; also citrine (yellow quartz).
Common opal=translucent, only slightly colored opal without fire or play of colors.
Comptonite=thomsonite.
Congo emerald=dioptase from the Congo, Africa.
Copper emerald=dioptase.
Copper-ore gem=mixture of various copper minerals, such as green malachite, green or blue chrysocolla, blue azurite, red cuprite.
Copper-pitch ore=compact black or dark-brown mixture of oxides of iron and copper.
Coral=hard calcareous structure secreted in or by the tissues of various marine zoophytes. When fossilized, the calcareous matter is often replaced by silica (see beckite).
Coral agate=beckite (see coral).
Cordierite=hyrous silicate of aluminum, iron, and magnesium.
Cornish diamond=quartz crystal from Cornwall, England.
Corundum=oxide of aluminum.
Corundum cat's-eye=corundum with a bluish, reddish, or yellowish reflection of light of a lighter shade than the stone itself.
Cotterite=quartz having a metallic pearly luster.
Creoline=purplish epidotized trap rock from Massachusetts.
Creolite=banded jasper from Shasta County, Cal.
Crimson night stone=purple fluorite from Idaho.
Crispite=sagenite.
Crocidolite=fibrous hornblende of a bluish or greenish color, hydrous silicate of iron and magnesium. The altered form consists of silica colored yellow and brown with oxide of iron and is called tiger-eye.
Cross stone=chiastolite (andalusite); also staurolite.
Crystal=colorless transparent quartz; also artificial flint glass.
Cupid's darts=quartz crystal with needle-like inclusions of goethite.
Cyanite=kyanite.
Cymophane=chrysoberyl having a bright spot of light which seems to float over the surface as the stone is moved.
Cyprine=bright-green vesuvianite.

D.

Damourite=compact mica, a result of the alteration of some preexisting mineral.
Danburite=borosilicate of calcium.
Datolite=compact massive hydroborosilicate of calcium.
Dauphine diamond=rock crystal (quartz).
Davidsonite=greenish-yellow beryl from vicinity of Aberdeen, Scotland.
Delawarite=aventurine feldspar from Delaware County, Pa.
Demantoide=olive-green, brown, blackish-green, or light-green grossularite (garnet) from the Ural Mountains, Russia.
Dendrite=having the form of a tree.
Dendritic agate=mocha stone and moss agate.
Diallage=foliated variety of diopside.
Diamond=carbon, in isometric crystals.
Diaspore=hydrous oxide of aluminum.
Dichroite=cordierite.
Diopside=silicate of calcium and magnesium (pyroxene).
Dioptase=green hydrous silicate of copper.
Disthene=kyanite.
Doublet=consists of a real gem cemented to a piece of glass cut and colored to imitate the real stone.
Dravite=brown tourmaline.
Drop of water=rounded (water-worn), colorless, and transparent pebble of topaz.
Dumortierite=blue or lavender hydroborosilicate of aluminum.
Dysluite=yellow or grayish-brown spinel.

E.

Edisonite=mottled blue turquoise.
Egyptian jasper=banded yellow, red, brown, or black jasper.
Egyptian pebble=Egyptian jasper.
Elaeolite=silicate of aluminum, sodium, and potassium. Same as nephelite.
Eldoradoite=iridescent quartz from Eldorado County, Cal.
Elie ruby=red pyrope (garnet) from Elie in Fifeshire, Scotland.
Emerald=green beryl; also improperly applied to any green stone.
Emerald copper=dioptase.
Emerald malachite=dioptase.
Emeraldine=chalcedony artificially colored green.
Emeralite=green and bluish-green tourmaline from San Diego County, Cal.
Emerandine=dioptase.
Enhydros=hollow nodules of chalcedony partly filled with water.
Enstatite=silicate of magnesium.
Epidote=greenish hydrous silicate of aluminum, iron, and calcium.
Essonite=yellow variety of grossularite (garnet).
Euclase=bluish or greenish hydrous silicate of aluminum and beryllium.
Evening emerald=peridot.
Euxenite=complex mineral containing columbium, titanium, and yttrium, and other elements.
Eye agate=concentric rings of agate with a dark center; also thomsonite.
Eyestone=thomsonite.

F.

Fairy stone=twinned crystal of staurolite, forming a cross.
False amethyst=purple fluorite.
False chrysolite=moldavite.
False diamond=quartz crystal.
False emerald=green fluorite.
False hyacinth=garnet.
False lapis=agate or jasper artificially colored blue.
False lapis lazuli=lazulite.
False ruby=red fluorite.
False sapphire=blue fluorite.
False topaz=yellow quartz; also yellow fluorite.
Fancy=term applied to stones having value other than intrinsic value.
Fancy agates=agates showing delicate markings and intricate patterns.
Fancy stone=unusual stone.
Fashoda garnet=dark brownish-red pyrope (garnet).
Feldspar=group of minerals, including orthoclase, microcline, albite, oligoclase, andesine, labradorite; silicates of aluminum and potassium, sodium, or calcium.
Feldspar sunstone=sunstone.
Female sapphire=light-colored sapphire.
Feminine=term applied to stones of a paler color than masculine ones.
Fergusonite=black mineral composed chiefly of columbate of yttrium.
Figure stone=agalmatolite.
Fire marble=dark-brown shell marble with brilliant firelike internal reflections.
Fire opal=red or yellowish-red opal.
First bye=diamond with a faint greenish tint.
First water=pure and colorless diamond.
Fish-eye=moonstone.
Fish-eye stone=apophyllite.
Flash opal=opal in which the color shows as a single flash.
Flêches d'amour=sagenite (quartz).
Fleurus diamond=quartz crystal.
Flint=compact silica, opaque, and of dull colors.
Floating light=cymophane.
Flos ferri=aragonite in shapes resembling coral.
Flowers of iron=flos ferri (aragonite).
Flower stone=beach pebbles (chalcedony) with flower patterns.
Fluorspar=fluorite.
Fluorite=fluoride of calcium.
Fool's gold=pyrite.

Fortification agate=agate with parallel zigzag lines.
Fossil coral=coral replaced by silica (beckite).
Fossil pineapple=opal pseudomorph after glauberite, from New South Wales.
Fossil turquoise=bone turquoise.
Fowlerite=variety of rhodonite containing zinc.
Franklinite=black oxide of iron, manganese, and zinc.
Frost stone=translucent gray chalcedony with pure-white patches or tufts, like snowflakes, scattered through it, from the Mojave desert, Cal.
Fuchsite=green muscovite (mica).

G.

Gadolinite=velvety-black silicate of yttrium, beryllium, iron, and other elements.
Gahnite=green zinc spinel.
Garnet=group of silicate minerals. The species are: Almandite, silicate of aluminum and iron; andradite, silicate of iron and calcium; grossularite, silicate of aluminum and calcium; pyrope, silicate of aluminum and magnesium; spessartite, silicate of aluminum and manganese; uvarovite, silicate of chromium and calcium.
Garnierite=green hydrous silicate of nickel and magnesium.
Gem=cut and polished precious stone.
Gemstone=gem.
Geneva ruby=synthetic ruby made in Geneva, Switzerland.
Geyserite=siliceous deposit from a geyser.
Gibraltar stone=banded, mottled, or clouded carbonate of calcium.
Girasol=corundum cat's-eye with a bluish, reddish, or yellowish reflection of light, lighter in shade than the stone itself, which moves on the surface of the stone like the lines of a starstone; also opal (see girasol opal); also moonstone (feldspar).
Girasol opal=fire opal.
Glass=artificial noncrystallized substance composed of silica and several bases, notably an alkali and lead.
Glass agate=obsidian.
Goethite=hydrous oxide of iron.
Golconda diamond=diamond obtained from the regions watered by Krishna and Godavari rivers but polished in Golconda, India.
Gold=metallic element, often mounted as found, as a nugget.
Gold opal=opal which shows yellowish light over a large area.
Gold quartz=massive quartz inclosing gold.
Golden beryl=clear bright-yellow beryl.
Golden stone=greenish-yellow chrysolite (olivine).
Golden topaz=topaz of a golden-yellow color; also golden-yellow citrine (quartz).
Goldstone=aventurine. An imitation of goldstone consists of glass with included metal filings (fraudulently sold as fire agate).
Gooseberry stone=brownish-green grossularite (garnet).
Goshenite=colorless, white, or bluish beryl from Goshen, Mass.
Goutte d'eau=colorless topaz.
Goutte de sang=blood-red spinel.
Graphic granite=pegmatite composed of quarts and feldspar so arranged as to simulate writing.
Green agate=zonochlorite.
Green garnet=any green garnet; also incorrectly applied to green enstatite from South Africa.
Green starstone=chlorastrolite.
Greenstone=zonochlorite; also chlorastrolite; also californite (vesuvianite).
Grossularite=pale-green or yellow garnet.
Guarnaccino=yellowish-red garnet. Same as vermeille.
Gypsum=hydrous sulphate of calcium.

H.

Hair stone=quartz with inclusions of hairlike crystals or fibers of some other mineral. Same as sagenite.
Harlequin opal=opal in which the colors form a minute mosaic or are set in small squares.
Hatchet stone=nephrite.

Haüynite=complex silicate of aluminum, calcium, sodium, and potassium with the sulphate radicle.
Hawk eye=quartz with inclusions of fine blue parallel fibers of crocidolite.
Heliodor=beryl from Rossing, German Africa; contains a small amount of uranium and is weakly radioactive. By daylight gold-yellow, by artificial light a delicate blue-green.
Heliolite=sunstone (feldspar).
Heliotrope=bloodstone (quartz).
Hematite=oxide of iron, either black or red.
Hemimorphite=calamine (English usage).
Hercynite=black to dark-green spinel composed of the oxides of aluminum and iron.
Herkimer diamond=clear quartz crystal from Herkimer County, N. Y.
Hessonite=variety of grossularite (garnet).
Hetaerolite=brilliant-black radiated mineral composed of the oxides of zinc and manganese.
Hiddenite=green or yellowish-green spodumene.
Horatio diamond=colorless quartz from Arkansas.
Hornblende=silicate of aluminum, iron, calcium, magnesium, and other elements.
Hornstone=compact form of silica, like flint but more brittle.
Hungarian cat's-eye=quartz cat's-eye.
Hyacinth=red zircon; also wrongly applied to essonite or other light-colored garnets, to yellowish-red spinel from Brazil, and to red iron-stained quartz.
Hyacinth of Compostella=quartz, with red hematite inclusions.
Hyacinthozontes=sapphire-blue beryl.
Hyalite=clear and colorless opal.
Hyalosiderite= rich olive-green olivine, containing much iron.
Hydrophane=opal which becomes transparent in water.
Hypersthene=silicate of magnesium and iron, variety of enstatite.

I.

Iceland agate=obsidian.
Iceland spar=clear calcite.
Iceland agate lava=obsidian.
Ichthyophthalmite=apophyllite.
Idocrase=vesuvianite.
Ilmenite=black oxide of iron and titanium.
Image stone=agalmatolite.
Imperial yu-stone=green aventurine quartz.
Ilvaite=hydrous silicate of iron and calcium.
Inca stone=pyrite.
Indian agate=moss agate.
Indian topaz=saffron-yellow topaz; also yellow quartz.
Indicolite=blue tourmaline.
Iolanthite=jasper from Crooked River, Crook County, Oreg.
Iolite=cordierite.
Iridescent quartz=rock crystal (quartz) filled with fine cracks containing air films which reflect the colors of the rainbow.
Iris=iridescent quartz; also applied to other iridescent minerals. California iris is spodumene.
Irish diamond=quartz crystal from Ireland.
Iron glance=hematite.
Isle of Wight diamond=quartz crystal.
Isle Royal greenstone=chlorastrolite.
Isopyre=very impure opal.
Italian chrysolite=vesuvianite.
Iztac Chalchihuitl=white or green Mexican onyx.

J.

Jacinth=yellow zircon, also improperly applied to essonite and other yellowish garnets.
Jade=two minerals, nephrite and jadeite. True jade is nephrite; many other minerals are also called jade, such as pectōlite, vesuvianite, garnet, bowenite, serpentine, plasma, prehnite, agalmatolite, sillimanite, and saussurite (a rock).

Jadeite=greenish silicate of aluminum and sodium (pyroxene).
Jager=bluish-white diamond of modern cut. Originally referred to diamond from the Jagersfontein mine, South Africa.
Jargon=white or grayish-white zircon.
Jargoon=jargon.
Jasp agate=intermediate between jasper and chalcedony with predominant opaque jasper.
Jasper=massive quartz, impure and opaque, containing more iron oxide than agate.
Jasper opal=deeply colored opal with many included impurities.
Jasperine=banded and variously colored jasper.
Jet=pitch-black or velvet-black coal sufficiently hard and compact to receive a brilliant polish.
Job's tears=local name for peridot from Arizona and New Mexico; also hyalosiderite, a rich olive-green olivine.

K.

Kashmir sapphire=cornflower-blue corundum.
Keystoneite=blue chrysocolla or chalcedony colored by copper silicate.
Kidney stone=nephrite.
King topaz=clear pink, orange, red, yellow, or flesh-colored corundum.
Kinradite=jasper with spherulites of quartz, from the region around San Francisco, Cal.
Kornerupine=silicate of aluminum and magnesium.
Kunzite=transparent lilac spodumene.
Kyanite=silicate of aluminum.

L.

Labrador feldspar=labradorite.
Labrador hornblende=hypersthene.
Labrador spar=labradorite.
Labrador stone=labradorite.
Labradorite=feldspar, silicate of alumium, sodium, and calcium.
Lake George diamond=clear quartz crystal from Herkimer, N. Y.
Lake Superior greenstone=chlorastrolite.
Lapis lazuli=rock composed essentially of the minerals lazurite, haüynite, scapolite, calcite, pyroxene, amphibole, mica, and feldspar.
Lava=volcanic rock.
Lavendine=amethyst (quartz).
Lazulite=blue hydrous phosphate of aluminum, iron, and magnesium.
Lazurite=blue silicate of aluminum, calcium, and sodium, with the sulphate radicle.
Lechosos opal=opal showing deep-green flashes of color or specked with green and carmine; also used for milky opal.
Leelite=deep flesh-red orthoclase, having a waxy luster.
Lennilite=greenish feldspar from Lenni Mills, Delaware County, Pa.
Leopardite=rock (porphyry) with black spots of oxide of manganese.
Lepidolite=mica, hydrous silicate of aluminum, lithium, and potassium, with fluorine.
Lenco sapphire=white sapphire.
Lignite=brown coal showing the form and fiber of the original tree.
Lintonite=zeolite, probably thomsonite, with alternating bands of green and red.
Lithia emerald=green spodumene.
Lithoxyle=wood opal showing woody structure.
Lodestone=magnetite (oxide of iron) which shows polarity.
Love arrows=sagenite (quartz).
Lucky stone=fairy stone (staurolite).
Lumachelle=fire marble.
Lydian stone=basanite (quartz).
Lynx sapphire=water sapphire (cordierite); also vary dark blue sapphire.
Lynx stone=cordierite.

M.

Macle=chiastolite.
Madeira topaz=citrine (quartz).
Magic stone=hydrophane.
Magnetite=black magnetic oxide of iron.

Mahogany ore=compact mixture of oxides of iron and copper.
Malachite=green hydrous corbonate of copper.
Malacolite=diopside.
Male sapphire=deep-colored sapphire.
Marble=recrystallized limestone, carbonate of calcium.
Marcasite=sulphide of iron, in orthorhombic crystals. The same sulphide of iron, in isometric crystals, is pyrite.
Marekanite=mottled brown and black obsidian.
Mariposite=green compact micaceous hydrous silicate of aluminum, magnesium, and potassium.
Marmorosch diamond=quartz crystal from Marmaros Comitat, Hungary.
Masculine=term applied to stones of a deep and rich color.
Matara diamond=colorless or faintly smoky zircon from Ceylon; the pale-brown zircons are sometimes decolorized by heat.
Matrix=rock surrounding mineral.
Meerschaum=sepiolite.
Melanite=dull-black andradite (garnet).
Menaccanite=ilmenite.
Menilite=grayish-brown banded, sometimes concretionary, opal from vicinity of Paris, France.
Mesolite=zeolite similar to thomsonite in composition, hydrous-silicate of aluminum, calcium, sodium, and potassium.
Mexican onyx=banded, mottled, or clouded carbonate of calcium (aragonite).
Mica=group of silicate minerals, containing aluminum, and potassium, with water, and other elements.
Microcline=potash feldspar in triclinic crystals, silicate of aluminum and potassium.
Microlite=essentially a tantalate of calcium.
Mineral turquoise=true turquoise.
Mocha agate=translucent agate or chalcedony with brown, red, or black dendritic figures like trees or plants.
Mocha stone=chalcedony with brown, red, or black, treelike inclusions of manganese oxide.
Mohave moonstone=translucent, lilac-tinted chalecedony from the Mohave Desert, Cal.
Moldavite=dark-green glass resembling obsidian.
Monazite=phosphate of cerium ad other rare-earth elements.
Money stone=local name in Pennsylvania for rutile.
Montana agate=moss agate from Montana.
Montana ruby=garnet.
Montana sapphire=corundum; generally applied to dark-blue or greenish-blue sapphire (compare river sapphire).
Mont Blanc ruby=quartz.
Moonstone=feldspar (usually oligoclase or the adularia variety of orthoclase) showing a pearly opalescence; also commonly but erroneously applied to some white or gray chalcedony and to satin spar (gypsum).
Mora diamond=probably quartz crystal.
Morganite=rose-colored beryl from Madagascar.
Moriah stone=granular and spotted verd antique (serpentine).
Morion=deep-black almost opaque smoky quartz.
Moroxite=deep-green or blue-green apatite.
Mosaic agate=brecciated Mexican onyx.
Moss agate=chalcedony with greenish mosslike or treelike inclusions.
Moss jasper=opaque and translucent chalcedony crowded full with mosslike markings.
Moss opal=milky opal with black mosslike dendritic inclusions.
Mother of emerald=prase (quartz).
Mother-of-opal=rock matrix containing minute disseminated specks of precious opal.
Mother-of-pearl=the hard iridescent internal layer of various shells.
Mountain mahogany=banded obsidian.
Muller's glass=hyalite.
Myrickite=agate or chalcedony containing bright-red inclusions of cinnabar, from the Death Valley region, Cal.

N.

Nacre=mother-of-pearl.
Natrolite=zeolite, hydrous siliciate of aluminum, and sodium.

Needle stone=sagenite (quartz).
Nephelite=silicate of aluminum, sodium, and calcium.
Nephrite=true jade, a tough compact fine-grained tremolite (white) or actinolite (green).
Nevada diamond=obsidian, artificially decolorized.
New rock=bone turquoise (in distinction from "old rock"=true turquoise).
New Zealand greenstone=serpentine, richly colored, from New Zealand; also jade or nephrite from New Zealand.
Nicolo=onyx with a black or brown base and a bluish-white thicker wavy, top layer.
Nigrine=dark-brown to black rutile with some iron.
Noble opal=precious opal.
Novaculite=fine-grained hard sandstone; flint (quartz).

O.

Obsidian=lava in form of glass.
Ocean spray=satin spar (gypsum).
Occidental agate=agate less perfect than oriental agate.
Occidental amethyst=true amethyst (quartz).
Occidental cat's eye=quartz cat's eye.
Occidental chalcedony=somewhat opaque chalcedony; more opaque than oriental chalcedony.
Occidental diamond=rock crystal (quartz).
Occidental topaz=yellow quartz.
Occidental turquoise=bone turquoise.
Octahedrite=oxide of titanium in tetragonal crystals, with slightly different properties from rutile.
Odontolite=bone turquoise.
Oeil de boeuf=labradorite.
Old rock=turquoise from Persia.
Oligoclase=feldspar, silicate of aluminum, sodium, and potassium.
Olivine=silicate of magnesium and iron. The world olivine is used as a trade name for green garnet (demantoid from the Ural Mountains), and is also improperly applied to any green stone. The following distinctions are sometimes applied to the mineral olivine: Chrysolite, inclining to yellow; peridot, inclining to yellowish green; olivine, inclining to green.
Onegite=quartz with inclusions of hair-like crystals of goethite.
Onyx=banded chalcedony with alternating bands of cloudy milk-white and another color, usually black.
Oolite=concretionary massive limestone (carbonate of calcium) made up of minute spherical grains.
Opal=amorphous massive form of hydrous silica.
Opal agate=banded opal having alternate layers of opal and agate.
Opal jasper=jasper opal.
Opal onyx=alternate layers of precious and of common opal.
Opalescent chrysolite=chrysoberyl.
Opaline=opal matrix.
Opaline feldspar=labradorite.
Ophiolite=serpentine.
Orange topaz=same as Spanish topaz, smoky quartz changed to yellow by heat.
Oregon jade=californite (vesuvianite).
Oriental=variety of corundum (not necessarily found in the Orient).
Oriental agate=finely marked and very translucent agate.
Oriental alabaster=aragonite.
Oriental amethyst=purple corundum.
Oriental aquamarine=light-green corundum.
Oriental cat's-eye=chrysoberyl cat's-eye; also smoky corundum.
Oriental chalcedony=very translucent chalcedony (compare with occidental chalcedony).
Oriental chrysoberly=yellowish-green corundum.
Oriental chrysolite=greenish-yellow corundum; also chrysoberyl.
Oriental emerald=green corundum.
Oriental garnet=almandine (garnet).
Oriental girasol=girasol (corundum).
Oriental hyacinth=rose-colored corundum.
Oriental hyacinth=aurora-red corundum.

Oriental jasper=bloodstone (quartz).
Oriental lapis=lapis lazuli.
Oriental moonstone=pearly corundum.
Oriental onyx=banded, mottled, or clouded stalagmites (aragonite).
Oriental opal=Hungarian opal carried to the Orient by merchants and then shipped back to Europe.
Oriental peridot=green corundum.
Oriental sapphire=(in part) blue corundum.
Oriental smaragd=green corundum.
Oriental sunstone=girasol (corundum).
Oriental topaz=yellow corundum.
Oriental turquoise=turquoise.
Orthoclase=potash feldspar in monoclinic crystals, silicate of aluminum and potassium.
Orthose=moonstone (feldspar).
Ouachita stone=novaculite (whetstone); quartz.
Ouvarovite=emerald-green garnet colored by chromium.
Ox-eye=labradorite (feldspar).

P.

Pagoda stone=agalmatolite.
Pagodite=agalmatolite.
Paphos diamond=quartz.
Parisite=carbonate of cerium and other rare elements, with fluorine.
Paste=artificial lead glass used to imitate gems.
Paulite=hypersteue.
Pealite=opal-like variety of geyserite (silica).
Pearl=lustrous calcareous concretion with animal membrane between successive layers, deposited in the shells of various mollusks. Not a mineral but an animal product.
Pearlite=obsidian with spherulites.
Pearlylite=variety of obsidian.
Pebble=rock crystal (quartz).
Pecos diamond=quartz from Pecos River, Texas.
Pectolite=hydrous silicate of calcium and sodium.
Pegmatite=coarsely grained rock composed of quartz and feldspar.
Pelhamite=variety of serpentine.
Peliom=cordierite.
Pennsylvania diamond=iron pyrite.
Peridot of Ceylon=Same as Ceylon peridot, honey-yellow tourmaline.
Peridot=olivine. (See olivine).
Peristerite=iridescent albite (feldspar).
Persian lapis=lapis lazuli.
Perthite=potash feldspar (orthoclase or microcline) with laminae of soda feldspar (albite).
Peruvian emerald=the best emeralds from Muzo, Colombia.
Petoskey agate=cemented portions of fossil coral (beckite).
Petrified honeycomb=beckite.
Petrified wood=wood replaced by silica.
Phenacite=silicate of beryllium.
Phenomenal gem=one which shows a play or change of color by artificial light, or shows a movable line of light.
Piedmontite=brownish-red variety of epidote.
Pin fire opal=opal in which the area of the individual colors is very small.
Pink topaz=topaz either naturally pink, or artificially colored pink by heating the yellow or brown varieties.
Pink wollastonite=lilac-colored pyroxene (diopside) from the region of San Francisco, Cal.
Pipestone=catlinite (compact red clay).
Pisolite=concretionary massive limestone, similar to oolite but made up of larger spherical grains.
Pistacite=greenish epidote.
Pitch opal=brown opal with a pitchy luster.
Pitchstone=obsidian of a pitchy luster.
Plasma=massive translucent quartz, dark grass-green in color, sometimes with white or yellow inclusions of celadonite or of delessite.
Pleonaste=black spinel.

Polycrase=black mineral similar in composition to euxenite.
Porcelain jasper=baked and hardened clay.
Porphyry=rock, variegated in structure, with individual crystals much larger than the fine-grained matrix.
Potstone=soapstone (impure talc).
Prase=massive, translucent, and spotted quartz of a green to leek-green color caused by inclusions of minute crystals of actinolite or other minerals.
Prase opal=apple-green translucent opal.
Precious coral=red coral.
Precious opal=opal showing a play of colors.
Precious schorl=tourmaline.
Prehnite=greenish hydrous silicate of aluminum and calcium.
Prismatic moonstone=clouded chalcedony (quartz) from Mohave Desert, Cal.
Prismatic quartz=cordierite.
Prosopite=hydrous fluoride of aluminum and calcium.
Pseudochrysolite=moldavite.
Pseudodiamond=quartz crystal.
Pseudoemerald=malachite.
Pyrite=sulphide of iron, in isometric crystals.
Pyrope=blood-red garnet, silicate of aluminum and magnesium.
Pyroxene=group of complex silicates of aluminum, iron, calcium, magnesium, and other elements.

Q.

Quartz=crystallized silica.
Quebec diamond=quartz crystal.
Quinzite=rose-colored common opal.

R.

Radio opal=opal of a smoky color caused by organic inclusions or impurities.
Radiumite=mixture of black pitchblende, yellow uranotile, and orange gummite.
Rainbow agate=agate which shows iridescence when cut across the concentric structure.
Rainbow quartz=iridescent quartz.
Rattle boxes=limonite geodes from Chester County, Pa.
Realgar=orange sulphide of arsenic.
Reconstructed gem=one artificially made by fusing and recrystallizing fragments of natural gems.
Red stone=ruby.
Resin opal=opal with a resinous luster.
Rhinestone=rock crystal (quartz).
Rhodochrosite=pink carbonate of manganese.
Rhodolite=rose-colored garnet, between pyrope and almandite; silicate of aluminum, iron, and magnesium; from Macon County, N. C.
Rhodonite=pink silicate of manganese.
Riband agate=agate with parallel layers.
Riband jasper=jasper with differently colored, alternating bands.
Ribbon agate=banded agate.
Ring agate=agate with differently colored bands arranged in concentric circles.
Ripe diamond=true diamond (see unripe diamond).
River agate=moss-agate pebbles found in brooks and streams.
River sapphire=light-colored sapphire from Montana.
Rock crystal=clear quartz crystal.
Rock ruby=red garnet (pyrope).
Rocky Mountain ruby=garnet.
Romansovite=brown grossularite (garnet), silicate of aluminum and calcium.
Rosaline=thulite (pink zoisite).
Rose quartz=massive rose-red to pink quartz.
Rose topaz=pink topaz.
Roselite=pink garnet. Mineralogically a hydrous arsenate of calcium and cobalt.
Royal topaz=blue topaz.
Rubasse=quartz artificially stained red.
Rubellite=pink and red tourmaline.
Rubicelle=yellow or orange-red spinel.

Rubino-di-rocca=red garnet having a tinge of violet.
Ruby=red corundum.
Ruby spinel=deep-red spinel.
Ruin aragonite=brecciated Mexican onyx (aragonite).
Rutile=oxide of titanium.

S.

Sabalite=yellowish to greenish banded phosphatic material, similar to or inclosing variscite, from Utah.
Sacred turquoise=pale-blue smithsonite.
Sagenite=transparent quartz with inclusions of hairlike or needle-like crystals or fibers of some other mineral, generally rutile.
Samarskite=black mineral of complex composition, essentially a columbate of yttrium, uranium, and iron.
Sandy sard=sard dotted with darker spots (quartz).
Saphir d'eau=water sapphire (blue cordierite).
Sapparé=transparent kyanite.
Sapphire=blue corundum. The name is also applied to colorless and colored (except red) corundum.
Sapphire quartz=blue quartz.
Sapphirine=blue chalcedony, blue quartz; also blue spinel; silicate of aluminum and magnesium.
Sard=chalcedony of a rich brown color, with a reddish tint; brownish-red or dark-brown carnelian (sardoine).
Sardoine=brownish-red or dark-brown carnelian.
Sardonyx (sard-onyx)=white and brown banded chalcedony.
Satelite=serpentine cat's-eye.
Satin spar=finely fibrous gypsum having a pearly opalescence; also finely fibrous calcite having a silky luster; also finely fibrous aragonite having a silky luster.
Saussurite=greenish to white or gray rock composed chiefly of zoisite.
Saxon chrysolite=pale wine-yellow or greenish-yellow topaz tinged with green.
Saxon topaz=pale wine-yellow topaz; also citrine (quartz).
Scapolite=group of minerals composed of silicates of aluminum, calcium, and sodium, with the chloride, carbonate, or sulphate radicles.
Scarab=precious stone inscribed with symbols, engraved like a beetle.
Schaumburg diamond=quartz crystal from Schaumberg, Hesse, Germany.
Schiller quartz=quartz cat's-eye.
Schiller spar=bastite (enstatite).
Schnecken topaz—Saxon topaz.
Schorl=black tourmaline.
Schorlomite=black garnet containing considerable titanium.
Scotch topaz=smoky quartz.
Selenite=colorles, transparent gypsum.
Semicarnelian=yellow agate.
Semiopal=colorless to strongly colored somewhat opaque, common opal.
Semiturquoise=soft pale-blue turquoise.
Sepiolite=hydrous silicate of magnesium.
Serpentine=hydrous silicate of magnesium.
Serpentine cat's-eye=serpentine showing when cut a changeable luster or opalescence without play of colors.
Siam=dark-red ruby.
Siam ruby=dark-red ruby from Siam; also red spinel.
Siberian amethyst=rich or dark-colored amethyst.
Siberian aquamarine=very light greenish-blue beryl.
Siberian chrysolite=demantoid (garnet).
Siberian ruby=red tourmaline.
Siberian topaz=very pale blue or bluish-white topaz.
Siberite=violet-red tourmaline.
Siderite=sappharine (blue quartz). Mineralogically, a carbonate of iron.
Siliceous malachite=green chrysocolla.
Silicified wood=wood replaced by silica and small amounts of iron compounds.
Sinople=quartz having red hematite inclusions.
Slave's diamond=colorless topaz.
Smaragdite=green variety of amphibole, like actinolite; also applied to other green stones, as the emerald, fuchsite, etc.

Smaragdus=smaragdite.
Smithsonite=carbonate of zinc. In England this carbonate of zinc is called calamine.
Smoky quartz=quartz crystals of a smoky or brown color.
Smoky topaz=true topaz of a smoky color; also more commonly smoky quartz.
Sobrisky opal=opal from the Lead Pipe Spring district in the Death Valley region, Cal.
Sodalite=silicate of aluminum and sodium, with chlorine, generally blue.
Soldier's stone=amethyst.
Spanish emerald=emerald of the finest quality (presumably from South America).
Spanish lazulite=cordierite.
Spanish topaz=smoky quartz changed to yellow by heat.
Specular iron ore=hematite.
Spessartite=yellow, brown, or red garnet, silicate of aluminum and manganese.
Sphaerulite=variety of obsidian.
Sphalerite=sulphide of zinc.
Sphene=titanite.
Spinel=group of minerals composed of oxides of aluminum, iron, chromium, magnesium, or zinc. The name spinel is also applied to the species of this group which consists chiefly of aluminum and magnesium oxides.
Spinel ruby=red spinel.
Spinel sapphire=blue spinel.
Spodumene=silicate of aluminum and lithium.
St. Stephen stone=translucent chalcedony with round blood-red spots through it.
Stalactite=carbonate of calcium in pendent masses deposited in caverns by evaporating water.
Stalagmite=carbonate of calcium deposited from evaporating water on the floors of caverns.
Star stone=starolite (quartz).
Star ruby=ruby (corundum) showing a star of light.
Star sapphire=grayish-blue sapphire (corundum) showing a star of light.
Star topaz=asteriated oriental topaz (yellow corundum).
Starolite=asteriated quartz.
Staurolite=hydrous silicate of aluminum, iron, and magnesium.
Steinheilite=cordierite.
Stibiotantalite=tantalate of antimony.
Succinite=amber; also amber-colored grossularite (garnet).
Sulphur diamond=pyrite.
Sun opal=fire opal.
Sunstone=feldspar (usually oligoclase or labradorite) containing inclusions of minute scales of iron oxide.
Swiss lapis=agate or jasper artificially colored blue.
Synthetic gem=one artificially made from chemicals.
Syrian garnet=almandite (garnet) of a violet shade.

T.

Tabasheer=amorphous opal-like silica deposited in the joints of bamboo.
Tauridan topaz=very pale blue topaz.
Taxoite=serpentine from Chester County, Pa.
Test stone=basanite (jasper).
Texas agate=agate jasper from Texas.
Thetis hairstone=transparent quartz with inclusions of hairlike crystals of green actinolite.
Thomsonite=zeolite, hydrous silicate of aluminum, calcium, and sodium.
Thulite=rose-red zoisite.
Tiger-eye=yellow to brown, altered crocidolite.
Titanite=silicate of calcium and titanium.
Toad's-eye tin=concentric cassiterite. Same as wood tin but on a smaller scale.
Topaz=silicate of aluminum, with fluorine. Most of the ordinary topaz of commerce is "false topaz" or yellow to brown quartz. Much of the "yellow quartz" is smoky quartz artificially changed from brown to yellow by heat. The term topaz is also improperly applied to any yellow stone.
Topaz cat's-eye=yellow corundum showing an elongated or round patch of opalescent light.

Topazolite=colorless, yellowish, or greenish andradite (garnet).
Touchstone=basanite (jasper).
Tourmaline=group of closely related minerals which are complex hydroborosilicates of aluminum and one or more other bases, such as iron, manganese, calcium, magnesium, sodium, or lithium.
Trainite=impure banded variscite.
Tree agate=mocha stone.
Tree stone=mocha agate.
Trenton diamond=quartz crystal from Herkimer County, N. Y.
Trilobite=fossil.
Triphane=yellow or greenish-yellow spodumene.
Troostite=pink to gray willemite containing some manganese.
Turquoise=hydrous phosphate of aluminum and copper.
Turkis=turquoise.
Turtle back=chlorastrolite; also matrix turquoise; also matrix variscite.

U.

Unripe diamond=quartz.
Ural chrysoberyl=alexandrite.
Uralian emerald=Siberian demantoid (green garnet).
Utahlite=compact variscite.
Uvarowite=green garnet containing chromium.

V.

Vallum diamond=quartz crystals from the Tanjore district, Madras Presidency, India.
Variolite=darg-green orthoclase (feldspar) containing lighter-colored globular particles.
Variscite=hydrous green phosphate of aluminum.
Vegetable fossil=amber.
Verd antique=variegated serpentine; also clouded yellowish to bluish-green marble.
Verdite=green rock, composed chiefly of fuchsite (green muscovite containing chromium).
Verdolite=talcose-dolomitic breccia rock from New Jersey.
Vermeille=orange-red almandite (garnet); also orange-red spinel.
Vermilion opal=milky opal impregnated with cinnabar.
Vermilite=vermilion opal.
Vesuvian gem=vesuvianite.
Vesuvianite=complex silicate, chiefly of aluminum and calcium.
Vinegar spinel=yellowish-red spinel.
Violane=dark violet-blue diopside (pyroxene), from Piedmont, Italy.
Violet stone=cordierite.
Violite=compact purple chalcedony from San Diego County, Cal.
Volcanic chrysolite=vesuvianite.
Volcanic glass=obsidian.
Volcanic lava=lava.
Volcanic scoria=vesuvianite.
Vulpinite=anhydrite.

W.

Wabanite=banded cream to black and gray to purple chocolate-colored slate from Massachusetts.
Wardite=hydrous phosphate of aluminum.
Water agate=shell of chalcedony containing bubble of water.
Water chrysolite=moldavite.
Water opal=moonstone (feldspar).
Water sapphire=true water sapphire is cordierite; also white topaz.
Water stone=hydrolite (opal).
Wax agate=yellow agate, with a pronounced waxy luster.
Wax opal=yellow opal with a waxy luster.
Wernerite=scapolite.
White carnelian=cloudy, milk-white, or very pale reddish or yellowish chalcedony.
White emerald=cæsium beryl.

White jade=white nephrite; also compact white garnet; also white californite (vesuvianite).
White sapphire=colorless corundum; also quartz.
White topaz=colorless topaz; also quartz.
Willemite=silicate of zinc.
Williamsite=variety of serpentine of a rich blackish oil-green color. It may contain disseminated particles of black chromite, giving a mottled effect.
Wiluite=green vesuvianite; also yellowish-green to greenish-white garnet.
Wilsonite=purplish-red scapolite.
Wolf's eye=moonstone (feldspar).
Wolf's eye stone=crocidolite.
Wollastonite=silicate of calcium.
Wood agate=wood petrified or replaced by agate.
Wood opal=wood silicified by opal.
Wood stone=silicified wood.
Wood tin=cassiterite with a concentric structure.
World's eye=hydrophane (opal).

X.

Xanthite=dark yellowish-brown vesuvianite from Amity, N. Y.

Y.

Yogo sapphire=dark-blue corundum from Yogo Gulch, Mont.
Yu stone=jade.

Z.

Zincite=oxide of zinc, mostly red.
Zircon=silicate of zirconium.
Zoisite=hydrous silicate of aluminum and calcium.
Zonite=variously colored chert or jasper, from Arizona.
Zonochlorite=banded prehnite, similar to chlorastrolite.

PART II.

A.

Allanite.
Amphibole=actinolite, axstone, byssolite, crocidolite, hawk's-eye, hornblende, jade, kidney stone, nephrite, New Zealand greenstone, smaragdite, smaragdus, tremolite, wolf's-eye stone.
Anatase.
Andalusite=chiastolite, cross-stone, macle.
Anhydrite=vulpinite.
Ankerite=brown spar.
Apatite=moroxite, asparagus stone.
Apophyllite=fisheye stone, ichthyophthalmite.
Aragonite=alabaster, California onyx, flos ferri, flowers of iron, Gibraltar stone, iztac chalchihuitl, Mexican onyx, mosaic agate, oriental alabaster, oriental onyx, ruin aragonite, satin spar, stalactite, stalagmite, verd antique. (See also calcite.)
Axinite.
Azurite=blue malachite, chessy copper, chessylite.
Azurmalachite.

B.

Barite.
Benitoite.
Beryl=aeroides, amethiste basaltine, aquamarine, aquamarine chrysolite, bixbite, caesium beryl, canary beryl, chalchihuitl, chrysoberyllus, chrysolithus, davidsonite, emerald, golden beryl, goshenite, heliodor, hyacinthozontes, morganite, Peruvian emerald, Siberian aquamarine, smaragdite. Spanish emerald, white emerald.
Beryllonite.
Bone turquoise=fossil turquoise, new rock, occidental turquoise, odontolite.
Brookite=arkansite.

C.

Calamine=Aztec stone, chalchihuitl, hemimorphite.
Calcite=agrite, calcomalachite, fire marble, Iceland spar, lumachelle, marble, oolite, pisolite, satin spar.
Cancrinite.
Cassiterite=toad's-eye tin, wood tin.
Chondrodite.
Chromite=chromic iron.
Chrysoberyl=alexandrite, cat's-eye, Ceylon cat's-eye, chrysolite, cymophane, floating light, opalescent chrysolite, oriental cat's-eye, ural chrysoberyl.
Chrysocolla=keystonite, siliceous malachite.
Clay=catlinite, pipestone, porcelain jasper.
Coal=anthracite, black amber, brown coal, candle coal, cannel coal, jet, lignite.
Cobaltite.
Copper ore gem=carmazul, chrysocarmen, copper pitch ore, mahogany ore.
Cordierite=dichroite, iolite, lynx-stone, peliom, prismatic quartz, saphir d'eau, Spanish lazulite, steinheilite, violet stone, water sapphire.
Corundum=adamantine spar, asteria, asteriated topaz, Australian sapphire, Burma ruby, cat sapphire, Ceylon ruby, corundum cat's-eye, female sapphire, girasol, Kashmir sapphire, king topaz, leuco-sapphire, lynx sapphire, male sapphire, Montana sapphire, oriental, oriental amethyst, oriental aquamarine, oriental cat's-eye, oriental chrysoberyl, oriental chrysolite, oriental emerald, oriental girasol, oriental hyacinth, oriental moonstone, oriental peridot, oriental sapphire, oriental smaragd, oriental sunstone, oriental topaz, red stone, river sapphire, ruby, sapphire, star ruby, star sapphire, Siam, star topaz, topaz cat's-eye, white sapphire, Yogo sapphire.

D.

Danburite.
Datolite.
Diamond=Bahia, blue-white, brilliant, by-water, canary, cape, carbonado, first bye, first water, Golconda, jager, ripe-diamond.
Diaspore.
Dioptase=achirite, Congo emerald, copper emerald, emerald copper, emerald malachite, emerandine.
Dumortierite.

E.

Epidote=piedmontite, pistacite.
Euclase.
Euxenite.

F.

Feldspar=andularia, albite, albite moonstone, amazon stone, andesine, aventurine feldspar, bemiscite, bull's-eye, cassinite, Ceylon opal, changeant, chesterlite, delawarite, fisheye, girasol, heliolite, Labrador spar, Labrador stone, labradorite, leelite, lennilite, microcline, moonstone, oeil de boeuf, oligoclase, opaline feldspar, orthoclase, orthose, ox-eye, peristerite, perthite, sunstone, variolite, water opal, wolf's eye.
Fergusonite.
Fluorite=blue john, chlorophane, cobra stone, crimson night stone, false amethyst, false emerald, false ruby, false sapphire, false topaz, fluorspar.
Fossil=beckite, beekite, fossil coral, Petoskey agate, petrified honeycomb, trilobite.
Franklinite.

G.

Gadolinite.
Garnet=Adelaide ruby, almandite, American ruby, andradite, Arizona ruby, Arizona spinel, Bobrowska garnet, Bohemian diamond, Bohemian garnet, California ruby, Cape ruby, carbuncle, Ceylon hyacinth, Ceylon ruby, chloromelanite, chrome garnet, cinnamon stone, colophonite, Colorado ruby, demantoide, Elie ruby, essonite, false hyacinth, Fashoda garnet, gooseberry stone, grossularite, guarnaccino, hessonite, hyacinth, jacinth, jade, melanite, Montana ruby, olivine, oriental garnet, ouvarovite, pyrope, rhodolite, rock ruby, Rocky Mountain ruby, romansovite, roselite, rubino-di-rocca, schorlomite, Siberian chrysolite, spessartite succinite, Syrian garnet, topazolite, Uralian emerald, uvarovite, vermeille, white jade, wiluite.

Garnierite.
Goethite.
Gold.
Gypsum=alabaster, moonstone, ocean spray, satin spar, selenite.

H.

Haüynite.
Hematite=bloodstone, iron glance, specular iron ore.
Hetaerolite.

I.

Ilmenite=menaccanite.
Ilvaite.

K.

Kornerupine.
Kyanite=cyanite, disthene, sapparé.

L.

Lapis lazuli=Armenian stone, azure stone, blue rock, Oriental lapis, Persian lapis.
Lazulite=false lapis lazuli.
Lazurite.
Limonite=rattlebox.

M.

Magnetite=lodestone.
Malachite=pseudo-emerald.
Marcasite.
Mesolite.
Mica=agalmatolite, damourite, figure stone, fuchsite, image stone, lepidolite, mariposite, pagoda stone, pagodite, smaragdite, verdite.
Microlite.
Moldavite=bottle stone, false chrysolite, pseudo-chrysolite, water chrysolite.
Monazite.

N.

Natrolite.
Nephelite.

O.

Obsidian=arrow points, black lava glass, glass agate, Iceland agate, Iceland agate lava, marekanite, mountain mahogany, Nevada diamond, pearlite, pearlylite, pitchstone, sphaerulite, volcanic glass.
Octahedrite=anatase.
Olivine=celestial precious stone, chrysolite, evening emerald, golden stone, hyalosiderite, Job's-tears, peridot.
Opal=amber opal, black opal, cacholong opal, common opal, fire opal, flash opal, flash fire opal, fossil pineapple, girasol opal, gold opal, harlequin opal, hyalite, hydrophane, isopyre, jasper opal, lechosos opal, lithoxyle, magic stone, menilite, moss opal, mother-of-opal, Muller's glass, noble opal, opal agate, opal jasper, opal onyx, opaline, oriental opal, pealite, pin fire opal, pitch opal, prase opal, precious opal, quinzite, radio opal, resin opal, semiopal, Sobrisky opal, sun opal, tabasheer, vermilion opal, vermilite, water stone, wax opal, wood opal, world's eye.

P.

Parisite.
Pectolite=jade.
Phenacite.
Pitchblende=radiumite.
Polycrase.
Prehnite=Cape chrysolite, chlorastrolite, green agate, green star stone, greenstone, Isle Royal greenstone, Lake Superior greenstone, turtleback, zonochlorite. (See also thomsonite.)
Prosopite.
Pyrite=alpine diamond, fool's gold, Inca stone, Pennsylvania diamond, sulphur diamond.

Pyrophyllite=agalmatolite.

Pyroxene=alalite, bastite, bronzite, chalchihuitl (jadeite), diopside, enstatite, green garnet (enstatite), hyperstene, jade, jadeite, Labrador hornblende, malacolite, New Zealand greenstone, paulite, pink wollastonite, Schiller-spar, violane, yu stone.

Q.

Quartz=agate, agate jasper, Alaska diamond, Alençon diamond, Aleppo stone, amberine, amethyst, amethystine quartz, Ancona ruby, apricotine, Arkansas diamond, arrow points, aventurine, azure quartz, Baffa diamond, basanite, beckite, beekite, bishop's stone, bloodstone, blood jasper, blue chrysoprase, blue moonstone, Bohemian diamond, Bohemian topaz, Bohemian ruby, Brazilian diamond, Brazilian pebble, Brazilian topaz, Briançon diamond, Bristol diamond, burnt amethyst, cacholong, cairngorm, California moonstone, Cape May diamond, carnelian, carnelian-onyx, catalinite, Catalina sardonyx, cat's-eye, cer-agate, chalchihuitl, chalcedony, chalcedony onyx, chalcedonyx, chert, chinarump, chloropal chrysoprase, Colorado topaz, Cornish diamond, cotterite, creolite, crispite, crystal, cupid's darts, Dauphine diamond, dendritic agate, Egyptian jasper, Egyptian pebble, eldoradoite, emeraldine, enhydros, eye agate, false diamond, false lapis, false topaz, fancy agate, feminine carnelian, flêches d'amour, Fleurus diamond, flint, flower stone, fortification agate, fossil coral, frost stone, geyserite, gold quartz, golden topaz, hairstone, heliotrope, Herkimer diamond, Horatio diamond, hornstone, hyacinth, Hungarian cat's-eye, hyacinth of Compostella, Imperial yu stone, Indian agate, Indian topaz, iolanthite, iridescent quartz, iris, Irish diamond, Isle of Wight diamond, jasp-agate, jasper, jasperine, kinradite, Lake George diamond, lavendine, love arrows, lydian stone, Madeira topaz, Marmorosch diamond, masculine carnelian, milky quartz, mocha stone, Mohave moonstone, Montana agate, Mont Blanc ruby, moonstone, Mora diamond, morion, moss agate, moss jasper, mother of emerald, myrickite, needlestone, nicolo, novaculite, occidental agate, occidental amethyst, occidental cat's-eye, occidental chalcedony, occidental diamond, occidental topaz, onegite, onyx, orange topaz, oriental agate, oriental chalcedony, oriental jasper, ouachita stone, Paphos diamond, pebble, Pecos diamond, petrified wood, plasma, prase, prismatic moonstone, pseudo diamond, Quebec diamond, rainbow agate, rainbow quartz, rhinestone, riband agate, riband jasper, ribbon agate, ring agate, river agate, rock crystal, rose quartz, rubasse, sagenite, sandy sard, sapphire quartz, sapphirine, sard, sardoine, sardonyx, Saxon topaz, Schaumburg diamond, Schiller quartz, Scotch topaz, semi-carnelian, Siberian amethyst, siderite, sinople, silicified wood, smoky quartz, smoky topaz, soldier's stone, Spanish topaz, St. Stephen stone, star stone, starolite, Swiss lapis, test stone, Texas agate, Thetis hairstone, tiger-eye, topaz, touchstone, tree agate, tree stone, Trenton diamond, unripe diamond, Vallum diamond, Venus hairstone, violite, water agate, wax agate, white carnelian, white sapphire, white topaz, wood agate, woodstone, zonite.

R.

Realgar.

Rhodochrosite.

Rhodonite=fowlerite.

Rock=agrite, catlinite, clay, creoline, graphic granite, lapis lazuli, lava, leopardite, matrix, mother-of-opal, novaculite, obsidian, pegmatite, pipestone, porcelain-jasper, porphyry, potstone, sausurite (jade), verdolite, volcanic lava, wabanite.

Rutile=money stone, nigrine.

S.

Samarskite.

Sapphirine.

Scapolite=wernerite; wilsonite.

Sepiolite=meerschaum.

Serpentine=bowenite, California cat's-eye, California tiger-eye, jade, moriah stone, New Zealand greenstone, ophiolite, pelhamite, satelite, serpentine cat's eye, taxoite, verd antique, williamsite.

Sillimanite=jade.

Smithsonite=azulite, bonamite, sacred turquoise.
Sodalite.
Sphalerite.
Spinel=Alabandine ruby, almandine spinel, automolite, balas ruby, ceylonite, chlorospinel, chromite, dysluite, franklinite, gahnite, goutte de sang, hercynite, hyacinth, magnetite, pleonaste, rubicelle, ruby spinel, sapphirine, Siam ruby, spinel ruby, spinel sapphire, vermeille, vinegar spinel.
Spodumene=California iris, hiddenite, kunzite, lithia emerald, triphane.
Staurolite=cross stone, fairy stone, lucky stone.
Stibiotantalite.

T.

Thomsonite=comptonite, eye agate, eyestone, lintonite.
Titanite=sphene.
Topaz=aquamarine topaz, Brazilian aquamarine, Brazilian ruby, Brazilian sapphire, Brazilian topaz, burnt Brazilian topaz, burnt topaz, drop of water, golden topaz, goutte d'eau, Indian topaz, pink topaz, royal topaz, Saxon chrysolite, Saxon topaz, Schnecken topaz, Siberian topaz, slave's diamond, tauridian topaz, water sapphire.
Tourmaline=achroite, andalusite, aphrizite, Brazilian emerald, Brazilian peridot, Brazilian sapphire, Ceylon chrysolite, Ceylon peridot, dravite, emeralite, indicolite, peridot of Ceylon, precious schorl, rubellite schorl, Siberian ruby, siberite.
Turquoise=celestial stone, chalchihuitl, chalchuite, edisonite, mineral turquoise, old rock stone, oriental turquoise, semiturquoise, turkis, turtleback.

V.

Variscite—amatrice, callainite, chlorutahlite, sabalite, trainite, turtleback, utahlite.
Vesuvianite=American jade, brown jacinth, California jade, californite, cyprine, greenstone, idocrase, Italian chrysolite, jade, Oregon jade, Vesuvian gem, volcanic chrysolite, volcanic scoria, white jade, xanthite.

W.

Wardite.
Willemite=troostite.
Wollastonite.

Z.

Zincite.
Zircon=Ceylonese zircon, hyacinth, jacinth, jargon, jargoon, matara diamond.
Zoisite=rosaline, thulite.

SALT, BROMINE, AND CALCIUM CHLORIDE.

By R. W. STONE.[1]

SALT.

PRODUCTION.

Salt is so abundant and so widely distributed in the United States that the industry can meet domestic requirements in spite of unfavorable conditions. At some plants in 1917 there was shortage of labor, difficulty in obtaining fuel, and an inadequate supply of freight cars, yet the total production for the country was a notable increase over that of 1916. The salt produced and sold in the United States in 1917 was 6,978,177 short tons, valued at $19,940,442, an increase of 9.7 per cent in quantity and 46.1 per cent in value over the production of 1916.

The values in the tables of this report are not supposed to include the value of cooperage or packages.

Salt produced and marketed in the United States, 1913–1917.

Year.	Quantity.				Total value.	Average price per ton.
	Manufactured (evaporated) (short tons).	In brine (short tons).	Rock salt (short tons).	Total (short tons).		
1913	2,131,229	1,622,382	1,062,291	4,815,902	$10,123,139	$2.10
1914	2,159,094	1,652,758	1,060,804	4,872,656	10,197,417	2.09
1915	2,335,823	1,851,199	1,165,387	5,352,409	11,747,686	2.19
1916	2,454,836	2,539,717	1,368,353	6,362,906	13,645,947	2.14
1917	2,482,564	2,890,588	1,605,025	6,978,177	19,940,442	2.86

From the itemized figures in the table it is determined that the increase in production of manufactured or evaporated salt in 1917 was 1.1 per cent, of brine salt 13.8 per cent, and of rock salt 17.3 per cent. The much larger increase in rock salt is a measure of the readiness with which the production of salt by mining can be expanded in comparison with the production by evaporating brine.

The average price increased 33 per cent and was $2.86 per ton in 1917, as compared with $2.14 in 1916. This great increase in price was caused by higher wages paid for labor and higher cost of fuel and all other supplies. Salt producers in New York could not get enough coal or cars, and labor was scarce. Coal and labor in Ohio were reported as the most costly ever known. Michigan operators reported business conditions good and demand heavy, but the cost of operating, according to some of them, was 25 to 35 per cent higher,

[1] The statistical part of this report is the work of Miss A. T. Coons for domestic material and of J. A Dorsey for imports and exports.

to others at least 50 per cent higher, and to still others nearly 100 per cent higher than in 1916; one firm stated that it paid more than twice as much for labor as in 1916. The statement came from Kansas that cost of producing salt had practically doubled, cooperage more than doubled, and cotton bags tripled, as compared with 1916. One Utah operator stated that the cost of operating had doubled since 1916; and California salt producers reported an increase of 30 to 50 per cent in cost of labor, 75 per cent in cost of fuel, and 50 to 150 per cent in cost of containers, and that the advance in price was not commensurate with the increased cost of production. Undoubtedly for these same reasons and because of an increasing scarcity of labor, the average price of salt will be much higher in 1918.

PRODUCTION BY STATES.

In 1917 the rank of States by total quantity of salt produced and also by total value of product was from first to sixth, respectively, Michigan, New York, Ohio, Kansas, California, and Louisiana. The number of operating plants in the principal States was California 26, Michigan 24, New York 23, Kansas 10, Ohio 9, and other States from 1 to 7—a total of 125 plants, as compared with 128 plants in 1916.

Salt produced and marketed in the United States, 1914–1917.

State.	1914		1915		1916		1917	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Michigan	1,633,937	$3,299,005	1,762,430	$4,304,731	2,088,559	$4,612,567	2,250,939	$6,877,202
New York	1,454,504	2,824,733	1,570,446	2,976,405	1,972,285	3,698,798	2,164,069	5,371,713
Ohio	767,597	1,320,554	823,234	1,462,192	938,867	2,038,749	1,026,803	2,839,575
Kansas	415,501	924,550	527,123	1,035,879	639,071	1,302,359	746,976	2,027,466
California	154,062	782,920	146,784	694,070	157,393	656,975	215,154	933,429
Texas	46,897	251,493	62,297	345,944	75,762	427,119	85,181	564,029
Utah	52,564	231,512	55,279	266,334	60,653	289,457	79,195	352,145
West Virginia	20,360	78,036	32,513	115,143	33,389	122,669	24,844	191,044
Idaho	42	520	(a)	(a)	44	511	16	216
Nevada	621	2,448	970	3,950	(a)	(a)	(a)	(a)
Other States	[b]326,571	481,646	[c]371,333	543,033	[d]396,883	496,743	[e]385,000	783,623
	4,872,656	10,197,417	5,352,409	11,747,686	6,362,906	13,645,947	6,978,177	19,940,412

[a] Included in "Other States."
[b] Includes Louisiana, New Mexico, Oklahoma, Pennsylvania, Porto Rico, and Virginia.
[c] Includes Hawaii, Idaho, Louisiana, New Mexico, Oklahoma, Porto Rico, and Virginia.
[d] Includes Hawaii, Louisiana, Nevada, New Mexico, Oklahoma, Porto Rico, and Virginia.
[e] Includes Hawaii, Louisiana, Nevada, New Mexico, Oklahoma, Pennsylvania, Porto Rico, and Virginia.

PRODUCTION BY GRADES.

Salt occurs naturally in two distinct ways—as rock salt in beds or associated with bedded or sedimentary deposits and in the form of natural brines or bitterns. The larger part of our production is derived by converting the naturally occurring rock salt into artificial brines, which are pumped to the surface and there evaporated. Large quantities of salt are made in Utah and California by solar evaporation of natural brine or sea water, and still greater quantities of rock salt are mined in New York, Michigan, Kansas, and Louisiana. As the rock salt and brine salt industries are very different, the quantity and value of these different kinds of salt produced and marketed in the United States are given in separate tables.

ROCK SALT.

Mining rock salt from beds several hundred feet below the surface in the Eastern States and from deposits at or near the surface in the Western States is an industry which has untold reserves to work upon. The rock-salt industry in the United States in recent years is summarized in the following table:

Rock salt produced and marketed in the United States,[a] 1913–1917.

Year.	Quantity (short tons).	Value.	Average price per ton.
1913	1,062,291	$1,968,567	$1.85
1914	1,060,804	2,024,898	1.91
1915	1,165,387	2,299,894	1.97
1916	1,368,353	2,665,270	1.95
1917	1,605,025	3,897,595	2.43

[a] California, Kansas, Louisiana, Michigan, New York, and Utah; in 1916 Idaho also; in 1917 Nevada also.

This table shows an increase in 1917 of 17.3 per cent in quantity and 46.2 per cent in value over the production of 1916, as compared with an increase of 17.4 per cent in quantity and 15.9 per cent in value in 1916 over the production of 1915.

New York is by far the largest producer of rock salt, its output being more than double that of Kansas, the next largest producer. Louisiana comes third and Michigan fourth, but the production of these two States was only a little more in 1917 than the output of Kansas. It is not possible to publish State totals for rock salt without revealing individual output, because in most States there are only one or two producers. Rock salt is mined by 18 producers in eight States.

BRINE SALT.

The various grades of salt produced by evaporating natural and artificial brine are put on the market under different names, according to use, size of grain, or method of preparation.

Brine salt produced and marketed in the United States, 1913–1917.

Year.	Table and dairy.		Packers' salt. Common fine.		Packers' salt. Common coarse.	
	Quantity (short tons)	Value.	Quantity. (short tons)	Value.	Quantity. (short tons)	Value.
1913	543,394	$3,223,836	912,948	$2,423,012	a 485,097	a $1,414,760
1914	577,020	3,221,007	873,301	2,383,588	530,483	1,453,484
1915	607,749	3,720,020	981,829	2,762,450	536,774	1,724,503
1916	654,601	4,326,531	1,048,032	3,314,795	567,985	1,958,094
1917	688,022	5,908,788	1,048,572	5,311,668	493,515	2,659,013

Year.	Coarse solar.		Pressed blocks and other grades.		In brine.		Total.	
	Quantity (short tons)	Value.	Quantity (short tons)	Value.	Quantity (short tons)	Value.	Quantity (short tons)	Value.
1913	162,631	$446,342	27,159	$67,608	1,622,382	$579,014	3,753,611	$8,154,572
1914	151,228	451,206	27,062	73,715	1,652,758	589,519	3,811,852	8,172,519
1915	162,569	508,402	46,902	130,452	1,851,199	601,965	4,187,022	9,447,792
1916	116,913	339,079	67,305	210,337	2,539,717	831,841	4,994,553	10,980,677
1917	159,361	524,987	93,094	554,805	2,890,588	1,083,586	5,373,152	16,042,847

a Includes a small output reported directly as packers' salt.

In this table the considerable increase in value of salt is very apparent. The quantity of table and dairy salt produced in 1917 was only a small increase over 1916, but the total value rose 36 per cent. There was almost no increase in the quantity of common fine packer's salt, but there was an increase of $2,000,000, or 60 per cent, in value. Common coarse salt decreased in quantity but increased 26 per cent over the value of 1916.

Good weather conditions for solar evaporation are reflected in the crop of coarse solar salt, and the increased cost of operating is shown in the much greater value of the crop. Pressed blocks for salting stock were made in California, Kansas, Michigan, Ohio, and Utah. Salt used for this purpose is not of the highest grade, and sulphur is mixed with some of it as a medicament for the cattle. The average value of pressed blocks ranges from $5.60 a ton in Kansas to $15 in Ohio and $19.32 in California. The average price of pressed blocks for the United States was $7.10 a ton. Salt not classified and included under "other grades" amounted to 28,714 tons, valued at $97,532.

The quantity and value of salt in brine used by chemical works showed increase. Products made by chemical companies from nearly 3,000,000 tons of brine salt include salt cake, soda ash, caustic soda, sodium bicarbonate, sodium carbonate, sodium acetate, sodium chlorate, sodium phosphate, sodium silicate, sal soda, Glauber's salt, calcium chloride, chlorine, and hydrochloric acid.

Without including the salt in brine sold as such or used by chemical works, the evaporated salt was produced in the States and in the quantities shown in the following table:

Evaporated salt produced and marketed in the United States in 1916 and 1917.

State.	1916		1917	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
California	154,375	$647,951	192,565	$902,753
Kansas	267,698	906,213	299,877	1,449,442
Michigan	934,862	3,783,838	891,195	5,859,594
New York	502,314	2,053,009	517,273	3,077,910
Texas	75,762	427,119	85,181	564,029
Utah	55,901	278,828	73,282	337,102
West Virginia	33,389	122,669	24,844	191,044
Hawaii, Idaho, Nevada, New Mexico, Ohio, Oklahoma, and Porto Rico	430,535	1,929,209	a 398,347	a 2,577,387
	2,454,836	10,148,836	2,482,564	14,959,261
Percentage of increase in 1917	......	......	1.1	47.4

a Includes Pennsylvania also in 1917.

AVERAGE PRICE.

The average price per ton of all grades of salt produced and marketed in the United States, as shown in the table on page 169, has advanced from $2.14 in 1916 to $2.86 in 1917. Rock salt commonly is cheaper than evaporated or brine salt, and the price of each differs in different localities by reason of a variety of factors, among which supply and demand are potent. The following table shows some anomalous variations in price from year to year in certain States, but a general tendency toward higher prices is noticeable and is most apparent in the averages given at the bottom of the table. The averages for the United States are computed from the quantity and value of the entire production for the year indicated and not from the State averages in the respective columns above them.

Average price per ton of domestic salt, 1913–1917.

State.	Rock salt.					Brine salt.				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
California	$3.00	$7.00	$3.98	$2.99	$4.21	$5.07	$5.08	$4.73	$4.20	$4.34
Hawaii	......	......	......	......	......	7.00	......	8.00	7.00	15.00
Idaho	......	......	......	10.00	10.00	12.79	12.38	10.00	15.00	15.60
Kansas	1.24	1.29	1.34	1.35	1.66	3.32	3.24	2.55	2.61	3.63
Louisiana	2.10	2.29	2.52	2.28	3.37	......	......	......	......	......
Michigan	2.24	2.56	2.02	2.60	2.92	2.01	1.99	2.43	2.18	3.06
Nevada	......	......	......	......	3.00	6.33	3.94	4.07	4.35	3.18
New Mexico	......	......	......	......	......	4.00	7.00	2.76	2.00	2.41
New York	1.86	1.91	1.95	1.98	2.41	1.92	1.96	1.86	1.81	2.52
Ohio	......	......	......	......	......	1.77	1.72	1.78	2.17	2.77
Oklahoma	......	......	......	......	......	3.50	3.69	6.91	6.22	6.61
Pennsylvania	......	......	......	......	......	5.25	5.25	......	......	3.00
Porto Rico	......	......	......	......	......	2.90	2.89	2.57	2.62	4.24
Texas	......	......	......	......	......	5.59	5.36	5.55	5.46	6.62
Utah	2.97	2.81	2.29	2.24	2.54	4.25	4.61	5.04	4.99	4.60
West Virginia	......	......	......	......	......	4.00	3.83	3.54	3.67	7.69
Average for the United States.	1.85	1.91	1.97	1.95	2.43	2.17	2.14	2.26	2.62	2.99

DOMESTIC CONSUMPTION.

On the assumption that the population of the United States is 100,000,000, the quantity of salt used in this country in 1917 amounted to about 140 pounds, or half a barrel, per capita. The following table shows that very nearly all the salt used in the United States in 1917 was of domestic origin and that the percentage of imports to domestic consumption was less than ever before. Part of our domestic production was exported, but the exports were partly offset by imports, which were 0.9 per cent of the total consumption.

Supply of salt for domestic consumption, 1890–1917, in short tons.

Source.	1890	1900	1910	1915	1916	1917
Domestic production	1,242,779	2,921,708	4,242,792	5,352,409	6,362,906	6,978,177
Imports	257,323	199,909	137,103	122,326	122,079	64,922
Total	1,500,102	3,121,617	4,379,895	5,474,735	6,484,985	7,043,099
Exports	2,464	7,511	49,013	80,474	84,065	113,993
Domestic consumption	1,497,638	3,114,106	4,330,882	5,394,261	6,400,920	6,929,106
Comparison with preceding year	+122,865	+178,449	+6,444	+473,096	+1,006,659	+528,186
Percentage of imports to total consumption	17.2	6.4	3.2	2.3	1.9	0.9

IMPORTS.

According to figures obtained from the Bureau of Foreign and Domestic Commerce, Department of Commerce, and after conversion from pounds as reported by that bureau to short tons, the salt imported and entered for consumption in the United States in the last four years is as follows:

Salt imported and entered for consumption in the United States, 1914–1917.

Year.	In bags, barrels, and other packages.		In bulk.		Total quantity (short tons).	Total value.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.		
1914	32,807	$212,349	97,997	$168,454	130,804	$380,803
1915	28,724	196,593	93,602	169,859	122,326	366,452
1916	24,402	200,290	97,677	142,298	122,079	342,588
1917	13,472	139,339	51,450	140,796	64,922	280,135

The source of the imported salt is shown in the following table:

Salt imported into the United States, 1915–1917.

Country.	1915		1916		1917	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Germany	34,300	$663				
Italy	22,783,300	18,847	11,456,800	$8,028		
Portugal					3,724,600	$7,651
Spain	26,461,900	14,127	68,740,200	35,243	7,342,000	5,209
England	82,187,500	223,718	59,372,500	219,351	34,960,600	164,624
Canada	21,100,400	29,853	16,744,700	17,844	5,718,000	18,734
Mexico	245,900	1,217	105,000	684	956,800	823
Barbados	2,307,600	2,115	140,000	140		
Trinidad and Tobago	1,247,700	753				
Other British West Indies	71,178,000	59,809	81,388,200	55,257	65,859,900	72,621
Cuba	100	4				
Dutch West Indies	11,159,500	10,950	5,748,900	5,865	13,102,900	10,459
China					15,200	14
Japan	1,000	35				
Hongkong			200	6		
Portuguese Africa	8,444,800	4,384	237,400	170		
	247,152,000	366,475	243,933,900	342,588	131,680,000	280,135

A large part of the imported salt is coarse solar salt made by evaporating sea water and comes from the West Indies and Spain. This cheap material enters the United States at a low freight rate and is used largely for curing fish and meats. The importation of salt from England is largely to supply packers who think they can not get satisfactory results without Liverpool salt.

The slight discrepancy between the number of pounds imported as shown in this table and the number of tons in the second table above is explained by the fact that some of the salt imported was in warehouse at the close of the year and had not been entered for consumption.

EXPORTS.

The exports of salt in 1917 were more than 35 per cent greater in quantity and more than 76 per cent greater in value than in 1916. They were greater than ever before and were sent to all parts of the world. The accompanying tables were made from figures obtained from the Bureau of Foreign and Domestic Commerce.

Salt of domestic production exported from the United States, 1913–1917.

Year.	Quantity.		Value.
	Pounds.	Equivalent in short tons.	
1913	140,578,092	70,289	$515,194
1914	164,589,012	82,295	586,055
1915	160,948,077	80,474	613,847
1916	168,129,201	84,065	567,441
1917	227,985,222	113,993	1,000,773

The wide distribution of our salt is shown by the table below. In 1917 more than 90 per cent of the exported material went to our neighbors—Canada, Cuba, and Mexico—and, judged by its value, was mostly refined or package salt. Exports to Europe were almost negligible, the largest quantity to any one country being about 90 tons to Russia. A great increase has taken place in exports to Newfoundland and Labrador, and to Jamaica, Dominican Republic, and other West Indies, which formerly derived a large part of their salt from Europe; also much more than formerly salt has been taken to Japan, the increase being from 25 tons in 1916 to more than 900 tons in 1917. A considerable quantity of salt from the United States goes as far as Australia and New Zealand.

Salt exported from the United States in 1915, 1916, and 1917.

Country.	1915		1916		1917	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Europe:						
Belgium	59,863	$311				
Denmark			54	$2		
France	150,160	4,362	32,760	370	14,181	$187
Greece	640	4				
Iceland and Faroe Islands			3,000	24	9,245	119
Italy					600	4
Netherlands	43,140	297				
Norway	720	21	2,983	65	950	18
Portugal			375	5		
Russia in Europe	112,560	262	251,628	1,443	179,648	1,360
Serbia and Montenegro, etc	12,766	136				
Spain	5,500	65				
Sweden						
United Kingdom:						
England	313,783	4,284	286,458	5,247	7,572	160
Scotland	10,360	70				
Ireland	880	10	560	5		
North America:						
Bermuda	297,349	2,434	312,190	2,868	367,582	3,733
British Honduras	124,957	654	542,369	2,579	699,601	2,861
Canada	77,391,666	191,922	112,072,308	274,146	141,977,910	474,810
Central American States:						
Costa Rica	295,461	1,868	554,556	3,771	358,070	3,148
Guatemala	318,270	1,659	335,861	1,870	136,640	1,222
Honduras	2,782,795	13,117	760,638	4,147	1,774,138	9,810
Nicaragua	511,813	2,698	458,055	3,989	853,841	7,473
Panama	2,916,246	18,769	3,064,625	18,574	4,126,157	29,267
Salvador	150	2	10,621	113	504	10
Mexico	15,667,161	81,814	4,457,377	36,380	11,157,848	76,038
Miquelon, Langley, etc	1,790	27	1,798	21	5,450	45
Newfoundland and Labrador	1,241,630	5,732	818,560	3,092	4,081,348	29,014
West Indies:						
Barbados	40,300	444	2,187	35	5,633	112
Jamaica	6,797	51	373,564	1,357	764,245	2,844
Trinidad and Tobago			4,520	39	3,200	39
Other British	13,849	130	19,505	249	19,446	322
Cuba	48,753,322	209,855	40,101,863	169,798	52,171,794	262,265
Danish (Virgin Islands)	3,704	32	4,062	62	155,152	876
Dominican Republic	133,131	1,271	130,007	1,555	134,563	2,424
Dutch West Indies			2,156	23	498	11
French West Indies	22,506	334	22,162	354	29,787	578
Haiti	5,455	78	6,613	110	12,301	216
South America:						
Argentina	15,870	224	105,616	889	91,093	626
Bolivia			2,400	31		
Brazil	1,243,277	7,334	33,569	344	18,455	283
Chile	21,001	102	313,303	1,816	32,356	435
Colombia	62,288	494	285,356	1,458	287,655	2,959
Ecuador	15,000	75	240	12	50	2
Guiana:						
British	13,461	90	116,588	691	366,124	5,741
Dutch	3,188	29	2,713	58	16,632	173
French	1,720	15	1,560	23	5,650	48
Paraguay			1,800	47		
Peru	66,000	368	43,190	346	68,123	657
Uruguay					162	4
Venezuela	13,788	398	2,796	39	6,724	116

Salt exported from the United States in 1915, 1916, and 1917—Continued.

Country.	1915		1916		1917	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Asia:						
China	3,421	56	3,460	57	8,227	302
Chosen	3,800	56	7,917	77	11,475	185
East Indies:						
British:						
British India	3,000	14	934	24	7,319	126
Straits Settlements					2,850	132
Other British					1,484	28
Dutch	2,040	18	3,168	70	47,220	1,786
Hongkong			5,050	178	20,267	831
Japan	58,410	224	50,250	137	1,835,454	12,291
Russia in Asia	120,675	483	1,240	10	40	2
Siam	120	2			2,640	106
Turkey in Asia	6,250	67				
Oceania:						
British:						
Australia	2,078,345	22,997	626,550	10,417	2,604,029	35,637
New Zealand	5,493,512	33,200	1,438,411	11,575	3,017,167	20,369
Other British	496	5	6,450	105	6,516	143
French Oceania	225,361	1,971	229,025	1,867	198,613	2,208
German Oceania	2,095	25	9,550	137	31,886	435
Philippines	60,655	898	185,860	4,507	231,239	5,735
Africa:						
Belgian Kongo	200	1	100	2	723	12
British Africa:						
West					4,001	166
South	54,860	657	17,190	216	6,600	128
East					5,200	118
Canary Islands	924	7				
Egypt	9,360	80				
French Africa			1,400	14	112	4
Liberia	130,236	1,244	100	1	1,160	16
Madagascar						
Portuguese Africa					72	3
	160,948,077	613,847	168,129,201	567,441	227,985,222	1,000,773

BROMINE.

OCCURRENCE AND USES.

Bromine is derived from bittern left after extracting salt from the brine pumped from deep wells at Mount Pleasant, Midland, Saginaw, St. Charles, and Bay City in Michigan; at Pomeroy in Ohio; and at Mason, Hartford, and Malden in West Virginia.

The element bromine does not occur in native form but is derived in large quantities from natural brines. It exists in all sea water and in most mineral water and salt springs, and has been found in giant kelp. Bromine is at ordinary temperature a volatile, heavy mobile liquid of a reddish-brown color, giving off reddish-brown vapor. The vapor when inhaled dilute resembles chlorine in smell and in attacking the throat and nose, but in addition it has a very harmful effect on the eyes. The liquid is very poisonous and produces burns on the skin.

Bromine is used in many chemical reactions as an oxidizer instead of chlorine, also in dissolving gold and separating it from platinum and silver, and in manufacturing disinfectants, bromine salts, and aniline colors. Perhaps the best known and most widely used bromine salts are bromide of silver, used in photography, and potassium bromide, used in medicine where it is desirable to depress the nervous system. Because of its harmful effect on the eyes, nose, and throat, bromine is now used in large quantity for grim purposes of warfare. To increase the domestic supply the Government has arranged for the drilling of additional salt wells in Michigan, which are expected to be producing bromine-bearing brine by July, 1918.

PRODUCTION.

The quantity of bromine marketed in 1917 increased nearly 23 per cent over the production in 1916. The marketed output of the last eight years is given in the following table:

Bromine produced and marketed in the United States, 1910–1917.

Year.	Quantity (pounds).	Value.	Average price per pound.
1910	245,437	$31,684	$0.13
1911	651,541	110,902	.17
1912	647,200	145,805	.22
1913	572,400	115,436	.20
1914	576,991	203,094	.35
1915	855,857	856,307	1.00
1916	728,520	951,932	1.31
1917	895,499	492,703	.55

The prices in the table are derived from the total quantity and value as reported to the Geological Survey by the producers and represent average prices for the year f. o. b. at the plants.

The production of bromine was retarded in 1917 by steadily falling price and increasing cost of production, by railroad freight congestion, by embargo on shipments which hindered the movement of salt, by shortage of labor and fuel at some plants, by needed repairs, and by the extremely cold weather in December.

The stock of bromine on hand at the producing plants December 15, 1917, as reported to the Geological Survey by the producers, was about 7,000 pounds.

One plant which formerly produced bromine was closed during all of 1917, and of the 12 plants in operation some were idle a considerable part of the time. One of the 12 stopped producing entirely. The production of bromine in this country could be greatly increased if all the plants worked all the time. This, however, seems impossible at present because of a shortage of labor.

PRICE.

The wholesale price of bulk bromine in New York was 25 to 35 cents a pound in 1913, 30 to 35 cents from January to August, 1914, and 40 to 50 cents from September to December, 1914. The increase in price through 1915 to the spring of 1916 and the steady decline since then is shown in the following table, which has been compiled from the Journal of Industrial and Engineering Chemistry.

Wholesale price per pound of bulk bromine in New York City, 1915–1917.

	1915	1916	1917
January	\$0.40–\$0.50	\$5.00–\$6.50	\$1.40–\$1.50
February	.40– .50	5.00– 6.50	1.40– 1.50
March	.40– .50	5.00– 6.50	1.30– 1.40
April	.40– .50	Not quoted.	1.30– 1.40
May	.40– .50	4.75– 5.25	.80– 1.00
June	.85– .87	3.50	.85– 1.00
July	.85– .87	3.50	.55– .60
August	.85– .87	2.40– 2.50	.55– .60
September	1.00– 1.25	1.30– 1.40	.55– .60
October	1.25– 1.60	1.20– 1.30	.55– .60
November	1.50– 1.75	1.40– 1.50	.55– .60
December	1.50– 1.75	1.40– 1.50	.60– .65

METHODS OF MAKING BROMINE.

The Bureau of Mines, Department of the Interior, has published recently a bulletin by W. C. Phalen [1] describing the methods of making salt in the United States, which includes a description of the recovery of bromine from brine. In view of the large demand for bromine an abstract of Phalen's description of the methods of making bromine is given below.

Bromine occurs in natural brines only in small proportion and is always associated with other salts, principally the chlorides of calcium, magnesium, and sodium. Bromine is obtained from the mother liquors that remain after the crystallization of salt from brines, and it is also extracted from unconcentrated brine.

Three methods of extracting bromine, known as the periodic or intermittent process, the continuous process, and the electrolytic process, are described briefly in the following paragraphs.

Periodic or intermittent process.—The bittern left after the crystallization of salt is further concentrated to the strength desired, usually 39° to 41° Baumé, and is then run into a sandstone still. Stills are built in various ways but consist of an interior chamber with a capacity ranging from 400 to 1,200 gallons of liquid. The requisite quantity of sodium chlorate and sulphuric acid of 66° B. is added to liberate the bromine from the bittern. A jet of steam is discharged into the solution and as the temperature rises, a chemical reaction takes place which sets bromine free.

The bromine together with some chlorine passes from the still as a gas. The bromine is freed from chlorine by passing through washers filled with milk of lime, which forms, with the chlorine, calcium chloride and calcium hypochlorite. The distilled bromine passes through a lead pipe or earthenware condenser and is collected in glass bottles or stoneware receptacles. About 35 pounds of bromine is obtained from 700 gallons of bittern having a strength of 40° B.

Continuous process.—In the continuous process chlorine gas is passed through the bromine-bearing brine, and the bromine is liberated according to the simple reaction $MBr_2+Cl_2=MCl_2+Br_2$ in which M stands for metal, leaving the bromine mechanically held in the solution. The bromine is recovered from its solution in the brine by air currents. The bromine-laden air is then brought into

[1] Technology of salt making in the United States: Bur. Mines Bull. 146, pp. 85–94, 1917.

contact with any substance that will chemically combine with the bromine, for example, iron turnings or filings. Ferric bromide is formed, which with the moisture absorbed from the air, makes a solution.

Electrolytic process.—The principle that bromides decompose at a lower voltage than chlorides and hence are first decomposed by the electric current is the basis of the electrolytic process. A weak current is used, not more than 4 to 5 volts. By one method the brine is run into wooden tanks in which electrolysis takes place through carbon electrodes. The bromine solution from the tanks trickles continuously down a lattice work in a tall wooden tower against a strong air current. The bromine-laden air is then passed through water, forming aqueous solution which trickles downward through another tower of bromine-resisting material such as sewer pipe. In this tower are coils of thin iron ribbon or wire. The iron combines with the bromine, forming bromide of iron. This compound is treated with sodium, potassium, or ammonium hydroxide, depending on the bromide desired, and the mixture is boiled down. After the reaction is completed the precipitated ferric hydrate is filtered off and the clear solution further concentrated until the bromides crystallize out. These are dried over steam coils or in any other suitable manner.

CALCIUM CHLORIDE.

PRODUCTION.

Large quantities of calcium chloride are produced in connection with the ammonia soda process at Solvay, N. Y., Wyandotte, Mich., Barberton and Fairport Harbor, Ohio, Hutchinson, Kans., and Saltville, Va.; but this material derives its calcium from limestone and its chlorine from common salt, and is not an original constituent of the brine pumped at these places. For this reason the calcium chloride so produced is not considered by the Geological Survey in its statistics. Only that calcium chloride which is an original constituent of natural brine and which is produced in connection with the manufacture of salt and bromine from such brine is here recorded. It was made in 1917 at Midland, Mount Pleasant, Bay City, and Saginaw, Mich.; Pomeroy, Ohio; Mason, Hartford, and Malden, W. Va.; and Saltus, San Bernardino County, Cal.

The following table shows a large increase in quantity and a very large increase in value of calcium chloride in 1917:

Calcium chloride produced and marketed in the United States, 1910–1917.

Year.	Quantity (short tons).	Value.	Average price per ton.
1910	10,971	$74,713	$6.81
1911	14,606	91,215	6.25
1912	18,550	117,272	6.32
1913	19,611	130,030	6.63
1914	19,403	121,766	6.28
1915	20,535	130,830	6.37
1916[a]	27,709	224,997	8.12
1917	30,503	451,480	14.80

[a] Figures for 1916 revised in 1917.

USES.

Calcium chloride is used as the circulating fluid in refrigerating plants, in automobile gas-engine water jackets to prevent freezing, and, on account of its power of absorbing moisture, for laying dust on roads and drill grounds, drying gases, vegetables, and fruits, and dehydrating organic liquids. In solution it is especially valuable in automatic sprinkler systems and in fire buckets.

METHOD OF MAKING CALCIUM CHLORIDE.[1]

After salt, and in some places bromine, has been extracted from brine, the remaining bittern is heated, agitated with milk of lime, and the suspended matter is allowed to settle. The clear liquid is evaporated, and after partial separation of the salt the bittern is run to another evaporator and concentrated further. From this pan it goes to a settling tank where the rest of the salt settles out. The bittern is then boiled in a cauldron and run into metal drums, where it solidifies. It is placed on the market in this form.

[1] Phalen, W. C., Technology of salt making in the United States: Bur. Mines Bull. 146, pp. 95–97, 1917.

MICA.

By Waldemar T. Schaller.

INTRODUCTION.

Mica is used in the form of sheet mica, splittings, and ground mica. The uncut sheet of smallest practicable size, known as punch mica, should yield a disk or washer at least 1½ inches in diameter if the mica is stained and 1¼ inches in diameter if the mica is clear. The smallest "plate sheet" should yield a rectangle at least 1½ by 2 inches. Sheet mica is used in various sizes, chiefly for insulation in electric appliances, for glazing the fronts of stoves, for lamp chimneys and shades, and for phonograph diaphragms. Both domestic and foreign mica are used for these purposes. For certain high-potential electric appliances only a high-grade mica free from inclusions, cracks, pin holes, or other defects, can be used.

Splittings or films are very thin sheets of mica, about a thousandth of an inch thick. These are manufactured into built-up mica board, such as micanite, micabeston, micabond, and micadamite. (See p. 192.) No appreciable quantity of splittings or films of domestic mica is sold, practically the entire supply of splittings consumed in the manufacture of mica board being imported. This built-up mica board is largely used in electric insulation.

Ground mica finds its chief applications in the manufacture of patent roofing, in the annealing of steel, in lubrication, and in decoration. These and other uses are described in detail on page 191. Although some ground mica is imported, the bulk of such mica consumed, about 96 per cent, is of domestic origin. Mica has been estimated to constitute about 4 per cent of all igneous rocks, and as no special property is required of mica suitable for grinding, it is evident that any desired quantity of ground mica can be produced in this country.

The requirements for sheet mica to be used in the industries are very particular, and only a very small percentage of the total mica extracted can finally be utilized as sheet. The specifications for mica to be used in high-potential appliances, such as are used in wireless apparatus and in airplanes and automobile trucks, are very rigid.

Owing to the restrictions imposed on the importation of mica the question has arisen whether the entire demand of the country can be supplied by the domestic production. This question can not be definitely answered at present, but there seem to be grave doubts as to the domestic output being sufficiently increased.

The sheet mica imported from India has been largely used in many industries in this country and has been generally found to give very satisfactory results. Much of the domestic mica produced is said to be unfit for many of the purposes to which Indian mica is applied. An inquiry as to the possibility of domestic mica replacing imported Indian mica must have reference to the quality of the domestic mica and the quantity of suitable material which can be produced. Several large users have stated that this country contains deposits of mica which is fully as good as the Indian mica.

For the 18-year period 1900-1917 the proportion of the consumption of sheet mica (including splittings) represented by domestic production has averaged about 38.5 per cent, with extreme variations of 14 per cent in 1902 and 64 per cent in 1908. The average for 1900-1913 was 38 per cent. For the years 1903–1907, 1909, and 1912–1917 the percentages lay between 30 and 50. For the war years the percentages have shown very little change, being 41 for 1914, 40 for 1915, 40 for 1916, and 42 for 1917. In other words, there has been very little change in the ratio of domestic production to consumption of sheet mica since 1913. This ratio shows a decrease, however, as compared with the years immediately preceding 1914, except 1912, for the percentages were 44 for 1913, 30 for 1912, 59 for 1911, 56 for 1910, 49 for 1909, and 64 for 1908. For the years 1900 to 1907 the percentage was lower than 38 each year.

PRODUCTION.

Although the total value of all mica produced and sold in the United States in 1917, as reported to the United States Geological Survey, was the highest on record, the total quantity was smaller than that for any preceding year since 1908, except 1912 and 1914. This was due in part to the fact that a good deal of the scrap mica mined was not sold. The quantity of sheet mica produced and sold in 1917 showed an increase of 47 per cent over that of 1916, being 1,276,533 pounds as compared with 865,863 pounds in 1916 and 553,821 pounds in 1915; but the output for 1917 was exceeded in 1913, 1911, 1910, 1909, and 1906. Unfortunately the compiled statistics have always lumped together cut and uncut, clear, slightly spotted and stained, and heavily spotted and stained, punch and washer mica as sheet mica, so that no information is available as to the quantity of clear sheet mica produced. Moreover, not all clear mica is suitable for all high-potential work, and no record is available of the quantity of domestic sheet mica produced that would comply with certain rigid specifications.

The statement, therefore, that in 1917 the United States produced 1,276,533 pounds of sheet mica gives no information as to how much of this was clear, or how much was above a certain size, or how much was suitable for specific purposes. Therefore in making a comparison between domestic production and imports, it must be remembered that, whereas imports consist largely of clear sheets of good quality, the domestic product includes all qualities from clear to heavily spotted and stained.

Mica produced and sold in the United States, 1908–1917.

Year.	Sheet mica.		Scrap mica.		Total quantity (short tons).	Total value.
	Quantity (pounds).	Value.	Quantity (short tons).	Value.		
1908	972,964	$234,021	2,417	$33,904	2,903	$267,925
1909	1,809,582	234,482	4,090	46,047	4,995	280,529
1910	2,476,190	283,832	4,065	53,265	5,303	337,097
1911	1,887,201	310,254	3,512	45,550	4,456	355,804
1912	845,483	282,823	3,226	49,073	3,649	331,896
1913	1,700,677	353,517	5,322	82,543	6,172	436,060
1914	556,933	278,540	3,730	51,416	4,008	329,956
1915	553,821	378,259	3,959	50,510	4,236	428,769
1916	865,863	524,485	4,433	69,906	4,866	594,391
1917	1,276,533	753,874	3,429	52,908	4,067	806,782

This table has been compiled from the figures reported by the producers. The total therefore includes cut mica ready for the trade, also uncut, punch and washer, scrap, and run of mine mica, the last being sold either in bulk by the ton or on contract at a fixed price per ton for all mica obtained. The prices paid for run of mine mica represent the value of the mica as it is taken from the mine, the finished cut mica brings a much higher price, as it is ready to be used and has had a considerable amount of money spent on it. It is obviously inconsistent to add together the value of mica of two classes differing so greatly, yet this procedure is the only one that can at present be followed. For the output of some of the mines an estimate of 10 per cent of the total mica as uncut sheet has been made.

The domestic production in 1917 came from eight States, which, grouped in the order of quantity of sheet mica produced, are North Carolina, New Hampshire, Virginia, South Dakota, Georgia, Alabama, Idaho, and Colorado. As in previous years, North Carolina led all other States both in quantity and in value of mica produced.

Percentage of production of mica in 1917, by States.

State.	Quantity.		Value.
	Sheet.	Scrap.	
North Carolina	50	64	72
New Hampshire	37	20	21
Virginia	6	8	3
South Dakota	3	8	1
Georgia Alabama Idaho and Colorado	4	....	3
	100	100	100

The annual production of mica, by States, for the years 1912–1917 is shown in the following table. Where less than three producers reported returns, the figures are omitted, so that no individual production is disclosed. For several years, therefore, the figures of production can not be given.

Mica produced by chief producing States, 1912–1917.

Year.	Sheet mica.			Scrap mica.		Total quantity.	Total value.
	Quantity.		Value.	Quantity.	Value.		
North Carolina:	*Pounds.*	*Short tons.*		*Short tons.*		*Short tons.*	
1912	489,599	245	$219,874	2,492	$36,675	2,737	$256,549
1913	803,462	402	230,674	2,729	37,239	3,131	267,213
1914	274,121	137	171,370	1,789	23,900	1,926	195,970
1915	281,074	141	266,650	2,840	33,943	2,981	300,593
1916	546,553	273	380,700	2,755	41,880	3,028	422,580
1917	643,476	322	543,207	2,180	34,134	2,502	577,341
New Hampshire:							
1912	308,047	154	32,238	264	5,100	418	37,338
1913	731,478	366	65,765	692	13,906	1,058	79,671
1914	133,556	67	39,588	600	8,249	667	47,837
1915	96,685	48	59,414	516	7,557	564	66,971
1916	125,502	63	64,386	724	10,853	787	75,239
1917	472,519	236	159,822	680	9,229	916	169,051
Virginia:							
1912	0	0	0	0	0	0	0
1913	4,585	23	4,578	30	572	53	5,150
1914	27,672	14	22,358	153	2,295	167	24,653
1915	10,808	5	9,590	63	828	68	10,418
1916	39,978	20	18,251	182	2,703	202	20,954
1917	68,558	34	22,831	253	2,709	287	25,540
South Dakota:							
1912	(a)	(a)	(a)	(a)	(a)	(a)	(a)
1913	19,225	10	2,206	591	10,403	601	12,609
1914	27,323	14	1,366	515	6,138	529	7,504
1915	25,992	13	8,230	179	2,684	192	10,914
1916	115,392	58	49,298	527	10,472	585	59,770
1917	37,523	19	5,975	272	5,033	291	11,008
Alabama:							
1912	0	0	0	0	0	0	0
1913	(a)	(a)	(a)	(a)	(a)	(a)	(a)
1914	32,900	16	3,964	0	0	16	3,964
1915	8,400	4	5,545	23	395	27	5,940
1916	14,132	7	4,955	65	660	72	5,615
1917	18,476	9	3,528	12	280	21	3,808
Georgia:							
1912	0	0	0	0	0	0	0
1913	0	0	0	0	0	0	0
1914	(a)	(a)	(a)	(a)	(a)	(a)	(a)
1915	4,949	2	635	0	0	2	635
1916	16,037	8	2,094	0	0	8	2,094
1917	30,534	15	12,141	26	1,400	41	13,541

[a] The figures can not be given, as there were less than 3 producers.

With reference only to the quantity of sheet mica produced, a this is the most important item in the table, North Carolina increased its production in 1917 over 1916 only 18 per cent. The production of either 1916 or 1917 was about double that of either 1914 or 1915, but less than that of 1913 and only slightly more than that of 1912. Although there has been an annual increase since 1914, the increase is far less than was expected. The production of New Hampshire in 1917 was nearly four times as great as that of 1916, but 1914 exceeded 1915 and also 1916, and 1913 exceeded all other years from 1912 to 1917. Virginia produced more in 1917 than in any two preceding years, but Virginia's total is only a small percentage of the country's production. Georgia shows a promising increase each year, but the total quantity produced is even smaller than that of Virginia. Alabama has annually increased its production since 1915, but that of 1914 was slightly greater than that of 1916 and 1917 combined. The total quantity, moreover, is very small. Both South Dakota and Idaho have proved very disappointing; these two States have been large producers in the past.

In conclusion, it may be said that the large producing States have done little more than hold their general average; they have failed to show that under the stimulus of high prices their production could be materially increased. Two of the small producing States—Virginia and Georgia—have shown a relative increase, but even so their total production is very small. The other small producing States and also the other States west of the Mississippi which in previous years have produced sheet mica have failed to show that they could produce good sheet mica in increased quantity.

PRICES.

The prices paid for mica in 1917 continued, with minor fluctuations, to increase throughout the year. The prices paid for domestic mica in the South in 1917 were from 10 to 20 per cent higher than the prices for similar mica in 1916. The greatest increase was for the smaller sizes, especially for the 1½ by 2, 2 by 2, and 2 by 3 inches. The largest sizes showed no increase in price.

The average price per pound of sheet mica produced in 1917 was 59 cents, a price lower than for either 1916 (61 cents) or 1915 (68 cents), but higher than for any other preceding year. A very large amount of punch or washer mica was produced in 1917, and as this averaged only 5 cents a pound it materially lowered the average value of all sheet mica with which it was combined. If all the producing companies would report their punch mica separately, as is provided for in the blank cards sent out by the Geological Survey, figures for cut sheet, uncut sheet, and punch or washer mica could be separately compiled.

Average prices per pound paid in the South for rough-trimmed sheet mica of good quality, split and sorted to cut the sizes indicated, 1913–1917.

Size (in inches).	1913	1914	1915	1916	1917
Punch	$0.035	$0.03	$0.04	$0.05	$0.055
1½ by 2	.12	.10	.20	.30	.40
2 by 2	.30	.25	.40	.55	.70
2 by 3	.70	.65	.70	.90	1.10
3 by 3	1.15	1.00	1.00	1.35	1.55
3 by 4	1.35	1.20	1.25	1.70	1.85
3 by 5	1.70	1.50	1.50	1.95	2.15
4 by 6	2.25	2.00	2.10	2.85	3.10
6 by 6	3.00	2.70	2.80	3.50	3.80
6 by 8	4.00	3.60	3.50	5.00	4.70
8 by 10	6.00	5.40	5.20	7.50	7.50

The prices per square inch for the different sizes are given in the following table, which shows that the highest price, per unit area, was paid for 3 by 3 inch mica in 1913 and 1914, for 2 by 3 inch in 1915, for 2 by 3 inch and 3 by 3 inch in 1916, and for 2 by 3 inch in 1917, indicating that the smaller sizes were worth more per square inch in 1915–1917 than in 1913–1914.

Average prices per square inch paid for mica for different sizes, 1913–1917.

Size (in inches).	Area (in square inches).	Price per square inch (in cents).				
		1913	1914	1915	1916	1917
1½ by 2	3	4	3.3	6.7	10	13.3
2 by 2	4	7.5	6.3	10	13.8	17.5
2 by 3	6	11.7	10.8	11.7	15	18.3
3 by 3	9	12.8	11.1	11.1	15	17.2
3 by 4	12	11.3	10	10.4	14.2	15.4
3 by 5	15	11.3	10	10	13	14.3
4 by 6	24	9.4	8.3	8.8	11.9	12.9
6 by 6	36	8.3	7.5	7.8	9.7	10.6
6 by 8	48	8.3	7.5	7.3	10.4	9.8
8 by 10	80	7.5	6.8	6.5	9.4	9.4

The prices given above apply only to good sheet mica of the first and second qualities. The mica must be nearly free from spots and stains, for mica with such flaws is worth much less, as is shown in the following table:

Average prices paid in the South per pound for rough-trimmed sheet mica, split and sorted to cut the sizes and qualities indicated, December, 1917–January, 1918.

Size (in inches).	Good quality.	Slightly spotted or clay-stained.	Heavily spotted or clay-stained.
Punch	$0.07	$0.06	$0.05
1½ by 2	.45	.35	.20
2 by 2	.80	.65	.35
2 by 3	1.25	1.00	.65
3 by 3	1.60	1.40	.90
3 by 4	1.90	1.60	1.20
3 by 5	2.25	1.90	1.40
4 by 6	3.25	2.50	1.75
6 by 8	5.00	3.75	2.25

The following table presents the average prices paid for domestic, Canadian, and Indian mica in the United States in 1917. This comparison is only approximate because of the fluctuation in the price of imported mica, the great scarcity of clear Indian mica imported toward the end of 1917, and the different schemes of grading used for domestic and imported micas. It is believed, however, that, if used with due caution, the table will serve to show the comparative values of the different micas. The prices shown for imported micas include freight and duty. The thanks of the United States Geological Survey are hereby expressed to the many mica producers, dealers, and importers who have generously furnished individual information from which the average values shown have been computed.

Average prices per pound of mica, split and trimmed to cut the sizes indicated, in the United States in 1917.

Size (in inches).	Area (in square inches).	Domestic mica in the South (muscovite).		Canadian mica (phlogopite).	Indian mica, slightly stained (muscovite).		
		Good quality.	Slightly spotted or stained.				
Punch	....	$0.055	$0.05	....			
1 by 1	1 to 3	....	....	$0.11	......	Grade 6	......
1 by 2		....	....	.18	......		
1½ by 2		.40	.30	.25	......		
1 by 3		....	....	.25	......		
2 by 2	3 to 6	.70	.60	40	$0.70	Grade 5	$0.75
2 by 3		1.10	.90	.50	.90		
2 by 4	6 to 10	....	....	.80	......	Grade 4	1.20
3 by 3		1.55	1.30	1.00	1.40		
3 by 4	10 to 15	1.85	1.55	1.40	1.50	Grade 3	1.70
3 by 5		2.15	1.70	1.45	2.35		
4 by 6	15 to 24	3.10	2.50	1.90	3.20	Grade 2	2.80
6 by 6	24 to 36	3.80	3.00	3.00	4.00	Grade 1	3.55
6 by 8	36 to 48	4.70	3.50	3.75	4.85	Grade A-1	4.40
8 by 10	48 or more	7.50	5.65	5.50	......	Grade special	6.05

IMPORTS AND EXPORTS.[a]

IMPORTS.

The sheet mica, including splittings, imported for consumption in the United States during 1917, as reported by the Bureau of Foreign and Domestic Commerce, was valued at $1,429,004, the highest value recorded by the United States Geological Survey. In 1917 there were also imported 46 tons of ground mica, valued at $1,044.

During the war imports of mica have been received annually from England, India, and Canada. In addition, mica was received in the last six months of 1914 from Germany, China, Guatemala, and Cuba; in 1915 from the Netherlands, Germany, Norway, Brazil, Guatemala, Japan, and Scotland; in 1916 from Brazil, Argentina, France, and Scotland; and in 1917 from Argentina, Brazil, Costa Rica, Guatemala, Mexico, Newfoundland, and Peru. The country named is not necessarily the country of origin of the mica.

Mica imported for consumption in the United States, 1908–1917.

Year.	Sheet.				Ground.		Total.	
	Unmanufactured.		Cut or trimmed.					
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		Pounds.		Pounds.		Pounds.	
1908	497,332	$224,456	51,041	$41,602	....	....	548,373	$266,058
1909	1,678,482	533,218	168,169	85,595	....	....	1,846,651	618,813
1910	1,424,618	460,694	536,905	263,831	(b)	$1,298	(b)	725,823
1911	1,087,644	346,477	241,124	155,686	(b)	3,389	(b)	505,552
1912	1,900,500	649,236	88,632	99,737	[b] 343,824	[c] 6,611	2,332,956	755,584
1913	2,047,571	751,092	(b)	191,926	290,757	4,765	(b)	947,783
1914	360,888	168,591	(b)	456,805	404,848	4,088	(b)	629,484
1915	433,822	240,449	(b)	447,962	344,040	3,858	(b)	692,269
1916	703,832	421,856	(b)	646,080	362,000	3,420	(b)	1,071,356
1917	656,391	414,823	(b)	1,014,181	92,963	1,044	(b)	1,430,048

[a] The statistical information on imports and exports given in this report has been compiled, as in earlier reports, by J. A. Dorsey, of the United States Geological Survey, from data furnished by the Bureau of Foreign and Domestic Commerce, United States Department of Commerce.

[b] Quantity not reported. [c] Figures cover only last six months of 1912.

The figures in the following table refer to mica brought to port of entry and not necessarily entered for consumption in the same year. These figures, therefore, are not comparable to those given in the table of mica imported for consumption.

Sources of imported mica, 1915–1917.

Country.	1915	1916	1917
	Per cent.	*Per cent.*	*Per cent.*
India, direct and through England	32	47	53
Canada	65	50	38
Brazil	1	3	6
Argentina	0	(a)	3
Guatemala	(a)	0	(a)
Mexico	0	0	(a)
Miscellaneous	b 2	(a)	(a)
	100	100	100

a Less than 1 per cent.
b Manufactured mica from Germany, Netherlands, and Norway.

EXPORTS.

In 1917 mica was exported to France, Italy, Portugal, Spain, England, Bermuda, Canada, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, Mexico, Newfoundland, British West Indies (Barbados, Jamaica, Trinidad, other), Cuba, Virgin Islands (Danish West Indies), Dominican Republic, Argentina, Brazil, Chile, Peru, Uruguay, Venezuela, British India, Straits Settlements, Dutch East Indies, Japan, Australia, New Zealand, Philippine Islands, and British South Africa.

Mica exported from the United States, 1910–1917.

Year.	Unmanufactured.		Manufactured.	Total value.
	Quantity (pounds).	Value.	Value.	
1910				$20,543
1911	415,862	$15,649	$20,267	35,916
1912	356,601	14,936	25,876	40,812
1913	298,711	14,175	48,009	62,184
1914	467,451	23,145	27,751	50,896
1915	54,183	5,118	33,915	39,033
1916	63,168	4,544	74,127	78,671
1917	a 11,771	3,073	71,412	74,485

a For six months, January to June.

USES.

The different uses to which mica is put depend on its form—whether in sheets or in powder. Sheet mica is used in the electrical industry, for glazing, and to some extent for other purposes. Ground mica is used chiefly in the decorative trades, for annealing, for lubrication, and in patent roofing.

Sheet mica finds its greatest use in the electrical industry, where an insulating, noninflammable material is necessary. It is used in sheets and as washers and disks in dynamo-electric machinery, electric-light sockets, spark plugs, insulators, guards in rheostats, fuse boxes, and telephones. Flexible cloth and tape, covered with mica, find varied uses in electrical apparatus. Sheet mica is used for glazing the fronts of stoves, for furnace sight holes, for screens in front of highly heated material, for optical lanterns as a retarder of heat waves, and for making lamp chimneys and lamp shades. It is also used in spectacles (amber-colored phlogopite [1] would seem to be the ideal material for goggles in oxy-acetylene welding), motor goggles, sand blasting, sight holes of divers' helmets and smoke helmets, compass cards, automobile shields, phonograph diaphragms, in windows where glass would be broken by heavy shocks or by vibrations as in the conning towers of warships and of submarines, and in lantern transparencies.

A peculiar silvery mica is used in India for inlay work. In India also pictures and portraits in large numbers are painted on sheets of mica.

Sheet mica has come to be of importance as a war mineral through its use as insulator in electric apparatus, especially in condensers, magnetos, and spark plugs; also as windows in masks worn for defense against asphyxiating gases, and for other uses where a transparent, noninflammable, nonshattering material is necessary, as in automobile goggles and as coverings for wounds.

Ground mica is used for decoration in wall paper, to which it gives luster and brightness; in fancy paints, ornamental tiles, concrete, rubber goods, pipe and boiler coverings, insulating compounds, fireproof paints and coverings, patent roofing material, molded mica (ground mica mixed with shellac), and calico printing; as absorbent for nitroglycerin in the manufacture of "mica powder;" in annealing steel; to a large extent as a lubricant for wooden bearings, or, mixed with oil, as a lubricant for metal bearings; in the manufacture of automobile treads on new tires, as well as in repair stock; and as a filler for various other products. Tar and other roofing papers are coated with coarsely ground mica to prevent sticking when they are rolled for shipment. A possible value of ground mica as a chemical source of potash salts has been suggested, especially its direct application to the soil as a fertilizer.

A recently patented insulating material,[2] claimed to be hard and almost incombustible, is composed of 14 per cent sifted mica, 52 per cent pulverized asbestos, 20 per cent mineral caoutchouc, 10 per cent rubber solution, 3 per cent sulphur, and 1 per cent resin. The material can be molded and wrought and can be used as a substitute for porcelain, marble, slate, and vulcanized substances.

In India ground mica is used for processional ornaments, such as lamps, pottery, curtains, cloth, and tinsel decorations on fans, and in buildings, especially in temples and palaces. Large quantities have also been employed for medicinal uses—an application which has not extended beyond its country of origin.

Several trade names have been given to the mica products described below.

Micalite is applied by Eugene Munsell & Co., 68 Church Street, New York, N. Y., to the mica used in mica chimneys, candle shade protectors, and canopies.

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[1] Thin sheets of phlogopite, if of suitable clearness and color, afford very great relief to the eyes in glaring sunlight and seemed to make objects more clearly visible.

[2] Jour. Indust. Eng. Chemistry, vol. 10, p. 314, 1918.

Micanite is a term applied by the Mica Insulator Co., of Schenectady, N. Y., to a manufactured mica board or plate, built up by successive layers from many small thin films of mica, which, after being dipped into and cemented with shellac, are then subjected to pressure under heat to dry out the shellac. These large sheets are then milled to the requisite thickness and made suitable for many electrical purposes.

Micabeston, which is similar to micanite, is manufactured by the American Mica Co., of Newton Lower Falls, Mass. Several varieties are made, one of which becomes flexible when heated and rigid when cold, and is used for insulation in field coils, transformers, armatures, etc., where high heat is not generated, another variety remains rigid under a high heat and is used in commutators of generators and motors.

Micabond, made by the Chicago Mica Co., of Valparaiso, Ind., is also similar and is made in varying qualities with different properties, depending on its use.

Micadamite, manufactured by Meirowsky Bros., 106–108 Broadway, Jersey City, N. J., is similar built-up mica plate, manufactured into rings, tubes, segments, and many other forms of insulation.

These manufactured mica sheets use a number of different substances as binders in addition to shellac, chiefly paper of various grades (Japan tissue, manila, rope, fish), muslin cloth, rubber, and gutta percha.

Silberglimmer (silvery mica) is muscovite which has been heated to a sufficiently high temperature to make it softer and opaque and silvery in appearance. It is also known as annealed mica and finds a use in certain parts of electric apparatus.

Rimco is mica ground by a nonmetallic process by the Richmond Mica Co., Richmond, Va., for use as a tire powder. It is also used by manufacturers of oils and lubricating greases.

Micamima, prepared by the Crawford Mica Co., of Crawford, Nebr., is a coarsely ground mica used in the manufacture of concrete facing material; mixed with other minerals it is used to give the effect of natural rock, and it may be used for different decorative purposes.

Micolith, or micholithic, prepared by the Texas Mica Co., of Pecos, Tex., is another similar product used to give the effect of natural rock to concrete facings.

Tungash, as the Denver Mining & Manufacturing Co., of Denver, Colo., calls its product, is a bronze-colored, metallic-looking material of value for decoration. The crude biotite mica, altered and hydrated, has a dull greenish-black appearance when mined. On being heated it expands to a light product, which has a rich golden-bronze color and a decidedly metallic luster.

Clinomica is the name given by the American Mica Co., 52 Broadway, New York, to its ground clinochlore, a micaceous mineral of the chlorite group. Clinomica possesses essentially the qualities of ground mica and is used as a dusting material in the rubber and composition-roofing industries, for paints, cements, lubricants, molded electric insulation, and as a filler for various products.

FOREIGN MICA.

ARGENTINA.

According to a report in Commerce Reports,[1] an exporter in Buenos Aires is prepared to supply sheet mica of good quality for export to the United States, delivery on the dock, in quantities of 11,000 pounds per month, at the following prices per pound:

Prices per pound of Argentine mica in Buenos Aires.

Grade.	Area in square inches.	Price per pound.	
		Clear.	Spotted.
5	3½ to 5	$0.36	$0.12
4	6 to 9	1.00	.40
3	10 to 13	1.20	.70
2	14 to 23	1.36	.88
1	24 to 34	1.46	1.06
A	35 to 47	1.72	1.23

The prices given in the Commerce Reports are reported in Argentine pesos per kilo but have been changed to United States currency, per pound, on the basis of 1 peso = 44 cents and 1 kilo = 2.2 pounds.

BRAZIL.

Mica has been found in the contiguous States of Bahia, Goyaz, Minas Geraes, and Sao Paulo, Brazil. According to a report [2] by Vice Consul Richard P. Momsen, Rio de Janeiro, the States of Goyaz and Minas Geraes contain especially valuable deposits in the neighborhood of Bicas and the city of Santa Luzia de Carangola, on the Leopoldina Railway, and near San Domingos de Rio de Peixe, in the municipality of Conceicao. The most valuable deposits in the State of Goyaz are found in the municipality of Meia Ponte.

In Sao Paulo deposits of mica have been discovered in Bananal, Itapecerica, Paranahyba, San Bernardo, and Juquie. The mines at Juquie, in the neighborhood of Itapecerica, are mostly near the Government railway between Itapecerica and Prainha, in the neighborhood of Iguape at the point where the railroad crosses Juquie River. Very important mines are situated on the right side of Braco Grande River, 11 miles south of the village of Juquitiba.

It is stated that the Brazilian mica industry should prove to be very lucrative, for, properly prepared, the mica is well thought of in foreign markets. Considerable capital has been invested in the industry, and special attention has been given to the preparation, classification, and packing of the mica to meet the requirements of the foreign markets. It is said that one of the great difficulties in the development of this industry is the lack of transportation facilities to the distributing centers and ports of departure.

[1] Commerce Repts., Aug. 12, 1917, p. 970.
[2] Commerce Repts., Apr. 11, 1918, p. 148.

CANADA.

It is expected that considerable attention will be paid to the occurrences of white mica or muscovite in Canada. Nearly all the mica produced in Canada is phlogopite or amber mica, but numerous deposits of muscovite are known. It is also reported that a mill is to be established near Kingston to grind the very dark mica found in the vicinity, the ground mica being used in the roofing industry and as a lubricant in axle grease.

Revised figures of the production of mica in Canada show the output of 417 short tons for 1915 (instead of 515) and of 1,208 short tons for 1916 (instead of 984); the value was $91,905 for 1915 (instead of $89,387) and $255,239 for 1916 (instead of $177,763). The preliminary estimate [1] for 1917 gives no quantity, but the value, $350,732, is the highest ever recorded for the production of mica in Canada.

GUATEMALA.

Vice Consul D. E. Connor, Guatemala City, states [2] that the high price of mica has stimulated prospecting and development work in the mica zone in the departments of Quiche and Baja Verapaz, Guatemala. The pioneer in mica development work in Guatemala was the Guatemala Mining & Development Co., an American firm, which six years ago spent considerable money in the exploitation and development of mica properties in Quiche and Baja Verapaz. This company ceased active operations after mining only a small quantity of the mineral. Sarecky & Chellis, American operators, are to-day the principal shippers of mica from Guatemala. A number of small prospectors are endeavoring to develop mica properties, but owing to the difficulty of procuring labor and the lack of explosives (the importation of which is prohibited, except under special permit of the Guatemalan Government) the operators have not yet been able to produce in large quantity. Muscovite, ranging in color from white to rum, has been shipped heretofore in sizes from 2 by 2 inches to 10 by 12 inches. A deposit of greenish mica containing chromium exists near Salama, Baja Verapaz, and is owned by Rafael Aparicio, of Guatemala City.

Surface mining of mica in Guatemala, owing to the large waste incident thereto, costs about 25 cents a pound; railway transportation from the mines to Puerto Barrios, Guatemala, is $24 a ton, and ocean transportation, Puerto Barrios to New York, is about $20 a ton. Butcher & Baxter recently began prospecting and development work at El Chol, Baja Verapaz, and are now exporting mica, chiefly to New York. Exports within the last two years aggregated 12,000 pounds. The Guatemala Mining & Development Co. sent one shipment to London, England, and the remainder of the exports went in several shipments to Boston and New York, consigned by Sarecky & Chellis, of Guatemala City.

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[1] Preliminary report on the mineral production of Canada, 1917: Canada Dept. Mines Mines Branch Pub. 478, Feb. 26, 1918.

[2] Commerce Repts., p. 719, Aug. 23, 1917.

INDIA.

The estimated production of sheet mica in India in 1916 amounted [1] to 2,170 tons, valued at $531,638. According to the latest figures, India furnished nearly 67 per cent of the estimated world's production of sheet mica in 1916, which amounted to 3,245 short tons—India, 2,170 tons; United States, 433 tons; Canada, 604 tons; other countries, 38 tons.

MEXICO.

A small production of dark amber-colored phlogopite mica from a deposit near Guadalajara, Mexico, is reported. Associated rocks are said to be limestone, but it is not known whether the mica occurs in limestone or in calcite veins, such as are found in Canada. Small lots have been sent to the United States, but it is not thought that the locality will produce much mica of value.

PERU.

Vernon F. Marsters, geologic engineer, of Kansas City, Mo., has stated that he noticed a mica prospect some distance north of Mollendo (port of Arequipa), Peru. Some preliminary work had been done on a pegmatite dike and sheets of mica 9 inches square had been found. Most of the mica, however, would not exceed 4 inches square.

Several hundred pounds of mica is reported to have been exported from Peru to the United States in 1916 and 1917.

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[1] India Geol. Survey Records, vol. 48, pt. 2, 1917.

ASBESTOS.

By J. S. Diller.[1]

DOMESTIC OUTPUT.

CHRYSOTILE ASBESTOS.

The asbestos industry of the United States is in better condition than ever before, and the outlook is encouraging. Most of the asbestos that is used in the large asbestos factories of the United States comes from Canada, but the growing appreciation of American fiber is a welcome feature.

The total quantity of domestic asbestos reported to the Geological Survey as sold in 1917 was 1,683 short tons, valued at $506,056, an increase in quantity of 204 short tons and in value of $57,842, representing about 13 per cent in both quantity and value of the product marketed in 1916.

The average price for the whole country of all grades of asbestos, both crude and mill fiber, was $301 a short ton, practically the same as the average price for 1916. This average price is in strong contrast to the corresponding price of Canadian fiber, which in 1916 was $38.97 and in 1917 was $50.04 a short ton. This marked difference in the average price in the two countries is due to the larger proportion of crude fiber shipped without milling in the United States. In the United States nearly half of the total output is crude fiber, but in Canada less than a twentieth part is crude fiber.

The asbestos produced in the United States in 1917 came from Arizona, California, Georgia, Idaho, Maryland, Virginia, and Wyoming.

ARIZONA.

The greater portion of the total output of asbestos in the United States comes from Arizona, and the two producing localities are indicated upon the accompanying map (fig. 5), one northeast of Globe on Ash Creek and the other north of the Roosevelt Reservoir in the Sierra Ancha. Asbestos was first discovered in Arizona in the Grand Canyon, where there are two localities, also indicated on the map. Good samples of asbestos have been reported from Kingman, but the locality is not known to the writer, although rocks similar to those associated with asbestos are known to occur in that region. The asbestos of Arizona is serpentine in the form of chrysotile of the

[1] The statistics for this chapter were prepared by Miss H. M. Gaylord, of the United States Geological Survey.

cross-fiber type and the veins occur in cherty limestone containing forms which C. D. Walcott regards as fossil algæ of Algonkian age.

Sierra Ancha deposits.—One of the best localities in which to study the asbestos in relation to its associated rocks is in the Sierra Ancha, whose structure is illustrated in figure 6.

The mine of the American Ores & Asbestos Co. is situated on the outcrop of the limestone (e, fig. 6). A number of tunnels have been

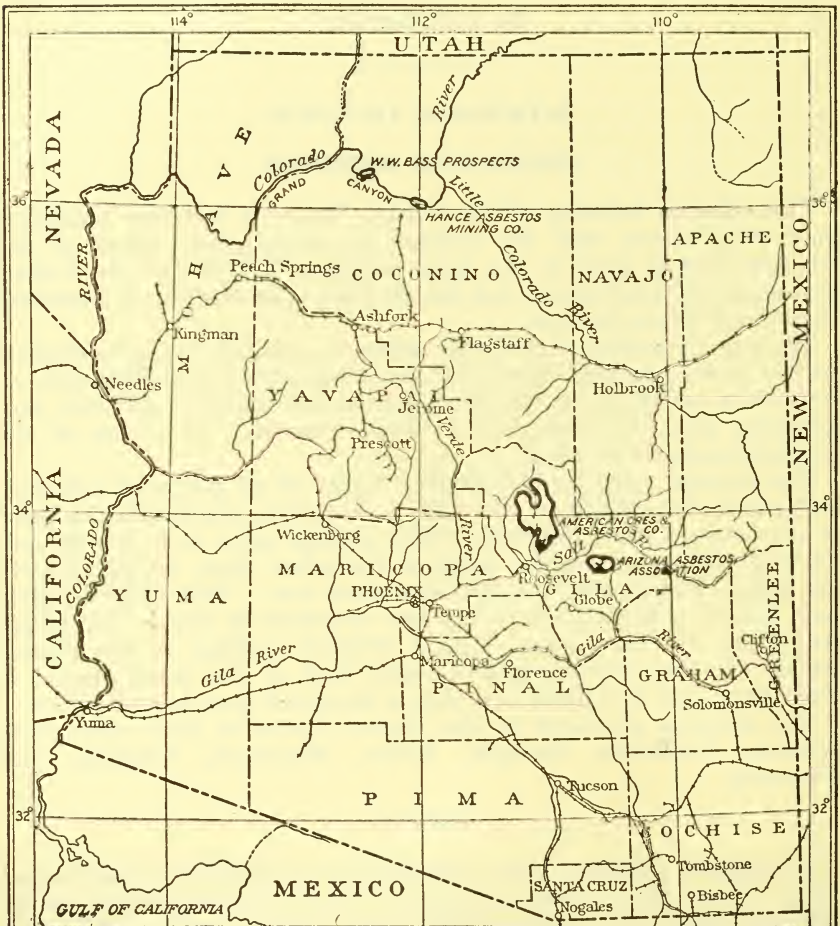


FIGURE 5.—Map showing distribution of asbestos mines and prospects in Arizona.

run in along the asbestos veins, of which there were two horizons in the upper part of the limestone, near the summit of Mount Baker. The mine was opened in 1917 by Charles F. Sloane. It is still without a mill and ships only spinning fiber, which is sent to the United States Asbestos Co., of Lancaster, Pa. The cross-fiber veins of asbestos are practically parallel to the stratification of the limestone. Mount Baker is one of the local names applied to the south end of the Sierra

Ancha and, as shown in figure 6, is generally capped by thick horizontal sandstones (a and b), beneath which extends the asbestos-bearing limestone intruded and split by the great sill of diabase (f). The upper surface of the diabase is irregular. In some places the diabase cuts up through the limestone and completely envelops large fragments of it. At such places the limestone may be fissured and asbestos is likely to be most abundantly developed.

The southern portion of the Sierra Ancha is essentially a plateau, whose border is deeply cut by the tributaries of Coon Creek and Cherry Creek on the east, as well as by the branches of Sallymay and other creeks that flow into Roosevelt Reservoir on the west. Upon this serrated border the limestone and diabase contact is locally well exposed, especially upon the east side and toward the head of Cherry Creek, where deposits of asbestos have been prospected and claims

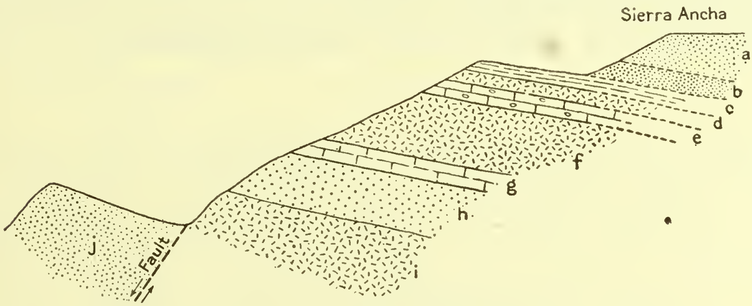


FIGURE 6.—Section of the slope of Sierra Ancha (Mount Baker), northeast of Roosevelt Reservoir, Gila County, Ariz.

a. Gray sandstone.
b. Red sandstone. (a and b together are nearly 1,000 feet in thickness and form the flat summit of Mount Baker.)
c. Red and gray thin-bedded, locally fine-banded siliceous strata. In places near bottom contain a limy bed, 40 feet in estimated thickness.
d. Diabase sill, 5 to 12 feet thick.
e. Chiefly gray limestone, 25 to 30 feet thick. Contains cross-fiber veins of asbestos in irregular and nodular belts of serpentine parallel to the stratification. The most valuable serpentine belts containing asbestos veins are near the top and bottom of the limestone, near the diabase contact, although such belts may occur within the mass. Some of the cherty nodules of serpentine are supposed to be fossils of Algonkian algae.
f. Diabase sill, 500 feet thick.
g. Gray banded, somewhat cherty limestone, 150 feet thick. Contains, especially near the top, small veins of asbestos and nodules of serpentine. The two limestones (e and g) belong to the same mass split apart by the intruded sill of diabase (d).
h. Reddish quartzite and siliceous beds, 200 feet in thickness, limited below by diabase (i), which appears to be separated from sandstone (j) by a fault.

located over a wide stretch of country. The writer was unable to reach the deposits of the Cherry Creek country in 1917, but the specimens sent from that locality and the outcrops on the eastern slope of the Sierra Ancha indicate the probability that deposits of considerable size may occur in that region.

Ash Creek deposits.—The best-known and one of the most productive asbestos localities in the United States is on Ash Creek, where the mine of the Arizona Asbestos Association, under the superintendence of N. A. Nelson for the H. W. Johns-Manville Co., has been in successful operation for several years. The company employs about 50 men and, when visited by the writer in September, 1917, was working night and day. Most of the fiber is carefully cobbed and bagged as crude Nos. 1 and 2, but a considerable part is run through a small mill consisting of a Blake crusher, cyclone screens, and sorters, making four grades of mill fiber in addition to the two grades of crude, which constitute the larger portion of the shipments and which is hauled by trucks 42 miles to the railroad at Rice or is packed about the same distance by burro train to Globe.

The relations of the rocks at Ash Creek are essentially the same as in the Sierra Ancha, although there is a wide difference in details. In a very general way figure 7 represents the relation of the diabase (a) intruding the limestone (b) and developing the three or more horizontal bands of cross-fiber asbestos veins (c). The limestone is overlain by sandstone (d). In the Ash Creek region the asbestos veins occur near the diabase, for the most part in the lower portion of the limestone, but at one place Mr. Nelson called the writer's attention to commercial pits in limestone overlain by diabase.

The limestone upon the east side of Ash Creek is much broken and dislocated by the irregular, roughly dikelike mass of diabase, and the greatest amount of fiber generally occurs where the irregularities or uprisings of the diabase contact are most pronounced.

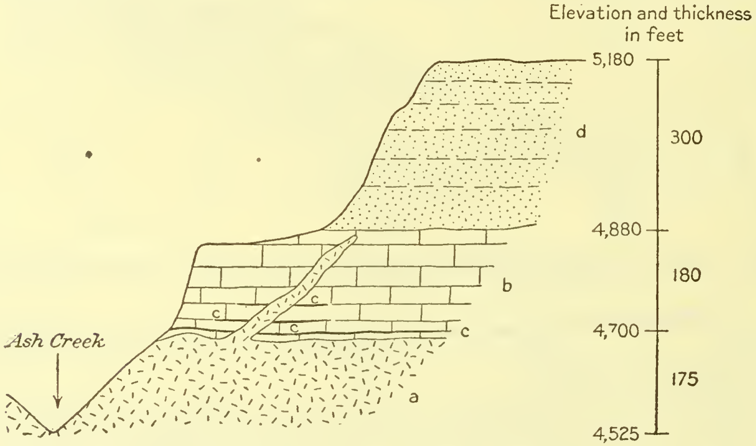


FIGURE 7.—Section of the eastern slope of Ash Creek, Ariz.

Two prominent veins of asbestos commonly occur within about 5 feet of each other, and both of them can be worked from the same tunnel. In such occurrences the asbestos may constitute as much as 5 per cent of the total rock removed in running the tunnel. In general, however, the commercial fiber is less than 1 per cent of the rock removed.

The Ash Creek mine has a total length of more than 7,000 feet of underground workings. The longest tunnel penetrates the canyon wall for about 600 feet and passes through portions of diabase intruding the limestone from below.

North of the Ash Creek mine, near Salt River, prospects are being developed by the Penn Asbestos Mining & Refining Co., the Colorado-Arizona Asbestos Mining Co., and others, all of which have taken out small quantities of asbestos for testing but have not yet reached regular production.

Origin of the asbestos.—There is a common belief among those who have had much experience in mining asbestos in Arizona that it is most abundantly developed near the surface of the ground and decreases more or less regularly as the distance increases from the surface into the canyon wall. However, there has not yet been sufficient detailed observation to establish fully this view, the tendency of which, as advocated by C. W. Barnard in unpublished work, is to connect the deposition of the asbestos more or less directly with the present lines of drainage.

On the other hand, the constant association of the asbestos and limestone near its contact with diabase strongly suggests that the serpentine and asbestos are the result of hydrothermal metamorphic action of the intruding diabase upon the limestone. The fact that the asbestos is generally found in greatest abundance in fissured limestone, where the heated waters of the intruding diabase may have penetrated the limestone and converted it into serpentine and asbestos, lends support to this view.

It is gratifying to know that those most interested in the asbestos of Arizona are not mine promoters and speculators but large consumers of asbestos, who appreciate its value and are developing its resources with intelligent care.

WYOMING.

About 28 miles south of Lander, Wyo., the American Fireproofing & Mining Co. is operating an asbestos mine of unusual scientific interest. It is the locality prospected by William Price in 1914.[1] The asbestos is chrysotile, in part of spinning grade, and occurs in cross-fiber veins along the contact of a dike of pyroxenite or its alteration product, serpentine, and gneissoid rocks or schists that are generally micaceous. The dike has a width of 400 feet. On the northwest a mass of gneissic schist, 400 feet wide, separates the pyroxenite or serpentine from a large mass of younger granite. On the southeast there is a thin layer of schist between the serpentine and the quartzite. The serpentine includes fragments or lenses of the micaceous schist, and asbestos has been formed locally about these inclusions, as well as on both sides of the serpentine dike. The northwest contact has been prospected to a depth of 70 feet and horizontally for 250 feet, and a crosscut is being made to connect the sides. The fiber ranges from one-sixteenth to 1⅛ inches in length, and the veins are parallel to the contact, giving the serpentine contact belt a ribboned or banded structure for a thickness of 1½ to 3 feet. In places the asbestos rock is replaced by a black deposit resembling manganese ore, but the sample examined reacted only for iron. The yield of commercial asbestos in the banded belt along the contact is generally small, although of sufficient importance to merit careful attention, for this locality has already yielded considerable asbestos, of which some has been spun into yarn and wicking of good quality.

CALIFORNIA.

The John D. Hoff Asbestos Co., of Oakland, and the Sierra Asbestos Co., of Washington, Nevada County, Cal., reported a larger production of asbestos in 1917 than in 1916. The output in 1917 was obtained in Nevada and Inyo counties. That in Nevada County

[1] Spencer, A. C., U. S. Geol. Survey Bull. 626, pp. 18-19, 1916.

is chrysotile, in part of spinning grade. A mill with a capacity of 15 tons a day is in course of construction and a production of three grades of mill fiber, as well as some spinning fiber, have been reported sold. Notwithstanding its convenient location as to transportation, there was no production on Mears Creek in Shasta County in 1917. The prominent vein of slip-fiber amphibole might well supply material for a small trade in chemical filters.

AMPHIBOLE ASBESTOS.

MARYLAND.

A small production of amphibole slip-fiber asbestos has been developed recently in Maryland by the Powhatan Mining Co., of Woodlawn, Baltimore, to meet a demand for filters. Formerly the supply of asbestos for Gooch filters was imported from Italy. The veins operated upon thus far in Maryland are in the softened, weathered portion of the gneissoid schists of Harford County, a few miles north of Pylesville. The slip-fiber veins are generally small and the usable portions limited to the disintegrating residual material within 10 feet of the surface. Along fault planes, however, where the movement producing slip-fiber amphibole has been more intense and of greater extent with deeper weathering, suitable fiber may extend to greater depths. The fiber is shipped in bags to Woodlawn, where it is cleaned, prepared, and separated into a number of grades for the market.

VIRGINIA.

Virginia produces a small quantity of amphibole fiber consumed in the manufacture of tenax, a preparation used by dentists.

GEORGIA.

In Georgia two companies were active, the Sall Mountain Co., of Chicago, operating in White County, and the American Mineral & Grinding Co., of Atlanta, operating in Habersham County. The asbestos mined is for the most part of the mass-fiber type of amphibole, which has the advantage of yielding a larger proportion of available fiber, as compared with the amount of rock removed, than any other type of asbestos, although the usable part of the rock is confined to that which is more or less softened by weathering.

IDAHO.

The mass-fiber anthophyllite in the vicinity of Kamiah, Idaho, has been mined by the Kamiah Asbestos Manufacturing Co. For some years a small output has been shipped to Spokane to be used for pipe covering, plaster, and other local purposes.

PRICES.

On account of the increased demand for asbestos, prices have continued to advance, especially for the Canadian fiber, the prices for which in New York are given below.

Range of New York prices per short ton for Canadian chrysotile fiber, 1913–1917.

	1913	1914	1915	1916	1917
No. 1 crude	$320–$350	$350–$375	$350–$400	$350–$1,250	$700–$1,500
No. 2 crude	200– 225	225– 250	225– 275	250– 900	500– 900
No. 1 fiber	100– 125	100– 125	110– 150	150– 350	150– 450
No. 2 fiber	75– 100	75– 100	80– 125	75– 150	75– 150
Shorter fibers	10– 30	10– 30	10– 30	15– 60	18– 75

IMPORTS.

The chief source of supplies for the large manufacturers of asbestos in the United States is in imports mostly from Canada. The total imports of unmanufactured asbestos in 1917 were 134,108 short tons, an increase of 15 per cent over the imports of 1916 and nearly eighty times the production of the United States in 1917. The greatest actual increase was from Canada, 16,547 short tons, or 14 per cent. The greatest percentage increase, however (105 per cent), was from British and Portuguese South Africa. This overbalanced the decrease from England, whose asbestos was presumably reshipped from South Africa. The use of South African asbestos in the United States is growing, not only on account of its good quality but on account of its greater variation in mineral and chemical composition and consequent greater adaptability to different purposes.

Asbestos imported into the United States in 1916 and 1917.[a]

Country.	1916			1917		
	Unmanufactured.		Manufactured (value).	Unmanufactured.		Manufactured (value).
	Quantity (short tons).	Value.		Quantity (short tons).	Value.	
British South Africa	112	$10,625		1,791	$168,204	
Canada	114,978	3,069,617	$1,841	131,525	4,148,217	$13,495
Colombia			109			
England	1,072	223,228	119,123	296	65,651	40,449
France			10,762			8,428
Germany			100			
Japan			298			
Italy			2,538			2,721
Portuguese Africa				496	139,100	
Scotland			293			3
	116,162	3,303,470	135,064	134,108	4,521,172	65,096

[a] Figures compiled from records of Bureau of Foreign and Domestic Commerce, Department of Commerce.

EXPORTS.

It is a matter of surprise that the United States, so small a producer and so large an importer, was also in 1917 an exporter of unmanufactured asbestos to the extent of 708 short tons, valued at $116,580, as is shown in the following table:

Asbestos exported from the United States in 1917.[a]

Country.	Ore and unmanufactured.		
	Quantity (short tons).	Value.	Average value per ton.
France	168	$19,650	$116.96
Canada	71	48,370	681.27
Panama	168	4,090	24.35
Cuba	30	3,000	100.00
Colombia	1	30	30.00
Japan	91	25,440	279.56
Australia	179	16,000	89.39
	708	116,580	164.67

[a] Figures compiled from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

The United States is an especially large manufacturer of asbestos. Although it imported manufactured asbestos in 1917 to the value of $65,096, after supplying the vast needs of the country, it exported manufactured asbestos to the value of $1,932,071 to 62 countries, among which Canada, Cuba, and England took the largest amounts.

SAND-LIME BRICK.[1]

By Jefferson Middleton.

PRODUCTION.

The sand-lime brick industry, contrary to indications at the beginning of the year, showed decrease in both output and value in 1917 compared with 1916. The causes for the decrease in output are not difficult to find. The principal cause was the general decrease in building activities; the scarcity of labor, likewise a general condition, was another cause, and transportation conditions may be cited as a third reason for this decline. The increase in the cost of production was reflected in the increased cost to the consumer of the principal product—common brick—of $1.11 per thousand, compared with 1916. Notwithstanding the decrease in the value of the sand-lime brick marketed in 1917 the value in that year was the greatest in the history of the industry with the exception of 1916. The number of operators (47) reporting marketed product in 1917 continued to decrease and was the smallest since 1903, the first year for which statistics were collected by the United States Geological Survey; but the average value of sales per active operator was $30,220, compared with $27,813 in 1916.

The decrease in the quantity of sand-lime brick sold in 1917 compared with 1916 was 39,798,000 brick, or nearly 18 per cent, but the decrease in value was only $53,743, or 4 per cent. Nineteen States reported sales of sand-lime brick in 1917, a decrease of two. Connecticut, Illinois, and New Jersey, which marketed brick in 1916 reported none for 1917, and Louisiana entered the list of producers. Twelve of the 18 States that reported marketed production in both 1916 and 1917 showed increase in value in 1917.

In 1917, as for many years, Michigan was the leading State in sales of sand-lime brick, reporting 26 per cent of the total output and value; Minnesota was second, as in 1916; and Wisconsin was third in output and New York was third in value. Common brick represented 98 per cent of the total output and value in 1917.

The average price per thousand for common brick in 1917 was $7.54, compared with $6.43 in 1916. For front brick the average price was $9.36, compared with $9.64 in 1916.

The following tables show the annual quantity and value of sand-lime brick sold since 1903, and the quantity and value in 1916 and 1917 by States. In 1917 less than three operators reported sales in each of 11 States, and therefore, in order to avoid the disclosure of confidential returns made to the Geological Survey, the figures for these States have been combined under "Other States."

[1] The statistical data in this report were prepared by Miss Katrine W. Cottrell.

Sand-lime brick sold in the United States, 1903–1917.

Year.	Number of operators reporting sales.	Quantity (thousands).	Value of product.	Year.	Number of operators reporting sales.	Quantity (thousands).	Value of product.
1903	16	20,860	$155,040	1911	66	142,963	$897,664
1904	57	65,137	463,128	1912	71	178,541	1,200,223
1905	84	135,891	972,064	1913	68	189,659	1,238,325
1906	87	164,472	1,170,005	1914	62	172,629	1,058,512
1907	94	173,119	1,225,769	1915	56	179,643	1,135,104
1908	87	139,181	1,029,699	1916	53	227,344	1,474,073
1909	74	151,809	1,150,580	1917	47	187,546	1,420,330
1910	76	172,507	1,169,153				

Sand-lime brick sold in the United States in 1916 and 1917.

State.	1916			1917		
	Number of operators reporting sales.	Common brick.[a]		Number of operators reporting sales.	Common brick.[b]	
		Quantity (thousands).	Value.		Quantity (thousands).	Value.
California	3	347	3,337	(c)	(c)	(c)
Florida	4	15,350	90,794	3	14,397	95,158
Indiana	3	10,966	54,148	3	9,052	60,201
Massachusetts	3	16,255	110,333	3	15,351	127,695
Michigan	12	72,004	499,711	11	47,998	370,723
Minnesota	4	28,975	178,828	3	23,672	152,531
New York	3	15,821	109,037	3	15,535	130,626
Pennsylvania	3	16,838	94,328	3	11,042	83,123
South Dakota	3	3,996	32,139	(c)	(c)	(c)
Texas	3	6,214	45,092	3	7,376	65,102
Other States[d]	12	40,578	256,326	15	43,123	335,171
	53	227,344	1,474,073	47	187,546	1,420,330

[a] Common brick, except 3,501,000 front brick, valued at $33,733, made in California, Connecticut, Florida (973,000, valued at $8,276), Indiana, Michigan (888,000, valued at $7,815), New Jersey, North Dakota, Texas, and Wisconsin; and 175,000 fancy brick, valued at $2,700, made in California, New York, and Ohio.

[b] Common brick, except 3,739,000 front brick, valued at $35,011, made in Florida (1,631,000, valued at $13,889), Georgia, Idaho, Indiana, Louisiana, Massachusetts, Michigan (1,019,000, valued at $8,477), and Wisconsin.

[c] Included in "Other States."

[d] Includes 1916: Connecticut, District of Columbia, Georgia, Idaho, Illinois, Kentucky, New Jersey, North Dakota, Ohio, Washington, and Wisconsin; 1917: California, District of Columbia, Georgia, Idaho, Kentucky, Louisiana, North Dakota, Ohio, South Dakota, Washington, and Wisconsin.

SILICA (QUARTZ).

By Frank J. Katz.

INTRODUCTION.

Silica (SiO_2), which has been treated in these reports under the heading "Quartz" (including flint), occurrs in deposits of commercial importance in many different forms, such as vein quartz, as a constituent of pegmatites, as sand, sandstone, quartzite, or flint, as tripoli, and as diatomaceous (infusorial) earth. In some forms, such as rose, smoky, and amethystine quartz, it has value as gems. This chapter deals with silica of all kinds except gem quartz, silica used for making glass, and silica used in the form of sand, gravel, and crushed material for building, for concrete and mortar, for foundry and furnace work, and for cutting and grinding stone. Such material as is not here included is either gem material or sand, is commercially so designated, and is therefore considered in other chapters of Mineral Resources. Tripoli and diatomaceous earth are to a large extent consumed as abrasives and are considered in the chapter on abrasive materials.

USES.

Silica (quartz) as considered in this chapter is used for many purposes, principally in the manufacture of pottery, paints, and scouring soaps, as a wood filler, as a polisher, and in metallurgical and chemical processes. In the pottery industry, where it is generally called flint, silica is used in the body of the ware to diminish shrinkage and is also used in glazes. Silica for use in pottery should contain less than 0.5 per cent of iron-bearing minerals. Manufacturers of paint use considerable quantities of very finely ground silica, which forms as much as one-third of the total pigment in some paints. For this purpose finely ground crystalline material is superior to fine sand in its natural state because of the angularity of the grains, which makes them adhere more firmly to the article painted and after wear affords a good surface for repainting. The same angularity makes artificially comminuted crystalline quartz superior to natural sand for use in wood fillers. For soaps and polishing powders ground material is preferred to natural sand on account of its whiteness and angularity. For all these purposes large quantities of pure quartz sand and sandstone are finely ground and yield a product fully equal to that obtained by grinding massive crystalline quartz.

Quartz crushed and graded to various sizes is used in making sandpaper and sand belts, as a scouring agent, for "frosting" glass with sand-blast apparatus, and for other purposes. Blocks of massive quartz and quartzite are used in the chemical industry as a filler for acid towers and as a flux in copper smelting. Ground quartz is also used in filters and in tooth powders and by dentists as a detergent.

Sand and crystalline quartz have been used in making silicon and alloys of silicon with iron, copper, and other metals in the electric furnace. Quartz may be fused in the electric furnace to make chemical apparatus, such as tubes, crucibles, and dishes.

The material known commercially in the United States as tripoli, which is the siliceous residue of decomposed limestones, also yields an excellent grade of pulverized silica, which is used for the same purpose as silica powder obtained from massive crystalline quartz and from sands and sandstones. Diatomaceous (infusorial) earth is also used to make polishing powder that is employed for similar uses to those for which quartz, sand, and tripoli powders are employed, but diatomaceous earth has somewhat different properties and most of it finds different application, as insulating and filter material.

PRODUCTION.

The reports to the United States Geological Survey on the production in 1917 of silica for various uses considered in this chapter are summarized in the following table. The combined output of these materials increased 187 per cent in quantity and 68 per cent in value in 1917, as compared with 1916.

Silica sold for pottery, paints, fillers, polishers, abrasives, and other uses in 1915, 1916, and 1917.

Material.	1915		1916		1917	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Quartz (vein quartz, pegmatite, and quartzite)	112,575	$273,553	88,514	$242,786	142,673	$318,069
Sand and sandstone [a]	95,461	386,261	110,603	489,863	532,454	1,195,142
Tripoli	30,711	128,957	43,257	215,216	26,069	92,416
Diatomaceous earth [b]	4,593	38,517	2,721	26,337	3,033	31,368
	243,340	827,288	245,095	974,202	704,229	1,636,995

[a] Includes only finely ground material. Figures probably incomplete.
[b] Excludes California product used for filters and as insulating and fireproofing material.

SILICA INDUSTRY BY STATES.

Alabama.—Silica was produced by one firm operating at Tredegar, Calhoun County, Ala., in 1917. The material quarried is a soft siliceous residue somewhat like the tripoli mined in Missouri and Illinois.

Arizona.—One firm reported production in Arizona in 1917. The material was quartzite used for furnace linings.

California.—Vein and pegmatite quartz was produced in California in 1917, in Amador, Eldorado, Placer, and Riverside counties. There were five active producers during the year, of whom four marketed crude quartz and one ground quartz at a mill in Los Angeles. The prices for crude quartz ranged from $2 to $3.25 a long ton; ground quartz sold for about $11 a short ton. The California output of silica is used in the manufacture of glass, filters, soap, scouring and cleansing mixtures; for pottery, tile, and enamel ware, and in metallurgical furnaces. California also produced large quantities of diatomaceous earth.

Connecticut.—No report on production of quartz in Connecticut has been received for 1917. Connecticut produced some silica in the form of diatomaceous earth.

Illinois.—Illinois produced a large quantity of sand and sandstone, of which 51,567 short tons, valued at $268,393, was ground in 1917, and resold for use in pottery, paint, and in foundries. Three companies reported grinding, one at Oregon in Ogle County, and two at Ottawa in La Salle County. Illinois also contributed heavily to the silica supplies of the country from the tripoli deposits in Alexander and Union counties.

Maine.—Quartz was produced from pegmatite by one company operating at Cathance in Sagadahoc County, Me.

Maryland.—In Maryland six firms, five of which are grinders, reported production in 1917. The material was obtained from veins in pegmatites in Carroll, Cecil, and Harford counties. Crude quartz sold at $4 to $5.10 and crushed and ground quartz at $6 to $12.40 a ton. Maryland also produces diatomaceous earth.

Massachusetts.—In Cheshire, Berkshire County, Mass., large quantities of quartzite are quarried and crushed, chiefly for use as "glass sand." This output is reported in the chapter of this volume on sand. Two companies marketed quartz from the Cheshire region for use as an abrasive, and for use in the manufacture of soaps, pottery, and paint.

Michigan.—In Michigan there was one producer in 1917, as in previous years, with mine and mill at Ishpeming, Marquette County, and another mill at Milwaukee, Wis. The product of this mill is derived from vein quartz and is used chiefly in making paint and wood filler but also as a polisher.

Nevada.—A milling plant was reported in process of construction near Beatty, Nye County, Nev., where a pure quartzite is to be quarried and prepared for use in making glass, soap fillers, paint, enamel ware, etc.

New Jersey.—There was a large output of sand from Camden County, N. J., in 1917. This sand was ground in Pennsylvania for use in pottery, scouring soaps, and mold wash.

New York.—One quartz quarry at Bedford, Westchester County, N. Y., was operated in New York in 1917. The product was ground in Connecticut and used in making pottery, paint, wood filler, and soap.

North Carolina.—Quartz was quarried near Mount Holly, in Gaston County, and at Troy, in Montgomery County, N. C., in 1917. The output was largely used for packing acid towers; part was ground and otherwise prepared for use in the manufacture of acid-proof cements.

Ohio.—No production of quartz was reported from Ohio in 1917, but large quantities were ground in the State and sold to local potteries and other manufactories.

Pennsylvania.—In 1917 quartz was marketed by three producers in Pennsylvania, one in Adams County, operating a quartz grinding mill, and two in Chester County. Quartz sand and sandstones used for other purposes than those here considered are mined and milled in the State and much of the product here considered as originating in other States was ground in Pennsylvania.

Tennessee.—In 1917 Tennessee produced a large quantity of quartz, but the material was of comparatively low grade and of small value. It was used by the Tennessee Copper Co. as flux in copper smelting.

Virginia.—Material (said to be vein quartz) obtained at Mendota, Washington County, Va., in 1917 was marketed for use in polishing and cleansing compounds, in Bristol, Tenn.

West Virginia.—One producer at Berkeley Springs and one at Hancock, Morgan County, W. Va., ground sand and sandstone for use in the manufacture of pottery, scouring soaps, paints, for mold wash, and for the manufacture of fused silica ware.

Wisconsin.—One firm operating in Flieth, Marathon County, Wis., produced quartz in 1917. The product is derived from a very pure quartzite and is used for filter beds, for roofing, for concrete work, for chicken grits, and for sandpaper.

FLINT OR CHERT.

PRODUCTION.

So far as can be learned no true flint or chert has been produced for consumption as crushed or ground silica in grinding mills in the United States. The manufacture of flint, chert, and quartzite blocks for tube mill lining is reported in the chapter on abrasive materials.

IMPORTS.

The Department of Commerce records imports of " flint, flints, and flint stones, unground," from several countries. These imports are partly flint pebbles for use in grinding mills and partly material for such uses as are listed in this report. The accurate separation or classification of these materials, which are represented by the following figures is impossible, but estimates for 1917 indicate approximately 1,500 long tons of flint imported for use as ground silica in ceramic wares. The imports of flint "for consumption" into the United States in 1917 were valued at $197,156, compared with $313,120 in 1916, $274,904 in 1915, $432,694 in 1914, and $324,662 in 1913. A detailed table of imports of flint pebbles of various kinds, by countries, and a discussion of domestic substitutes for foreign flint pebbles, is given in the chapter on abrasives in Mineral Resources for 1917.

QUARTZ.

PRODUCTION.

Quartz from quartz veins, pegmatite, and quartzite, amounting to 142,673 short tons, valued at $318,069, was sold in 1917. This was an increase of 61 per cent in quantity and 31 per cent in value as compared with 1916. The increase in quantity was entirely in the quantity sold crude or merely coarsely crushed and graded. The total values of both crude and ground material were larger than in 1916. The quartz or silica here considered was produced in California, Maine, Maryland, Massachusetts, Michigan, New York, North Carolina, Pennsylvania, and Wisconsin.

The prices of crude quartz in 1917 ranged from $2 to $5.10 a long ton and (exclusive of large quantities used in copper smelting and foundry work, valued at between 45 and 85 cents a ton) averaged $3.25, as compared with $2.37 in 1916 and $3.30 in 1915. Prices for ground quartz ranged from $6 to $14 a short ton and averaged $12.25, as compared with $9.09 in 1916 and $10.56 in 1915.

Quartz sold in the United States, 1910–1917.

Year.	Crude.		Ground.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1910	49,886	$80,984	13,691	$112,773	63,577	$193,757
1911	77,759	70,430	10,184	84,692	87,943	155,122
1912	82,205	67,256	15,669	124,429	97,874	191,685
1913	74,176	54,442	23,726	147,046	97,902	201,488
1914	123,508	88,820	29,893	271,682	153,401	360,502
1915	94,299	80,630	18,276	192,923	112,575	273,553
1916	70,417	78,283	18,097	164,503	88,514	242,786
1917	126,575	120,856	16,098	197,213	142,673	318,069

Vein and pegmatite quartz and quartzite sold in the United States, 1916–17, by States.

State.	Crude.		Ground.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1916.						
Arizona, Colorado, and Washington	2,639	$6,808			2,639	$6,808
California	5,648	11,533			5,648	11,533
Connecticut, Massachusetts, New York, and Pennsylvania	3,044	12,507	7,262	$84,758	10,306	97,265
Maryland	4,482	13,428	2,721	18,284	7,203	31,712
Michigan, Wisconsin, and Virginia			8,114	61,461	8,114	61,461
North Carolina, Tennessee, and Virginia	54,604	34,007			54,604	34,007
	70,417	78,283	18,097	164,503	88,514	242,786
1917.						
California, Michigan, and Wisconsin	7,065	14,914	7,018	63,134	14,083	78,048
Maine, Massachusztts, New York, and Pennsylvania	115,193	90,140	5,286	94,248	120,479	184,388
Maryland and North Carolina	4,317	15,802	3,794	39,831	8,111	55,633
	126,575	120,856	16,098	197,213	142,673	318,069

ABRASIVE MATERIALS.[1]

By Frank J. Katz.

INTRODUCTION.

Industrial operations employ a great variety of abrasive materials. This chapter is concerned with only those mineral products which, as such or as essential constituents of manufactured products, are used for grinding and polishing and other abrasive operations and as cleansers or detersives. The chapter contains statistics of production, as to both quantity and value, either of the raw material alone or of material that has not been advanced beyond that stage of manufacture at which it is sold by the mine or quarry operator.

Artificial abrasives are included for comparison and because of their strong influence on the industry and markets of natural abrasives.

The statistics here given are, so far as possible, of only that part of the production of any mineral material that properly enters into the abrasive industries. Thus only a small percentage of the sandstone quarried is used in the manufacture of abrasives, grindstones, and pulpstones, the remainder being used chiefly in the building industry. The segregation of the production is not difficult in this instance, but there is difficulty in separating the production of the diatomaceous (infusorial) earth which is used strictly for abrasive purposes from that which is used in manufacture of filters or of insulating or fireproofing material. Here the total production must be included.

On the other hand, quartz and feldspar, both of which are used as abrasives, are excluded from this discussion because the precise separation according to their uses of these materials can not be made, their principal uses being for purposes other than abrasive, and therefore they are considered in other chapters.

CONSUMPTION.

The total value of the abrasive materials which are considered in this report and which entered into trade in 1917 was $11,088,938. This was an increase of $5,932,840, or 115 per cent as compared with 1916. There was an increase in the value of domestic production of natural and artificial abrasives amounting to nearly 30 and to more than 177 per cent, respectively, and imports increased about 46 per cent in value.

Among the natural abrasives a large gain was shown in production of grindstones and pulpstones, and there were gains also in production of oilstones, scythestones, emery, pumice, pebbles for grinding, and

[1] Miss A. T. Coons and Mrs. L. M. Beach have aided in the compilation of statistics in this report. The data on imports and exports were compiled by J. A. Dorsey from the records of the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce.

tube-mill lining ("flint liners"). The reported outputs of diatomaceous earth and tripoli and of garnet and millstones were less than in 1916. The total estimated value of all abrasive materials consumed in the United States during the years 1908–1917 is given in the first of the following tables and the value of different abrasive materials imported into the United States for consumption in the last four years is given in the second table.

Value of all abrasive materials[a] consumed in the United States, 1908–1917.

Year.	Natural abrasives.	Artificial abrasives.	Imports.	Total value.
1908	$1,074,039	$626,340	$476,073	$2,176,452
1909	1,329,750	1,365,820	653,779	3,349,349
1910	1,406,805	1,604,030	977,718	3,988,553
1911	1,526,763	1,493,040	815,854	3,835,657
1912	1,601,993	1,747,120	898,892	4,248,005
1913	1,648,578	2,017,458	916,913	4,582,949
1914	1,360,042	1,685,410	728,710	3,724,162
1915	1,218,508	2,248,778	540,783	4,008,069
1916	1,664,339	2,935,909	555,850	5,156,098
1917	2,139,393	8,137,242	812,303	11,088,938

[a] Exclusive of feldspar and various forms of quartz. See chapters on feldspar and silica (quartz).

Value of abrasive materials imported for consumption in the United States, 1914–1917.

Material.	1914	1915	1916	1917
Millstones and burrstones	$15,000	$17,027	$19,816	$18,227
Grindstones and pulpstones	109,539	68,892	63,277	57,950
Hones, oilstones, and whetstones	33,655	14,247	10,614	10,636
Emery and corundum	383,436	271,649	240,737	210,602
Diatomaceous earth, tripoli, and rottenstone	20,004	27,333	37,573	17,864
Pumice	92,668	65,691	116,543	147,278
Diamond dust and bort	74,408	75,944	67,290	349,746
	728,710	540,783	555,850	812,303

NATURAL ABRASIVES.

Under the head of natural abrasives in this report are included (1) millstones and related quarry products, such as chasers and dragstones, (2) grindstones and pulpstones, (3) oilstones and scythestones, (4) corundum and emery, (5) abrasive garnet, (6) diatomaceous (infusorial) earth and tripoli, (7) pumice, and (8) pebbles and lining for tube mills. The difficulty of separating abrasive quartz and feldspar from the quartz and feldspar produced for other purposes has led to their omission from the chapter on abrasives, and such information as appears about them in Mineral Resources will be found in chapters entitled "Feldspar" and "Silica" (quartz).

Natural abrasives were produced in 1917 in 28 States, which are listed below:

Alabama............Millstones.
Arkansas............Oilstones.
California..........Diatomaceous (infusorial) earth, pumice, and grinding pebbles.
Connecticut........Diatomaceous (infusorial) earth.
Florida..............Tube-mill lining.
Illinois..............Tripoli.
Indiana..............Oilstones and rubbing stones.
Iowa.................Tube-mill lining.
Kansas...............Pumice.

Kentucky..........Hones and rubbing stones.
Maryland...........Diatomaceous (infusorial) earth.
Michigan............Grindstones and scythestones.
Minnesota..........Grinding pebbles and tube-mill lining.
Missouri............Tripoli.
Nebraska...........Pumice.
Nevada..............Diatomaceous (infusorial) earth and grinding pebbles.
New Hampshire.....Garnet and scythestones.
New York...........Millstones, emery, garnet, and diatomaceous (infusorial) earth.
North Carolina......Millstones, corundum, and garnet.
Ohio...............Grindstones, pulpstones, oilstones, scythestones, and rubbing stones.
Oklahoma..........Tripoli.
Pennsylvania.......Millstones and rottenstone.
Tennessee..........Tube-mill lining.
Utah...............“Mineral soap” and diatomaceous (infusorial) earth.
Vermont............Scythestones.
Virginia............Millstones and emery.
Washington.........Diatomaceous (infusorial) earth.
West Virginia.......Grindstones and pulpstones.

Value of natural abrasives produced and marketed in the United States, 1913–1917.

Abrasive.	1913	1914	1915	1916	1917
Millstones	$56,163	$43,316	$53,480	$44,559	$43,489
Grindstones and pulpstones	855,627	689,344	648,479	766,140	1,147,784
Oilstones and scythestones	207,352	167,948	115,175	154,573	168,704
Emery	4,785	2,425	31,131	123,901	[a] 241,050
Garnet	183,422	145,510	139,584	208,850	198,327
Abrasive quartz and feldspar	([b])	([b])	([b])	([b])	([b])
Diatomaceous (infusorial) earth and tripoli	285,821	252,327	[c] 167,474	[c] 241,553	[c] 123,784
Pumice	55,408	59,172	63,185	82,263	84,814
Grinding pebbles	....	....	....	42,500	72,191
Tube-milling lining	....	....	....	....	59,250
	1,648,578	1,360,042	1,218,508	1,664,339	2,139,393

[a] Including corundum valued at $67,461.
[b] See chapters on feldspar and silica (quartz).
[c] Exclusive of considerable production for special uses upon which the Survey is not at liberty to report.

MILLSTONES.

PRODUCTION.

The value of the millstones (burrstones) and related quarry products—chasers, dragstones, and pavers—sold in the United States in 1917 amounted to $43,489, a decrease of 2.4 per cent as compared with 1916 and of 18.7 per cent as compared with 1915. The production in this country in 1917 was less than in 1912, 1913, 1915, and 1916, but larger than in any other year of the decade.

The setback in the millstone market in the late eighties and nineties (see second table, next page) because of the introduction of modern grain-milling machinery has been offset to some extent in the last 20 years by the growing use of millstones for grinding mineral products, such as feldspar, quartz, and pigments.

American millstones have been and are still for the most part made of quartz sandstones and conglomerates. Some are made of granite. The production recorded in the Survey's reports on mineral resources is only that which has been made for other than purely local use. A small number of stones for local use have been made of hard quartz or other rocks, particularly in the mountain sections of the Southern States.

Millstones and chasers were produced in 1917 in Alabama, New York, North Carolina, Pennsylvania, and Virginia. Those are the only States that have produced them in recent years. The output increased 200 per cent in Alabama and 110 per cent in New York, but decreased 78 per cent in North Carolina, 2 per cent in Pennsylvania, and 26 per cent in Virginia.

Value of millstones produced and marketed in the United States, 1912–1917.

State.	1912	1913	1914	1915	1916	1917
New York	$34,246	$21,987	$16,748	$16,883	$10,287	$22,103
Virginia	25,866	23,530	20,100	23,170	25,752	18,980
North Carolina Pennsylvania Alabama	9,352 1,950	8,772 1,874	5,164 1,304	13,427	8,520	2,406
	71,414	56,163	43,316	53,480	44,559	43,489

Value of millstones produced and marketed in the United States, 1880–1917.

1880	$200,000	1893	16,639	1906	48,590
1881	150,000	1894	13,887	1907	31,741
1882	200,000	1895	22,542	1908	31,420
1883	150,000	1896	22,567	1909	35,393
1884	150,000	1897	25,932	1910	28,217
1885	100,000	1898	25,934	1911	40,069
1886	140,000	1899	28,115	1912	71,414
1887	100,000	1900	32,858	1913	56,163
1888	81,000	1901	57,179	1914	43,316
1889	35,155	1902	59,808	1915	53,480
1890	23,720	1903	52,552	1916	44,559
1891	16,587	1904	37,338	1917	43,489
1892	23,417	1905	37,974		

IMPORTS.

Imports of millstones for consumption in the United States in 1917 were little less than in 1916, larger than in 1915 and 1914, but less than in earlier years. In 1917 there was a slight increase in imports of material in the rough and a large decrease in imports of finished stones.

Value of burrstones and millstones imported for consumption in the United States, 1912–1917.

Year.	Rough.	Made into millstones.	Total.	Year.	Rough.	Made into millstones.	Total.
1912	$26,236	$1,326	$27,562	1915	$16,045	$982	$17,027
1913	36,276	3,922	40,198	1916	15,495	4,321	19,816
1914	14,291	709	15,000	1917	17,048	1,179	18,227

MILLSTONE INDUSTRY.

In this report for 1909 and for 1913 descriptive notes were given on the millstone industry in New York and Virginia. As the industry is one which undergoes little change from year to year, statements made in former reports may be consulted to supplement the data for 1917 in this report.

New York.—For many years Ulster County, N. Y., led in the production of millstones and chasers (stones which run on edge or on a horizontal shaft), but in recent years the State yielded first place to Virginia in production of millstones, although still leading in output of chasers. In 1917 New York regained first rank in total output. Eleven operators reported production of millstones in 1917.

Virginia.—Four operating firms or individuals reported production in Montgomery County, Va., in 1917.

North Carolina.—One operator in Rowan County, N. C., reported production of millstones in 1917.

Pennsylvania.—In Lancaster County, Pa., a quartz conglomerate which has been known to the trade as Cocalico stone is made into millstones. Two manufacturers reported production in 1917.

Alabama.—Near Dutton, Jackson County, Ala., millstones have been made from sandstones of Pennsylvanian age. A few stones were manufactured in 1917.

Vermont.—A quartz conglomerate rock similar to the New York Esopus stone is found near Fair Haven, Rutland County, Vt. No millstones have been made of this rock in recent years.

Ohio.—At Peninsula, in Summit County, Ohio, a white variety of the Berea grit was formerly quarried for the purpose of grinding oatmeal and pearling barley, for which it was said to be especially well adapted. At present no millstones are made from the Berea grit.

Other States.—In many other States stones of different varieties and more or less suitable for coarse work are or have been quarried and fashioned for use in local mills.

GRINDSTONES AND PULPSTONES.

The value of grindstones and pulpstones produced and sold in the United States in 1917 was $1,147,784. This was the largest annual output ever recorded and was an increase of $381,644, or nearly 50 per cent, as compared with 1916. The increase was in both quantity and value of both grindstones and pulpstones. The following table shows the quantity (short tons of grindstones and number of pieces or individual pulpstones) and value of the total domestic production from 1914 to 1917 and replaces the corresponding table in previous issues of this report in which only the value of the output, distributed as far as possible by States, was shown. Because of the small number of producers it is impossible to make complete separation by kinds of product and by States without revealing productions by individuals, and it seems, therefore, more desirable to recast the data to show separately the quantity and value of each product rather than merely the total values for producing States.

The States and the number of quarries producing grindstones in 1917 were: Michigan, 2; Ohio, 22; and West Virginia, 2. Ohio, as usual, maintained the leading position in the industry, the value of the output being between five and six times that of Michigan and West Virginia combined.

The production of grindstones in 1917 amounted to 54,432 short tons, valued at $806,896, an increase of 3,593 tons, or 7 per cent, in quantity and of $175,399, or nearly 28 per cent, in value, as compared with 1916.

From study of the data for 1914–1917 reported to the Geological Survey on value of quarry products manufactured into grindstones, it appears that the unit is commonly the value per short ton, which varies between 15 and 25 per cent, according to quality and size of stones, the smaller stones selling at prevailingly higher prices. Stones range from less than a foot in diameter and less than a pound in weight to 6 and 7 feet in diameter, 1 foot or more in thickness, and between 1¼ and 2 tons in weight. In 1917 the prices of fashioned stones not mounted, as reported by the quarry operators, ranged between $12 and $20, but were mostly between $13 and $18 a short ton. Prices were prevailingly about 15 to 20 per cent higher than in recent years. The average value of all grindstone material sold in 1917 was $14.82 a short ton.

Pulpstones are heavy grindstones used for grinding wood into fine fiber for making pulp and paper. The standard size of pulpstones for certain types of machine is 27 inches in thickness by 54 inches in diameter and about 2 tons in weight. Machines of other types require stones 54 inches in thickness by 62 inches in diameter and about 4 tons in weight.

The Canada Department of Mines published in 1917 a report entitled "Test of some Canadian sandstones to determine their suitability as pulpstones"[1] by L. Heber Cole, which will be of interest and value to the manufacturers and users of pulpstones.

Pulpstones in 1917 were made by the International Pulpstone Co., at East Liverpool, Columbiana County, Ohio; by the Smallwood Stone Co., at Empire, Jefferson County, Ohio, and at Opekeska, Monongahela County, W. Va.; and by the American Stone Co., at Littleton, Jackson County, W. Va. The total output was 2,325 stones, valued at $340,888, an increase of 234 per cent in the number of stones, as compared with 1914 and 1915, and of 118 per cent, as compared with 1916. This notable growth was probably largely, if not entirely, due to the difficulty and high cost of importing stones from Great Britain, as witnessed by the table of imports on page 219.

Grindstones and pulpstones produced and sold in the United States, 1914–1917.

Year.	State.	Grindstones.		Pulpstones.	
		Quantity (short tons)	Value.	Quantity (pieces).	Value.
1914	Michigan, Ohio, and West Virginia	48,272	$609,530		
	Ohio			697	$79,814
1915	Michigan, Ohio, and West Virginia	42,623	564,340		
	Ohio			696	84,139
1916	Michigan, Ohio, and West Virginia	50,839	631,497		
	Ohio			1,066	134,643
1917	Michigan, Ohio, and West Virginia	54,432	806,896		
	Ohio and West Virginia			2,325	340,888

Value of grindstones and pulpstones produced and marketed in the United States, 1908–1917.

1908	$536,095	1913	$855,627
1909	804,051	1914	689,344
1910	796,294	1915	648,479
1911	907,316	1916	766,140
1912	916,339	1917	1,147,784

[1] Canada Dept. Mines Bull. 19, Ottawa, 1917.

IMPORTS AND EXPORTS.

The value of the imports of grindstones and pulpstones decreased in 1917 to $57,950, which was nearly 9 per cent less than in 1916 and 16 per cent less than in 1915. The imports for the last six years and the exports for 1915, 1916, and 1917, are given below.

Value of grindstones and pulpstones imported for consumption in the United States, 1912–1917.

1912	$131,080	1914	$109,539	1916	$63,277
1913	139,386	1915	68,892	1917	57,950

The value of the grindstones exported from the United States in 1917 was $198,772, against exports valued at $176,563 in 1916 and $128,879 in 1915.

CANADIAN PRODUCTION.[1]

The following table showing quantity and value of grindstones, scythestones, and pulpstones produced in Canada in the decade 1908 to 1917 is inserted for comparison with the production in the United States and because the Canadian output is to some extent contributory to the domestic supply.

Grindstones, pulpstones, and scythestones produced in Canada, 1908–1917.

Year.	Quantity. (short tons).	Value.	Year.	Quantity. short tons).	Value.	Year.	Quantity. (short tons).	Value.
1908	3,843	$48,128	1912	4,412	$52,090	1916	3,478	$52,782
1909	4,275	54,664	1913	4,837	51,325	1917	2,279	44,037
1910	3,973	47,196	1914	3,976	54,504			
1911	4,566	52,942	1915	2,508	35,768			

OILSTONES AND SCYTHESTONES.

PRODUCTION.

The commodities here grouped include oilstones and whetstones, hones, scythestones, and rubbing stones. The production in the United States during 1917 amounted to $168,704, an increase of $14,131, or 9 per cent, as compared with 1916, and of $53,529, or 46 per cent, as compared with 1915. The value of the output has not yet risen to the magnitude attained prior to 1914.

Production of oilstones and whetstones was reported by seven quarry operators in the Hot Springs district of Garland County, Ark.; by three in Orange County, Ind.; and by one in Scioto County Ohio. Production of scythestones was reported by one quarry operator in Orange County, Ind.; by one in Huron County, Mich.; one in Grafton County, N. H.; one in Cuyahoga and one in Scioto counties, Ohio; and one in Orleans County, Vt. Rubbing stones were produced by one concern in Floyd County and one in Orange County, Ind., and one in Hardin County, Ky. The Kentucky Lith-

[1] From reports of Canada Dept. Mines.

ographic Stone Co., at Brandenburg, Meade County, Ky., obtained in the course of its quarry operations material from which it manufactured hones. The major part of the country's production, as reported to the Geological Survey, was oilstones and whetstones from Arkansas, and next in importance were scythestones from Vermont, Ohio, New Hampshire, and Michigan. The quantities and values of the several commodities produced in 1917 were as follows: Oilstones and whetstones 1,225 short tons, valued at $116,910; scythestones 7,209 gross (weighing approximately 400 short tons), valued at $31,745; rubbing stones 382,833 pounds, valued at $19,955; hones 9¼ dozen, valued at $94. The combined quantity was approximately 1,816 short tons. It is to be understood that the quantities and values are for quarry products, which are for the most part subjected to finishing and manufacturing processes and are thereby enhanced in value before being sold to consumers.

A description of the scythestone industry in New Hampshire was given in this report for 1909, and a description of Arkansas oilstones, oilstone deposits, and industry was included in the report for 1911.

Value of oilstones and scythestones produced and marketed in the United States, 1908–1917.

1908	[1] $217, 284	1913	[2] $207, 352
1909	[2] 214, 019	1914	[3] 167, 948
1910	[1] 228, 694	1915	[4] 115, 175
1911	[2] 214, 991	1916	[3] 154, 573
1912	[2] 232, 218	1917	[5] 168, 704

Value of hones, oilstones, and whetstones imported for consumption in the United States, 1912–1917.

1912	$45, 398	1914	$33, 655	1916	$10, 614
1913	40, 222	1915	14, 247	1917	10, 636

CORUNDUM AND EMERY.

SUPPLY.

Domestic supply.—Unusual demand for emery and corundum has arisen through expansion of metal and glass grinding industries, etc., on account of war requirements coincident with decreased importation of foreign corundum and emery. Artificial abrasives to a considerable extent supplant or can be substituted for corundum and emery, but not for all purposes and not without difficulty in changing shop practices and overcoming trade prejudices. Although the output of artificial abrasives has tremendously increased, the demand for emery and corundum has not been checked. It is, therefore, desirable to review the sources of supply of corundum and emery.

The important domestic sources of corundum are limited to deposits in Jackson, Macon, and Clay counties, N. C., and Rabun

[1] Includes a quantity of "rubbing stone" quarried in Indiana.
[2] Includes a quantity of honestone quarried in Kentucky and "rubbing stone" quarried in Indiana.
[3] Includes a quantity of honestone quarried in Kentucky and Pennsylvania and "rubbing stone" quarried in Indiana.
[4] Includes a quantity of honestone quarried in Kentucky and Ohio and "rubbing stone" quarried in Indiana and Ohio.
[5] Includes a quantity of honestone quarried in Kentucky and "rubbing stone" quarried in Indiana and Kentucky.

County, Ga. The corundum deposits in that region and in other parts of the Appalachian States have been described by Pratt.[1] There has been little activity in corundum mining in this region during the last three years. Deposits are numerous and ample for a considerable supply of corundum. Output from the region can not, however, be expected to increase largely or rapidly, because transportation facilities are poor, skilled labor is insufficient, and milling equipment is almost entirely lacking. One other region of prospective importance in production of corundum in the United States is in Gallatin County, Mont., where, however, there is little likelihood of development and production. These deposits have not been worked since 1905, when high freight rates and other difficulties stopped all activity.

The emery deposits of the United States of known importance are as follows: (1) Vicinity of Chester, Mass. There has been no production from this region since 1913 and indications are that supplies of good emery have been exhausted. (2) Peekskill district, N. Y. Emery deposits in the Peekskill district, N. Y., have been productive for many years and have responded promptly to the increased demand for emery since 1914. The production has risen in the last two years to ten to fifteen times the normal output of the last decade, and the district may be expected to continue for a few years at least an output of, roughly, 15,000 tons a year. (3) Emery deposits in Virginia have recently been investigated and development of them has been begun. They will probably contribute an important share of the domestic output.

Foreign supply.—The Canadian corundum deposits in central Ontario, which made large contributions to the world's supply from 1904 to 1914, have for various reasons been almost unproductive in the last three years. There appears to be a large supply of corundum remaining in that region, and if the difficulties of labor supply and milling equipment can be overcome, a considerable production may be made in 1918.

Corundum deposits in India are numerous and the supply probably very large. There appears also to be an abundant supply in the Transvaal, South Africa. Notable quantities were imported from India and South Africa during 1917, and importers are desirous of obtaining more. However, because of the needs of our allies and because of trade regulations and shipping difficulties, probably little Indian and South African corundum will be obtained during 1918. Madagascar is also an important prospective source of corundum, but imports from that island are subject to the same restrictions and difficulties.

Before the war, Turkish emery was the largest item in the domestic consumption of high-grade natural abrasives. Supplies from Turkey are, of course, completely cut off and will probably not be available during the course of the war. The best grades of emery come from the Greek island Naxos. The French Government has assumed control of the Naxos emery industry and has conserved the output largely for the use of French and British war industrues. Arrangements

[1] Pratt, J. H., Corundum, and its occurrence and distribution in the United States: U. S. Geol. Survey Bull. 269, 1906.

requiring action through the State Department have been made whereby Naxos emery may be imported for specified war uses.

Restrictions of the United States Shipping Board and the War Trade Board on importation of emery and corundum fixed the maximum quantity obtainable in 1918 at 4,000 long tons of Greek emery and 750 long tons of corundum from India and South Africa.

PRODUCTION.

In 1917 three operators—two in Macon and one in Jackson counties, N. C.—produced corundum, the combined output being 820 short tons, valued at $67,461.

The domestic production of emery in 1917 came largely from the Peekskill region in Westchester County, N. Y., and from Virginia. There was no production from the mines in Chester, Hampden County, Mass. The production in 1917 was 16,315 short tons, valued at $173,589 for crude emery f. o. b. mines. This output was about 7 per cent larger than the quantity produced in 1916, more than five times that of 1915, and more than thirty-five times that of 1914. The average value of the crude quarry product in 1917 was about $10.60 a short ton, an increase of $2.60, or 32 per cent, as compared with 1916. The following table shows the quantity and value of emery produced and sold in the United States from 1907 to 1916 and the combined output of emery and corundum in 1917.

Emery produced and sold in the United States, 1907–1917.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1907	1,069	$12,291	1911	659	$6,778	1915	[a] 3,063	[a] $31,131
1908	669	8,745	1912	992	6,652	1916	15,282	123,901
1909	1,580	18,185	1913	[a] 957	[a] 4,785	1917	[b] 17,135	[b] 241,050
1910	1,028	15,077	1914	[a] 485	[a] 2,425			

[a] Estimated. [b] Including 820 short tons of corundum, valued at $67,461.

IMPORTS.

The following table gives the quantity and value of the emery and corundum imported into the United States from all foreign countries during recent years. The year 1917 was marked by further decrease in the total value, higher prices notwithstanding, of imports of all forms of emery and corundum, amounting to nearly 12.5 per cent as compared with 1916, 22 per cent as compared with 1915, 45 per cent as compared with 1914; and 57 per cent as compared with 1913. The imports have fluctuated irregularly in both quantity and value during the last decade. Nevertheless, the figures for 1917, because of the war's interference with mining in Turkey and Greece and with shipping, are far lower than in any previous year and probably reached the lowest level as by the arrangements above noted provision has been made for larger imports in 1918.

Emery and corundum imported for consumption in the United States, 1910–1917.

Year.	Grains.		Ore and rock.		Other manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.	Value.	
	Pounds.		*Long tons.*			
1910	2,311,464	$106,570	28,918	$509,661	$13,527	$629.758
1911	1,382,813	76,027	10,822	245,459	15,158	336,644
1912	2,135,922	105,325	16,391	369,529	16,871	491,725
1913	2,496,372	114,786	17,123	342,809	16,704	474,299
1914	1,781,821	79,989	12,909	280,866	22,581	383,436
1915	1,277,673	56,254	8,462	197,303	18,092	271,649
1916	1,689,689	90,646	7,623	113,176	36,915	240,737
1917	2,207,912	119,033	1,056	50,087	41,482	210,602

CANADIAN CORUNDUM.

Canadian corundum shipped, 1912–1917.[a]

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1912	1,960	$239,091	1915	339	$37,798
1913	1,177	137,036	1916	67	10,307
1914	548	72,176	1917	[b] 188	[b] 32,153

[a] Figures taken from the annual reports on mineral production of Canada, Canada Dept. Mines.
[b] Preliminary report on mineral production of Canada during 1917, Canada Dept. Mines, 1918.

ABRASIVE GARNET.

PRODUCTION.

The quarry output of domestic garnet sold for use as abrasive material in the United States in 1917 amounted to 4,995 short tons, valued at $198,327. This was a decrease of 1,176 tons, or 19 per cent, in quantity and $10,523, or 5 per cent, in value, as compared with 1916, but an increase of 694 tons, or 16 per cent, in quantity and $58,743, or 42 per cent, in value, as compared with 1915. Prices ranged from $12 to $50, but were prevailingly $40 a short ton, $5 more than in recent years.

Abrasive garnet produced and sold in the United States, 1907–1917.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1907	7,058	$211,686	1911	4,076	$121,748	1915	4,301	$139,584
1908	1,996	64,620	1912	4,947	163,237	1916	6,171	208,850
1909	2,972	102,315	1913	5,308	183,422	1917	4,995	198,327
1910	3,814	113,574	1914	4,231	145,510			

TRIPOLI, DIATOMACEOUS (INFUSORIAL) EARTH, AND ROTTENSTONE.

TRIPOLI.

The material called tripoli in the trade in the United States is a white or yellowish, light, porous, and generally pure siliceous rock which has resulted from the leaching of calcareous material from very siliceous limestones or highly calcareous cherts. In origin, properties, and some of its uses tripoli is like "rottenstone," which is here classed with it.

Some tripoli from Missouri is and always has been produced primarily for use as an abrasive, but most of it is mined to be worked up into filter blocks of various shapes. The cuttings and waste from making filters are ground and prepared for abrasive and other uses. The Illinois product is generally called "silica" and is used in paint, wood filler, metal polish, in soaps, in cleansers, for making glass, tile, and enamel, and for facing foundry molds.

A definite statement of the exact proportion used as an abrasive has not been obtained from producers of tripoli, nor has any attempt been made to get at the production of rough tripoli blocks worked up into filter stones. Even if this output has been ascertained it would be impossible to value the product on a uniform basis and thus to obtain a reliable ratio between quantity and value, for the reason that the price of filter stones varies and is dependent not only on the size of the stones but also on the work done on each stone.

DIATOMACEOUS EARTH.

Diatomaceous earth, called also infusorial earth and kieselguhr, is a light earthy material which from some sources is loose and powdery and from others is more or less firmly coherent. It often resembles chalk or clay in its physical properties but can be distinguished at once from chalk by the fact that it does not effervesce when treated with acids. It is generally white or gray in color, but may be brown or even black when mixed with much organic matter.

Diatomaceous earth is made up of remains of minute aquatic plants and is composed, chemically, of hydrous silica.

Owing to its porosity it has great absorptive powers and high insulating efficiency and is an effective filter. The hardness, the minute size, and the shape of its grains make it an excellent metal-polishing agent.

Heretofore diatomaceous or infusorial earth has been largely used as an abrasive in the form of polishing powders and scouring soaps, but of late its uses have been considerably extended. Because of its porous nature it has been used in the manufacture of dynamite as a holder of nitroglycerin, but not recently in the United States. It is used by sugar refiners for filtering or clarifying. Its porosity also renders it a nonconductor of heat, and this quality in connection with its lightness has very greatly extended its use as an insulating packing material for safes, steam pipes, boilers, and metallurgic apparatus, in making insulating brick, and as a fireproof building material. In this country it is used in the manufacture of records for talking machines. In Europe, especially in Germany, infusorial earth has lately found extended application. It has been used in preparing artificial fertilizers, especially in the absorption of liquid manures; in the manufacture of water glass, of various cements, of glazing for tiles, of artificial stone; as a carrier of ultramarine and various pigments, aniline and alizarin colors; in filling paper; and in the preparation of sealing wax, fireworks, gutta-percha objects, Swedish matches, solidified bromine, scouring powders, papier-mâché, and many other articles.

ROTTENSTONE.

Rottenstone is a porous, generally loosely coherent product of the weathering and leaching of siliceous limestones. It is produced at only one locality in the United States, at Antes Fort, Lycoming County, Pa., by the Penn Keystone Co., of Williamsport, Pa. It is used chiefly as polishing and scouring material.

PRODUCTION.

Tripoli and diatomaceous (infusorial) earth have been combined for consideration in these reports for many years for the reasons (1) that, because of the confusion in names it was not expedient to make the separation in the earlier canvasses after the beginning of the production of what is now called tripoli, and (2) that uses of the materials as abrasives are in part the same. Since 1913 the production of diatomaceous earth has also been separately reported. Since 1913 the statistics of production of Pennsylvania rottenstone have been included with tripoli.

Diatomaceous earth and tripoli produced and sold in the United States, 1907–1917.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons)	Value.
1907	14,824	$104,406	1911	16,082	$147,462	1915 [a]	35,304	$167,474
1908		97,442	1912	16,706	125,446	1916 [a]	45,978	241,553
1909	18,680	122,348	1913	27,383	285,821	1917 [a]	29,102	123,784
1910		130,006	1914	28,230	252,327			

[a] Exclusive of considerable production for special uses upon which the Survey is not at liberty to report.

Tripoli produced and sold in the United States, 1915–1917.

State.	1915		1916		1917	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Illinois	23,756	$59,390	33,187	$82,968	16,133	$31,338
Missouri Other States [a]	6,955	69,567	10,070	132,248	9,936	61,078
	30,711	128,957	43,257	215,216	26,069	92,416

[a] 1915, Pennsylvania and Georgia; 1916 and 1917, Pennsylvania and Oklahoma.

Diatomaceous earth produced and sold in the United States, 1915–1917.

State.	1915 [a]		1916 [a]		1917 [a]	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Western States [b]	3,850	$25,865	1,840	$14,700	2,796	$25,570
Eastern States [c]	743	12,652	881	11,637	237	5,798
	4,593	38,517	2,721	26,337	3,033	31,368

[a] Exclusive of considerable production for special uses upon which the Survey is not at liberty to report.
[b] California, Nevada, and Washington, and Oregon in 1915; California, Nevada, and Washington in 1916; California, Nevada, Utah, and Washington in 1917.
[c] 1915: New Hampshire, Massachusetts, Connecticut, New York, Maryland, and Virginia; 1916: Connecticut, Maryland, Massachusetts, New Hampshire, and New York; 1917: Connecticut, Maryland, and New York.

Production of tripoli and rottenstone.—The marketed production of tripoli and rottenstone for all purposes in the United States in 1917 was 26,069 short tons, valued at $92,416, a decrease of 17,188 tons, or 40 per cent, in quantity and $122,800, or 57 per cent, in value, as compared with 1916. The preceding table—Tripoli produced and sold in the United States—shows an apparently large difference in price for tripoli as between Illinois and other States. The production in Illinois, Missouri, and Oklahoma is all of similar material, nearly uniformly valued in all the three States at $2 a ton f. o. b. quarries for crude quarried product. The Pennsylvania output, on the other hand, was of rottenstone, which is valued roughly at $27.50 a short ton. Much of the output in Illinois, Missouri, and Oklahoma was sold ground or, in Missouri, manufactured into filter stones. The prices received for ground tripoli or tripoli flour ranged from $9 to $15 a ton, and the value of filter stones ranged between $18 and $27 a ton.

In Illinois three mines in Alexander County and four in Union County reported production in 1917. The production was less than half that made in 1916, and the average value of crude material was very nearly $2 a ton. Most of the output was, however, sold in ground form at prices ranging from $12.50 to $15 a ton. In Missouri four operators reported production in Newton County. A large part of the output was made into filter stones and the scrap from manufacture of filter stone, together with the remainder of the output, was ground for sale as tripoli flour.

Thompson & Trimble, operating a quarry in calcareous shale at Plattsburg, Clinton County, Mo., produced a small quantity of powdered rock for abrasive material, which is combined with the tripoli output from Missouri. Oklahoma deposits of tripoli were not productive, except those of the American Tripoli Co., which are worked as part of its plant in Newton County, Mo., and therefore separate data for the two States are not available. The Pennsylvania production of rottenstone was made at Antes Fort, Lycoming County.

Production of diatomaceous earth.—The marketed production in the United States of diatomaceous earth (also called diatomite, infusorial earth, kieselguhr, tripoli, and tripolite, and sold under various trade names) amounted in part in 1917 to 3,033 short tons, valued at $31,368, besides which there was considerable production for special uses, upon which the Geological Survey is not at liberty to report.

In 1917 the producing States were California, Connecticut, Maryland, Nevada, New York, Utah, and Washington. It will be noted in the table showing production for 1915, 1916, and 1917, by Western and Eastern States, that the production in the Eastern States is valued at between two and three times as much as the western output. The difference is due to the fact that the eastern product was largely sold as high-grade cleansing and polishing preparations, whereas the western product was sold as raw quarry product or went into the manufacture of structural materials and insulation. The projected large developments based on the Maryland and Virginia diatomaceous deposits have not been carried out.

IMPORTS.

Value of tripoli, diatomaceous earth, and rottenstone imported for consumption in the United States, 1912–1917.

1912	$24,253	1914	$20,004	1916	$37,573
1913	28,696	1915	27,333	1917	17,864

PUMICE.

The domestic product sold as pumice has been, prior to 1917, almost wholly a finely comminuted volcanic dust or "ash" composed of minute fragments of pumiceous, glassy lava, not properly called pumice. This material differs inappreciably from the product made by grinding the imported lump or block pumice, for which it is a satisfactory substitute. The imported Italian pumice, which formerly constituted the bulk of the pumice used in this country, is a massive, very finely pumiceous and vesicular, glassy lava coming from the Lipari Islands, a volcanic group north of Sicily in the Mediterranean Sea. Very little pumice of this type had been obtained from domestic sources prior to 1917. In that year, largely because of the difficulty of shipping from Mediterranean ports, a considerable output of good grades of lump pumice was obtained from the vicinity of Mount Shasta and the Salton Sea in California. Efforts were also made to exploit deposits of fair lump pumice in Coconino County, Ariz. On May 15, 1918, an absolute embargo on overseas imports of pumice went into effect, so that for the current year (1918), at least, consumers will be dependent on stocks of Italian pumice remaining in this country and on domestic supplies. These domestic materials, both the pumice dust from the Great Plains region and the western lump, have been and should continue to be satisfactory for all requirements other than the most exacting, which demand lump of very fine, even texture, free from discrete mineral particles (phenocrysts). Not over 100 tons per annum of such lump are ordinarily required, chiefly for lithographic work and for fine finish on copper, silver, and other metals before plating. It is probable that these needs can also be met by careful selection from domestic supplies.

PRODUCTION.

The statistics given represent pumice used for abrasive purposes solely, and for 1917 are exclusive of an undetermined quantity of lump pumice from California. The pumice used for building stone and for cement and concrete construction work is not included. The material has come from several counties in six States—Inyo, Imperial, and Siskiyou counties in California; Harper, Morton, and Phillips counties in Kansas; Furnas, Lincoln, and Harlan counties in Nebraska; Custer County in South Dakota; Cassia and Power counties in Idaho; and Millard County in Utah. Available deposits are very widespread and are particularly abundant in all the Great Plains States from South Dakota to Texas. The Geological Survey received reports of production in 1917 from Imperial County, Cal.; Meade and Harper counties, Kans.; and Furnas and Lincoln counties, Nebr.

The pumice sold or used by these producers in 1917 amounted to 35,293 short tons, valued at $84,814, an increase of 1,973 tons, or or about 6 per cent, in quantity, and $2,551, or 3 per cent, in value, as compared with 1916. In 1917 California produced a small output, somewhat larger than in 1916; the Kansas production increased slightly over that of the preceding year and again far exceeded that from Nebraska, which for a number of years prior to 1916 had been the leading State. The Nebraska production was less in 1917 than in 1916.

Pumice produced and sold in the United States, 1910–1917.

Year.	Quantity (short tons).	Value.	Price per ton.	Year.	Quantity (short tons).	Value.	Price per ton.
1910	23,271	$94,943	$4.08	1914	27,591	$59,172	$2.14
1911	21,689	88,399	4.08	1915	27,708	63,185	2.28
1912	27,146	86,687	3.19	1916	33,320	82,263	2.47
1913	24,563	55,408	2.26	1917	35,293	84,814	2.40

IMPORTS.

Value of pumice imported for consumption in the United States, 1912–1917.

1912	$74,478	1915	$65,691
1913	93,408	1916	116,543
1914	92,668	1917	147,278

The records of the Department of Commerce show general imports for 1917 amounting to 7,985 long tons of "unmanufactured pumice stones" and "manufactures of pumice stone" valued at $65,252.

PEBBLES FOR GRINDING.

Pebbles used for grinding minerals, ores, cement ingredients and clinker, and other materials may be properly considered abrasive materials. This report prior to 1914 had not included them, because none had been produced in the country except for limited local use, of which no record was obtained, and also because the records of imports of foreign pebbles for grinding are not kept separate from those of pebbles which are crushed and used as "flint" in the ceramic industry. Chapters on quartz or flint in Mineral Resources have annually given the quantity of the imports of pebbles used both for grinding and as flint. Little or no interest had been taken in domestic sources of grinding pebbles until the fall of 1914, when the threatened interruption of imports from Denmark and France, the principal sources of foreign supply, aroused American jobbers and consumers to become independent.

DOMESTIC SUPPLY.

Information on domestic sources of flint or other pebbles for grinding and substitutes therefor is summarized in the reports on abrasive materials in Mineral Resources for 1914 and 1916. A recent publication[1] by the Survey describes pebble deposits in Pike, Howard, and Sevier counties, Ark.

In 1917, as in 1916, pebbles for grinding ores, minerals, and clinker were obtained from beaches between Oceanside and Encinitas, San Diego County, Cal. These were gathered and marketed by five or more firms and individuals, whose names and addresses may be obtained from the Geological Survey. These pebbles are gaining in favor in metallurgic and cement plants. Omer Maris, of Manhattan, Nev., continued through 1917 the manufacture of "artificial pebbles" (mechanically smoothed and rounded rock blocks) and supplied metallurgic plants in the vicinity of his plant. The Jasper Quarry Co. (now the Jasper Stone Co.), of Sioux City, Iowa, began a new enterprise during 1917—the manufacture for use as pebbles of 3-inch to 5-inch cubical blocks from the quartzite at its quarry in Rock County, near Jasper, Minn. These cubes are reported to be satisfactory, as they are both very hard and very tough and are said to wear very slowly after the corners and edges are chipped off. The company has been selling these in the rough, but expects to have, before the close of 1918, mills for rounding them before shipment.

PRODUCTION.

Sales of pebbles for grinding, cubes, and artificially rounded blocks amounted in 1917 to about 12,000 short tons, valued at $72,191, an increase of 100 per cent in quantity as compared with 1916. Besides this marketed output there was considerable consumption of substitutes for grinding pebbles by mills which used local pebbles or boulders, lumps of ore, or native rock.

IMPORTS.

The exact quantity of flint pebbles annually imported for use in grinding is not determinable from reports of the Department of Commerce, as only the total invoice value of imports of all kinds of pebbles combined is recorded.

In the accompanying tables are given the value both of imports "for consumption" and of "general" imports classified according to countries of origin.[2] Both groups of figures are of interest to the present discussion.

Value of pebbles and flint imported for consumption in the United States, 1910–1917.

1910	$307,286	1914	$432,694
1911	236,158	1915	274,904
1912	289,904	1916	313,120
1913	324,662	1917	197,156

[1] Miser, H. D., and Purdue, A. H., Gravel deposits of the Caddo Gap and De Queen quadrangles, Ark.: U. S. Geol. Survey Bull. 690, pp. 15-30, 1918 (Bull. 690-B).

[2] These figures are not identical, because merchandise brought into the country and listed under "general imports" may be put into a warehouse and not be withdrawn for consumption during the calendar year of entry. It is credited "for consumption" to the year of its withdrawal from the warehouse.

Value of general imports of pebbles and flint into the United States, 1913–1971.

	1913	1914	1915	1916	1917
Belgium	$40,947	$70,851			
British India				$2,440	
Canada	8,599	63,996	$1,128		
Denmark	134,625	193,029	152,129	175,916	$122,883
England	2,626	2,199	1,303		
France	121,854	116,571	91,024	117,649	65,311
Germany	2	91			
Italy		22			39
Japan		12	97	7,924	
Newfoundland and Labrador	10,800	8,448			
Norway		1,846		1,780	
Portugal				214	
Sweden	56	22,081	28,088	7,197	7,744
	319,509	479,146	273,769	313,120	195,977

Some statistical details for 1915, 1916, and 1917 have, however, become available through a canvass of importers made by the committee on mineral imports and exports of the United States Shipping Board. These data are not complete, but they seem to the writer to warrant the following estimates and deductions, for which he alone is responsible.

It appears that the imports in 1917 amounted to about 15,000 long tons, or a little less, a decrease of 16,000 to 17,000 tons, or 51 to 53 per cent, as compared with 1915 and 1916, in which years the imports probably amounted to 31,000 or 32,000 long tons. Of the estimated 15,000 tons imported in 1917, about 1,500 tons was not abrasive material, but was so-called "boulder flint" and pebbles from France to be used as "ground flint" or "silica" in ceramic industries. This material had an average value in 1917 of about $7.65 a long ton c. i. f. New York.

The remainder (about 13,500 long tons) of the imports in 1917 was for use as abrasive pebbles for grinding. Of this quantity about 5,700 long tons were shipped from Havre, France, where they were valued at approximately $12 to $13 a ton. About 7,800 tons were shipped originally from Copenhagen, Denmark, where prices ranged from $15 to $20 a long ton. The value of the pebbles at New York includes these figures plus the cost of importation.

On the basis of the best figures available the distribution of the imports in 1917 was probably as follows:

Distribution of imported grinding pebbles in 1917.

	Quantity (long tons).	Percentage.
To grinders of—		
Gold, copper, and other ores	6,350	47
Cement ingredients and clinker	3,400	25
Ceramic materials, feldspar, and silica	2,300	17
To tube-mill manufacturers	1,0[illegible]0	6
Miscellaneous[a]	400	3

[a] Includes metallurgic works; talc, graphite, and color grinders; other uses not specified.

TUBE-MILL LINING.

"Flint liners" for tube mills are dimension blocks cut from flint or other hard siliceous rock. Before the war almost the entire supply for domestic consumption was imported from Belgium. High prices and the very considerable inconvenience in securing liners from Europe have developed a domestic supply. During 1917 approximately 3,050 short tons of liners, valued at $59,250, were sold by the following manufacturers: S. W. Chiles, Bethlehem, Pa.; American Flint Co., E. L. Lull, proprietor, Iron City, Tenn.; and the Jasper Quarry Co. (now the Jasper Stone Co.), Sioux City, Iowa. The products of these concerns appear to be wholly satisfactory substitutes for the materials formerly imported.

MINERAL SOAPS AND DETERSIVES.

Small quantities of so-called mineral soaps and natural mineral products which have cleansing or detersive qualities are marketed annually.

The Silver-ile Products Co., of Salt Lake City, manufactures an article which has effective soaplike qualities, partly derived from a clayey, probably colloidal earth, and partly from diatomaceous earth.

A pumice dust or fine volcanic ash from Oregon has been marketed as a medicinal detersive.

ARTIFICIAL ABRASIVES.

The artificial abrasives here considered are of three kinds: (*a*) Metallic abrasives, manufactured by the Pittsburgh Crushed Steel Co., Pittsburgh, Pa., and including "diamond crushed steel" (crushed crucible steel), "angular grit" (crushed chilled iron), and "crushed cast iron." (*b*) Silicon carbides—carborundum, manufactured by the Carborundum Co., at Niagara Falls, N. Y.; crystolon, manufactured by the Norton Co., at Chippewa, Ontario; and carbolon, manufactured by the Exolon Co., at Thorold, Ontario, and Blasdell, N. Y. (*c*) Aluminum oxides—alundum, manufactured by the Norton Co., at Niagara Falls, N. Y., and Chippewa, Ontario; aloxite, manufactured by the Carborundum Co., at Niagara Falls, N. Y., Niagara Falls, Ontario, and Shawinigan, Quebec; exolon, manufactured by the Exolon Co., at Blasdell, N. Y., and Thorold, Ontario; lionite, manufactured by the General Abrasives Co. (Inc.), at Niagara Falls, N. Y.

Besides the firms just mentioned, which manufactured abrasives in 1917, the D. A. Brebner Co. (Ltd.) and the National Abrasive Co. have plants at Hamilton, Ontario, for the manufacture of aluminum oxide abrasives. The product of the Brebner Co. is named coralox.

So far as known to the Geological Survey these are the only artificial abrasives manufactured in North America. Artificial abrasives sold under other names are merely the above-named products marketed under special trade names or are imported products.

The following tables show the production of artificial abrasives by kinds in 1916 and 1917, the total quantity in pounds, and the value of artificial abrasives sold from 1906 to 1917:

Artificial abrasives produced in the United States and Canada in 1916 and 1917.

Artificial abrasives.	1916		1917	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Silicon carbide [a]	7,025	$707,120	8,323	$1,074,152
Aluminum oxide [b]	30,708	2,139,230	48,463	6,969,387
Metallic abrasives [c]	1,073	89,559	1,125	93,703
	38,806	2,935,909	57,911	8,137,242

[a] "Carborundum," "crystolon," "carbolon."
[b] "Alundum," "aloxite," "exolon," "lionite."
[c] "Diamond crushed steel," "angular grit," "crushed cast iron."

Artificial abrasives produced in the United States and Canada, 1906–1917.

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1906	11,774,300	$777,081	1912	29,002,000	$1,747,120
1907	14,632,000	1,027,246	1913	33,489,000	2,017,458
1908	8,698,000	626,340	1914	27,191,611	1,685,410
1909	20,468,000	1,365,820	1915	37,684,000	2,248,778
1910	23,027,000	1,604,030	1916	[a]77,612,000	2,935,909
1911	21,292,000	1,493,040	1917	115,822,000	8,137,242

[a] Figures for 1916; revised in 1917.

ASPHALT.

By John D. Northrop.

INTRODUCTION.

The raw materials of the domestic asphalt industry include (1) a variety of native bitumens, pyrobitumens (substances that yield bitumen on destructive distillation), and bitumen-impregnated rocks obtained from mines or quarries in the United States; (2) natural asphalt imported from the West Indies and from Venezuela and refined in this country; and (3) asphaltic compounds of various types obtained in this country or imported from Mexico as by-products and residuals of the refining of asphaltic or of semiasphaltic petroleum.

The native bitumens produced commercially in the United States include the soft variety maltha, the hard varieties gilsonite and grahamite, and the cerous hydrocarbon ozokerite. Of the pyrobitumens, wurtzilite, known to the trade as elaterite, is the only one produced commercially in the United States, though unimportant deposits of albertite and of a closely related mineral, impsonite, are known to exist in this country. Of scientific interest rather than of present commercial importance are known deposits of the plastic native bitumen wiedgerite and of the pyrobitumens tabbyite, aeonite, and aegerite, all three of which are varieties of wurtzilite.

Commercial deposits of bitumen-impregnated rock in the United States include asphaltic sandstone, asphaltic limestone, and some of the bituminous shales, known locally as "elaterite" shale and as oil shale. Those forms of bitumen which are produced artificially from petroleum in the United States and in which the asphalt industry is interested, may be grouped broadly under two heads—solid and semisolid varieties, including fillers, binders, paving cements, and roofing compounds; and liquid varieties, including road oils, flux for softening harder bitumens, and asphaltic paints.

GENERAL CONDITIONS.

The statistics presented on subsequent pages indicate that the primary influence of the war on the asphalt industry of the United States has been one of stimulation so far as the markets for asphaltic material derived from petroleum and for imported asphalt are concerned, but that the relative abundance and adaptability of those materials has reacted unfavorably on the demand for the native bitumens and the various types of bituminous rock produced in this country.

The demand for asphaltic material for paving was never greater than in the early part of 1917, and, despite the entrance of this country into the war in April, few of the contracts for new work made in that year were annulled. Before the end of the year, however, a distinct tendency toward municipal economy became apparent in the restriction of contract work involving asphaltic material to the repairing and resurfacing of old pavements and in the postponement of projects involving the construction of much strictly new pavement. Offsetting this tendency in part was the increased demand for asphaltic material in the construction of highways in the vicinity of a great number of new military posts and cantonments and in the manufacture of roofing materials for the thousands of acres of semipermanent buildings that were erected for military purposes throughout the country in 1917.

With regard to the individual varieties of native asphaltic material produced in the United States, substantial increase took place in 1917 in the production of gilsonite, bituminous sandstone, and

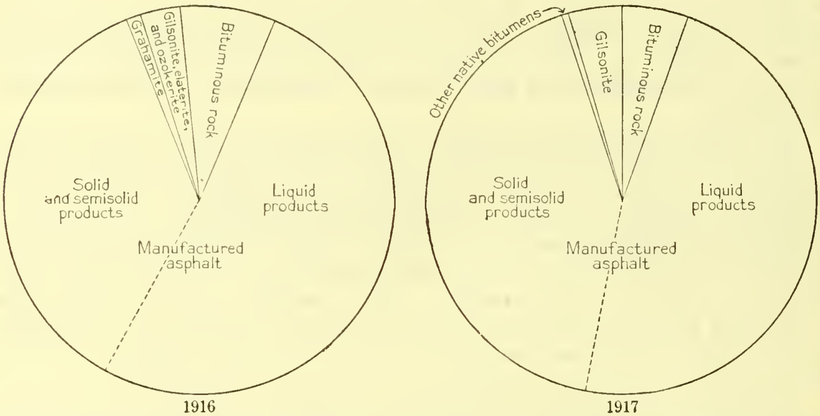


FIGURE 8.—Proportion of each principal variety of domestic asphaltic material, including material manufactured from crude petroleum of domestic origin, marketed in the United States in 1916 and 1917.

ozokerite, though the gain credited to these varieties was insufficient to offset the diminished production of grahamite, elaterite, and bituminous limestone.

With regard to the oil asphalts there was a substantial increase in 1917 in the production of both the solid and semisolid and the liquid varieties from petroleum of domestic origin as well as from petroleum imported from Mexico. The favor with which oil asphalt has been received in the United States is indicated by the facts that the production of oil asphalt from domestic petroleum has nearly doubled in the last four years and that the production of oil asphalt from imported petroleum has more than doubled in that period, despite the rapidly appreciating value for use as fuel of the grades of oil from which oil asphalt is derived.

Increasing requirements of petroleum fuel for bunker loading at Atlantic ports and for war industries on or adjacent to the Atlantic seaboard, together with Federal requisition of tankers formerly engaged in the transport of petroleum from Mexico and from Texas to the asphalt refineries at New York, Philadelphia, Baltimore, and Norfolk, resulted before the end of 1917 in a curtailment of the production of oil asphalt in the eastern United States that portends a considerably diminished output in 1918.

As in other recent years, imports of high-grade natural asphalt from Trinidad and Venezuela in 1917 exceeded the combined production of all varieties of native bitumen produced in the United States in that year. Imports from Trinidad increased about 6 per cent and from Venezuela about 42 per cent compared with 1916.

The domestic ozokerite industry, revived by the American Chemical & Ozokerite Co. in the closing months of 1916, made substantial progress in 1917, as a consequence of which the production of ozokerite was 369 per cent greater than in 1916.

The accompanying figure shows graphically the relative proportion of each principal variety of domestic asphaltic material marketed in the United States in 1916 and 1917.

MARKETED OUTPUT.

NATIVE BITUMENS AND BITUMINOUS ROCK.

The quantity of native bitumens, pyrobitumens, ozokerite, and bituminous rock produced and sold at mines and quarries in the United States in 1917 was 80,904 short tons. This quantity was less by 17,573 tons, or 18 per cent, than the output of corresponding materials in 1916.

The average price received for this material at the sources of production was $9.10 a ton and the market value of the entire production was $735,924, a loss of 27 cents a ton in average unit price and of $187,357, or 20 per cent, in gross market value, compared with 1916. At the mines gilsonite sold in 1917 for an average of $14.43 a ton, elaterite for $88.68 a ton, grahamite for $8 a ton, bituminous sandstone for $3.31 a ton, and bituminous limestone for $2 a ton. An analysis of the statistics of production in 1916 and 1917 shows gain in 1917 of 32 per cent in the output of gilsonite and of 350 per cent in the output of ozokerite, but loss of 51 per cent in the combined output of maltha, elaterite, and grahamite and of 34 per cent in the output of bituminous sandstone and bituminous limestone.

The gain in the output of gilsonite is ascribed to several factors including the increased demand for marine paints and protective coatings for steel work, of which that mineral forms the base, the increasing demand for automobile tires and other rubber products, in which gilsonite is used as a filler, and presumably to a slight extent to increased utilization of gilsonite fluxed with petroleum in the manufacture of paving cements. The decreased output of elaterite and grahamite was undoubtedly due to the costs of mining and marketing these materials and to the strength of the market competition with certain grades of oil asphalt.

The following table shows the combined output of all forms of natural asphalt entering the markets from mines and quarries in the United States since 1882:

Natural asphalt, bituminous rock, and ozokerite sold at mines, 1882–1917.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1882	3,000	$10,500	1894	60,570	$353,400	1906	73,062	$674,934
1883	3,000	10,500	1895	68,163	348,281	1907	85,913	928,381
1884	3,000	10,500	1896	80,503	577,563	1908	78,565	517,485
1885	3,000	10,500	1897	75,945	664,632	1909	99,061	572,846
1886	3,500	14,000	1898	76,337	675,649	1910	98,893	854,234
1887	4,000	16,000	1899	75,085	553,904	1911	87,074	817,250
1888	50,472	190,500	1900	54,389	415,958	1912	95,166	865,225
1889	51,760	174,037	1901	63,134	555,335	1913	92,604	750,713
1890	41,016	216,666	1902	84,632	461,799	1914	79,888	642,123
1891	45,079	249,264	1903	55,068	483,282	1915	75,751	526,490
1892	87,710	453,375	1904	64,167	420,701	1916	98,477	923,281
1893	47,779	372,232	1905	62,898	305,242	1917	80,904	735,924

MANUFACTURED ASPHALT.

The quantity of manufactured asphalt produced and sold in the United States in 1917 was 1,347,422 short tons, a gain of 86,701 tons, or about 7 per cent, over the output in 1916. The average price received at the refineries for this material was $11.26 a ton and the gross market value was $15,176,504, a gain of $1.58 in average unit price and of $2,978,802, or 24 per cent, in value, compared with 1916. The foregoing totals include 665,627 tons of solid and semisolid products, valued at $8,669,132, an average of $13.02 a ton, and 681,795 tons of liquid products, valued at $6,507,372, an average of $9.54 a ton.

The number of plants supplying the output of manufactured asphalt in the United States in 1917 was 40, of which 27 used exclusively petroleum from domestic sources, 9 used exclusively petroleum from Mexican sources, and 4 used petroleum from both sources.

The total sales in 1917 of manufactured asphalt derived from domestic petroleum amounted to 701,809 short tons, a gain of 13,475 short tons, or 2 per cent over sales in 1916. The average price obtained for this material was $11.02 a ton and the market value of the entire output was $7,734,691, a gain of $2.04 in average sale price and of $1,555,840, or 25 per cent, in total market value, compared with 1916. Included in the totals of manufactured asphalt derived from petroleum of domestic origin are 327,142 tons of solid and semisolid products utilized mainly in the paving and roofing industries, valued at $4,011,980, an average of $12.26 a ton, and 374,667 tons of liquid products including road oils, flux, and asphaltic paints, valued at $3,722,711, an average of $9.94 a ton. Compared with the price in 1916, the average market price per ton in 1917 of the solid and semisolid products derived from domestic petroleum was $1.64 higher and that of the liquid products was $2.12 higher.

The total sales in 1917 of manufactured asphalt derived from petroleum imported from Mexico amounted to 645,613 short tons, a gain of 73,226 tons, or about 13 per cent, over sales in 1916. The average price received for this material f. o. b. the refineries was $11.53 a ton and the gross market value of the material sold was $7,441,813, a gain of $1.01 in average sale price per ton and of $1,422,962, or nearly 24 per cent, in gross market value, compared with 1916.

The gross sales of manufactured asphalt derived from Mexican petroleum include 338,485 tons of solid and semisolid products, valued at $4,657,152, an average of $13.76 a ton, and 307,128 tons of liquid products, valued at $2,784,661, an average of $9.07 a ton.

Compared with the prices received in 1916 for corresponding products those received in 1917 for the solid and semisolid varieties averaged $1 a ton higher, and those received for the liquid varieties 66 cents a ton higher.

The accompanying figure shows graphically the trend of the market for manufactured asphalt in the United States since 1902.

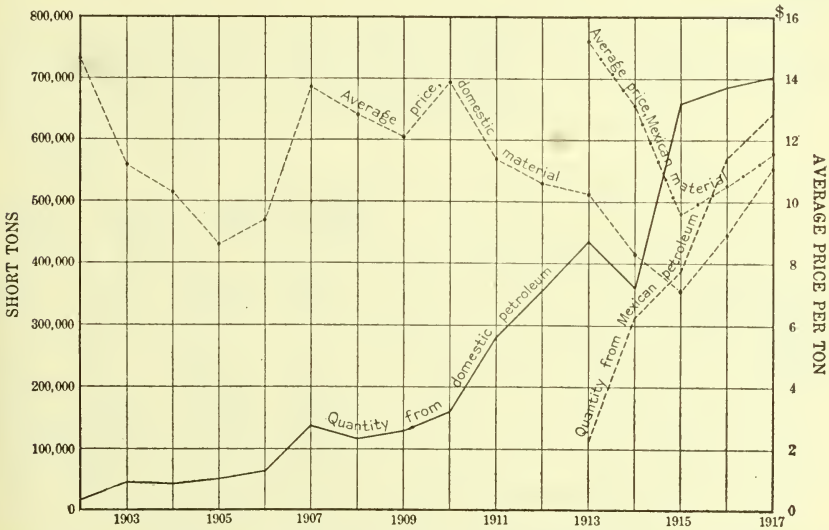


FIGURE 9.—Asphalt from domestic and from Mexican petroleum marketed in the United States, 1902–1917.

Asphalt manufactured from domestic petroleum and sold at refineries, 1902–1917.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1902	20,826	$303,249	1908	119,817	1,540,396	1914	360,683	3,016,969
1903	46,187	522,164	1909	129,594	1,565,427	1915	664,503	4,715,583
1904	44,405	459,135	1010	161,187	2,225,833	1916	688,334	6,178,851
1905	52,369	452,911	1911	277,192	3,173,859	1917	701,809	7,734,691
1906	64,997	615,406	1912	354,344	3,755,506			
1907	137,948	1,898,108	1913	436,586	4,531,657			

Asphalt manufactured from Mexican petroleum and sold at refineries, 1913–1917.

Year.	Quantity (short tons).	Value.
1913	114,437	$1,743,749
1914	313,787	4,131,153
1915	388,318	3,730,436
1916	572,387	6,018,851
1917	645,613	7,441,813

PRODUCTION BY CLASSES AND BY STATES.

Asphalt sold at mines and refineries, 1913–1917, by varieties.

Variety.	1913		1914		1915	
	Quantity (short tons).	Market value.	Quantity (short tons).	Market valve.	Quantity (short tons).	Market value.
Bituminous rock	57,549	$173,764	51,071	$162,622	44,329	$157,083
Gilsonite	35,055	576,949	19,148	405,966	20,559	275,252
Wurtzilite (elaterite)						
Grahamite			9,669	73,535	10,863	94,155
Maltha	....	....	....	....	....	....
Ozokerite	....	....	....	....	....	....
	92,604	750,713	79,888	642,123	75,751	526,490
Manufactured or oil asphalt [a]	436,586	4,531,657	360,683	3,016,969	664,503	4,715,583
	529,190	5,282,370	440,571	3,659,092	740,254	5,242,073

Variety.	1916		1917	
	Quantity (short tons).	Market value.	Quantity (short tons).	Market value.
Bituminous rock	63,172	$197,286	41,919	$136,255
Gilsonite	26,870	629,640	34,349	495,489
Wurtzilite (elaterite)	....	....		
Grahamite	8,431	92,555	4,618	103,180
Maltha	....	....		
Ozokerite	4	3,800	18	1,000
	98,477	923,281	80,904	735,924
Manufactured or oil asphalt [a]	688,334	6,178,851	701,809	7,734,691
	786,811	7,102,132	782,713	8,470,615

[a] Items include material derived from petroleum of domestic origin only.

Natural asphalt sold at mines, 1913–1917, by States.

State.	1913		1914		1915	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
California	27,870	$69,825	28,186	$77,810	17,794	$61,485
Kentucky	[a] 17,465	[a] 60,131	[a] 18,935	[a] 66,298	[a] 19,311	[a] 65,352
Oklahoma	16,459	91,416	9,669	73,535	16,907	118,351
Texas	(b)	(b)	(b)	(b)	(b)	(b)
Utah	30,810	529,341	23,098	424,480	[c] 21,739	[c] 281,302
	92,604	750,713	79,888	642,123	75,751	526,490

State.	1916		1917	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
California	18,135	$45,102	6,009	$19,447
Kentucky	[a] 37,777	[a] 122,984	[a] 33,910	[a] 112,808
Oklahoma	15,431	112,555	5,793	34,344
Texas	(b)	(b)	(b)	(b)
Utah	[c] 27,134	[c] 642,640	35,192	569,325
	98,477	923,281	80,904	735,924

[a] Includes Texas. [b] Included in Kentucky. [c] Includes Colorado.

CONDITIONS AND PRODUCTION IN THE PRINCIPAL PRODUCING STATES.

California.—As a consequence of increased costs of labor at the mines and of the competition afforded by 14 refineries producing manufactured asphalt in the same State, activity in the quarrying of bituminous rock in California was considerably diminished in 1917 compared with other recent years. The output in 1917, which amounted to 6,009 short tons, marketed at an average price of $3.24 a ton, consisted of bituminous sandstone from properties in Santa Cruz, San Luis Obispo, and Santa Barbara counties. Experiments by one of the California producers are reported to have resulted in a process for recovering the natural bitumen from the impregnated rock without the use of solvents and without alteration of the chemical composition of the original bitumen. The resulting asphalt is said to have proved in actual use to be a durable asphaltic cement, particularly characterized by its properties of cohesiveness, adhesiveness, and elasticity.

California, as in other recent years, led all other States in the production of manufactured asphalt, its output in 1917 aggregating 220,294 short tons, a decrease of 37,636 tons, or nearly 15 per cent, compared with 1916. Included in this quantity are 135,160 tons of solid and semisolid products, valued at $1,486,609, an average of $11 a ton, and 85,134 tons of liquid products, valued at $613,643, an average of $7.21 a ton. Compared with statistics for 1916, these figures show decrease in 1917 of 14,542 tons of solid and semisolid products but increase of $2.15 a ton in the average sale price of those products, and decrease of 23,094 tons of liquid products but increase of $1.36 a ton in the average sale price of that class of products. The decrease noted is unquestionably due to the steady appreciation in value of fuel oil, at the expense of which a part at least of the manufactured asphalt produced in California is made.

Colorado.—The vast deposits of oil shale in western Colorado attracted much favorable attention in 1917 as a prospective source of petroleum, and applications were filed on thousands of acres of shale land under the mining laws. Experimental plants for the retorting of the shale were erected near De Beque in Garfield County, and in the aggregate several hundred tons of shale was mined and shipped out of the State for purposes of experimentation. Aside from this development, which is discussed more fully in the current report on petroleum, about 700 tons of similar material, valued at $37,500, designated by the producers "elaterite shale," was produced and utilized in the manufacture of rubber substitutes, wood substitutes, and noncorrosive paints.

Illinois.—Four refineries operating wholly or in part on petroleum from Illinois sources produced in 1917 a total of 110,756 short tons of oil asphalt, valued at $1,317,855, including 3,910 tons of solid and semisolid products and 106,846 tons of liquid products.

Kentucky.—The production of asphaltic material in Kentucky in 1917 was restricted to one property in Edmonson County, operated by the Kentucky Rock Asphalt Co., of Louisville, successor to the Wadsworth Stone & Paving Co., of Pittsburgh, Pa., which sold its Kentucky properties in 1917.

The combined production of bituminous sandstone in Kentucky and Texas in 1917 was 33,910 short tons and the average price received for it was $3.33 a ton. The combined production of bituminous rock in these two States in 1916 was 37,777 tons and the average price received for it was $3.26 a ton.

Missouri.—Though none was marketed in 1917, about 5,000 tons of mine-run bituminous limestone was prepared for shipment from a property opened by the Western Chemical Aniline & Asphalt Co. near West Line, Mo. Specimens of the material from this property examined by the Kansas City Testing Laboratory are stated to have the following composition:

Composition of bituminous limestone from West Line, Mo.

Sample GG. 888:	
Bitumen	9.23
$CaCO_3$	87.70
SiO_2	2.30
	99.23
Extracted bitumen:	
Soluble in CS_2	99.8
Petrolene	85.0

Oklahoma.—The output of natural asphaltic material in Oklahoma in 1917, which amounted to only 5,793 tons, compared with 15,431 tons in 1916, consisted of grahamite from Pushmataha County and bituminous sandstone from Pontotoc County. The grahamite properties of the Choctaw Asphalt Co. in Pushmataha County were abandoned in 1917 because of exhaustion. Refiners handling petroleum from the Oklahoma-Kansas field produced in 1917 an aggregate of 206,223 tons of oil asphalt, valued at $1,975,493, an average of $9.58 a ton. Included in this output was 73,410 tons of solid and semisolid products, valued at $747,651, an average of $10.18 a ton, and 132,813 tons of liquid products, valued at $1,227,842 an average of $9.24 a ton.

Texas.—The contribution of Texas to the output of native asphaltic material in the United States in 1917 consisted of bituminous sandstone from the well-known locality in Uvalde County. The output was about 14 per cent less than in 1916, and is here included with that of Kentucky to avoid disclosure of individual operations.

Refiners of Texas petroleum produced in 1917 a total of 160,739 tons of oil asphalt, valued at $2,292,036, including 112,526 tons of solid and semisolid products, valued at $1,605,117, an average of $14.26 a ton, and 48,213 tons of liquid products, valued at $686,919, an average of $14.24 a ton. Five refineries, two of which also utilize Mexican petroleum, contributed to this production. One additional refinery in this State used Mexican petroleum exclusively, for the manufacture of asphalt.

Utah.—The contribution of Utah to the asphalt industry of the United States in 1917 consisted wholly of native bitumens and pyrobitumens, no bituminous rock having been produced commercially in the State in that year. The production in 1917 aggregated 35,192 short tons, valued at $569,325, and consisted of maltha from Box Elder County, gilsonite from Uinta and Duchesne counties, elaterite from Uinta County, and ozokerite from Wasatch County.

As in western Colorado, the interest in oil shale in northeastern Utah monopolized the attention that is normally directed to the expansion of markets for the other hydrocarbon minerals with which Utah is so richly endowed and to the improvement of facilities for satisfying those markets, and no new properties were opened in 1917. The demand for gilsonite was strong, and shipments of this bitumen, which amounted to 34,349 short tons, were about 32 per cent in excess of shipments in 1916. The output of elaterite was considerably less than in 1916, whereas that of maltha, which was used for demonstration and experimental purposes, was a net gain, none of this bitumen having been produced in 1916. The output of ozokerite in 1917 was 35,660 pounds, compared with only 7,600 pounds in 1916, a gain of 369 per cent. The greater part of this production was utilized in the manufacture of electrotyper's wax, a product indispensable in the printing and engraving industry.

Other States.—In addition to the sources of asphalt already mentioned, the following States, containing no commercially-developed scurces of raw material, contributed to the output of manufactured asphalt in 1917 through refineries treating asphaltic oils produced in adjacent States or imported from Mexico, namely, Indiana, Kansas, Louisiana, Maryland, New Jersey, Ohio, and Pennsylvania.

CONSUMPTION.

The quantity of asphaltic material actually consumed in the United States is not susceptible of accurate determination on the basis of the statistics collected by the Geological Survey. The sum of the quantity marketed from domestic sources and the quantity imported, less the quantity exported in a given year, provides, however, an approximation of the quantity consumed that is not without value in the absence of more specific data. On this basis the apparent consumption of asphaltic material, including natural asphalt, native bitumens, bituminous rock, and oil asphalt, in 1917 was 1,586,105 short tons, as compared with 1,466,095 short tons in 1916 and 1,224,037 short tons in 1915.

IMPORTS.

ASPHALT AND BITUMINOUS ROCK.

Asphalt and bituminous rock imported for consumption in the United States, 1913–1917.

Year.	Crude.		Dried or advanced.		Bituminous limestone.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	[a] 207,033	$738,452	[b] 14,750	$133,336	6,395	$38,823	228,178	$910,611
1914	137,352	664,558			1,705	11,060	139,057	675,618
1915	135,276	661,356			2,976	19,001	138,252	680,357
1916	147,383	732,917			330	1,795	147,713	734,712
1917	187,473	978,087			413	15,028	187,886	993,115

[a] Includes dried or advanced asphalt for last three months of 1913.
[b] Last three months of 1913 included in crude asphalt.

Asphaltic material imported into the United States, 1916–17, by countries.

[Gross imports.]

Source.	1916		1917	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Europe:				
Switzerland	295	$1,795		
England	794	8,599	1,784	$11,370
North America:				
Canada	124	1,642	88	1,889
Mexico	22	381	5,171	94,594
West Indies:				
Barbados	123	6,279	51	4,855
Trinidad and Tobago	92,858	494,740	98,458	553,969
Other British West Indies	520	23,470	5,762	24,568
Cuba	524	12,701	4,210	33,552
South America:				
Colombia			120	5,271
Venezuela	36,626	185,095	52,165	263,600
Oceania:				
Philippine Islands	1	10		
	131,887	734,712	167,809	993,668
Equivalent in short tons	147,713		187,946	

The foregoing tables show that the West Indies and Venezuela are the principal foreign contributors to the supply of natural asphalt in the United States. Increased receipts of Trinidad and Bermudez grades in 1917 reflect the high favor in which these asphalts are held by highway engineers and paving contractors in this country. The large relative gain in imports of asphaltic material from Mexico, Cuba, and West Indian Islands other than Trinidad in 1917, compared with 1916, and the appearance of Colombia among the creditor countries in 1917, furnish gratifying evidence of closer trade relations between the Pan American countries.

In addition to the imports of unmanufactured asphalt recorded in the foregoing tables asphalt products to the value of $10,864 were imported for consumption in the United States in 1917.

OZOKERITE.

The following table shows the receipts from foreign sources of mineral wax, including ozokerite, ceresine, and various compounded products of which these waxes form the base, entered for consumption in the United States during the last five years:

Mineral wax imported for consumption in the United States, 1913–1917.

Year.	Quantity (pounds).	Declared value.	
		Total.	Price per pound.
1913	7,141,514	$549,992	$0.077
1914	8,191,529	498,695	.061
1915	2,795,256	210,019	.075
1916	3,007,676	196,185	.065
1917	899,405	90,510	.101

Wholesale "spot" prices for imported ozokerite in the New York market ranged in 1917 from 60 to 75 cents a pound for the crude brown varieties and from 80 to 90 cents a pound for the green, quotations on all grades becoming nominal in August because of scarcity of supply. Competing grades of domestic ozokerite held steadily at 35 cents a pound until August, when the following scale of prices that remained unchanged to the end of the year went into effect: American refined white, 75 cents to $1 a pound; yellow, 60 to 65 cents a pound; and black, 164° F., 75 cents a pound.

ICHTHYOL.

The following table compiled from the records of the Bureau of Foreign and Domestic Commerce shows the quantity and declared value of ichthyol and ichthyol substitutes imported for consumption in the United States during the last five years:

Ichthyol and ichthyol substitutes imported for consumption in the United States, 1913–1917.

Year.	Quantity (pounds).	Value.
1913	58,485	$83,034
1914	61,416	86,415
1915	24,921	28,560
1916	116,738	93,762
1917	58,397	36,232

Because of the scarcity of the material, "spot" quotations on true ichthyol in the New York wholesale market were nominal throughout the year, ranging, however, from $12 to $18 a pound at the beginning of 1917 to $30 to $36 a pound at its end. The greater part, if not all, of the material imported in 1917 consisted of ichthyol substitutes from Switzerland and from Japan, which, along with American made substitutes derived from domestic materials, retailed in the United States at $5 to $7.50 a pound. Well-informed druggists familiar with the relative merits of true ichthyol and of the best brands of ichthyol substitutes have no hesitancy in ascribing the discrepancy in price recorded above almost wholly to the prejudice in favor of the original product created and fostered in this country by the German propagandists who control the deposits of asphaltic material in Austria from which the world was supplied with ichthyol prior to the war.

EXPORTS.

The foreign trade of the United States in unmanufactured asphalt decreased about 35 per cent in quantity but only 23 per cent in value, compared with 1916. The value (quantity not available) of asphalt products, including roofing compounds and asphalt-saturated fabrics, exported in 1917 was nearly equal to the value of the unmanufactured asphalt exported in that year and was 18 per cent greater than the value of asphalt products exported in 1916.

Significant increase was made in 1917 in shipments of unmanufactured asphalt to Chile and to British Honduras and of asphalt products to Italy, England, Costa Rica, Mexico, Argentina, China, British India, the Dutch East Indies, Japan, and the Philippine Islands.

The following tables have been compiled from the records of the Bureau of Foreign and Domestic Commerce:

Asphalt exported from the United States, 1913–1917.

Year.	Unmanufactured.		Manufactures of (value).	Total value.
	Quantity (long tons).	Value.		
1913	58,550	$1,267,625	$411,786	$1,679,411
1914	37,246	845,838	401,182	1,247,020
1915	38,203	735,952	438,685	1,174,637
1916	36,443	759,769	494,895	1,254,664
1917	26,881	587,256	585,472	1,172,728

Asphalt exported from the United States, 1916–17, by countries.

Destination.	1916			1917		
	Unmanufactured.		Manufactures of (value).	Unmanufactured.		Manufactures of (value).
	Quantity (long tons).	Value.		Quantity (long tons).	Value.	
Europe:						
Denmark	80	$1,142				
France	510	20,159	$20,350	501	$15,877	$22,918
Greece						35
Italy	115	5,373	6,236	616	9,203	22,748
Netherlands	17	516	7			
Norway	79	2,558		40	1,395	215
Russia in Europe			2,000			
Spain	192	4,144	4,330	128	4,268	3,394
Sweden	2,774	52,657		32	675	
Switzerland	68	1,449	1,043			
England	3,427	90,190	63,000	1,641	49,463	80,074
Scotland	199	4,291	1,244			
Ireland			848	75	3,903	
North America:						
British Honduras				7,789	153,934	
Canada	24,643	427,305	197,731	11,513	215,179	207,227
Central American States:						
Costa Rica			17			4,065
Guatemala			7			938
Honduras			60	23	1,081	81
Nicaragua	1	24	30			
Panama	690	20,575	39,977	776	22,924	10,026
Salvador			244			5
Mexico	13	232	890	151	2,498	6,897
Newfoundland			158			1,748
West Indies:						
Cuba	718	18,514	15,669	525	15,929	21,462
Danish (Virgin Islands)						3
Dominican Republic			197	12	556	1,397
British:						
Jamaica	10	303	2			14
Trinidad and Tobago						40
Other British Indies			13			463
Haiti				6	313	1,318
South America:						
Argentina	613	21,501	1,378	710	18,195	12,409
Brazil	134	3,753	4,984	491	14,059	8,494
Chile	2	58	19,387	1,306	35,834	18,090
Colombia		2	306	1	30	2,050
British Guiana	12	251				915
Dutch Guiana				1	47	66
Ecuador	4	111	6			68
Peru			328	4	195	3,050
Uruguay	1,399	64,211	8,270	234	11,666	2,074
Venezuela	6	323	207	43	1,293	1,669

Asphalt exported from the United States, 1916–17, by countries—Continued.

Destination.	1916 Unmanufactured. Quantity (long tons).	1916 Unmanufactured. Value.	1916 Manufactures of (value).	1917 Unmanufactured. Quantity (long tons).	1917 Unmanufactured. Value.	1917 Manufactures of (value).
Asia:						
China	25	$750	$11,607			38,312
China, territory leased to Japan			200			
East Indies:						
British India	8	308	9,482			26,404
Straits Settlements			1,170			442
Other British			2,100			839
Dutch			280			7,033
French			527			1,118
Hongkong			21,107	21	$520	15,338
Japan	312	7,948	13,763	120	4,197	20,315
Russia in Asia			37			
Siam			280			360
Oceania:						
British:						
Australia	369	10,731	22,496	12	847	8,753
New Zealand			11,751	3	182	4,328
French			99			
German			27			2,645
Philippine Islands			10,836			25,166
Africa:						
British South Africa	23	390	200			1,447
British West Africa			14			29
Madagascar				32	1,058	
Morocco				75	1,935	
	36,443	759,769	494,895	26,881	587,256	585,472
Equivalent in short tons	40,816			30,107		

ASPHALT INDUSTRY IN PRINCIPAL COUNTRIES.

PRODUCTION.

The following table shows the output of natural asphalt (all forms) in the principal producing countries, as far as reliable statistics are available:

Asphalt and bituminous rock produced in principal producing countries, 1906–1917.

Year.	United States. Quantity (short tons).	United States. Value.	Trinidad.[a] Quantity (short tons).	Trinidad.[a] Value.	Germany. Quantity (short tons).	Germany. Value.	Cuba. Quantity (short tons).	Cuba. Value.
1906	73,062	$674,934	150,373	$832,964	129,388	$268,631	5,717	$26,605
1907	85,913	928,381	171,271	832,274	139,567	264,494	5,571	37,594
1908	78,565	517,485	143,552	403,023	98,088	188,334	6,875	31,574
1909	99,061	572,846	159,416	459,446	85,446	176,897	11,900	48,246
1910	98,893	854,234	157,120	421,419	89,491	152,565	2,320	13,685
1911	87,074	817,250	[b] 201,284	[c] 603,800	90,256	154,938	3,638	21,928
1912	95,166	865,225	[b] 212,236	[c] 742,800	105,950	200,743	17,260	87,500
1913	92,604	750,713	[b] 257,635	[c] 1,030,540			[b] 1,749	30,935
1914	79,888	642,123	[b] 163,076	[b] 789,450			[b] 969	19,491
1915	75,751	526,490	[b] 152,349	[c] 736,760			[b] 486	11,247
1916	98,477	923,281	[b] 146,831	[c] 698,475			[b] 539	12,486
1917	80,904	735,924	[b] 146,322				[d] 305	7,354

[a] Includes small quantity of manjak, produced in Barbados.
[b] Exports.
[c] Estimated.
[d] Exports for six months.

Asphalt and bituminous rock produced in principal producing countries, 1906–1917—Con.

Year.	France.		Italy.[a]		Spain.		Japan.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1906	216,405	$345,599	144,802	$349,926	8,587	$17,130	43	$3,572
1907	195,136	330,065	178,127	442,014	9,057	16,001	644	5,436
1908	188,616	264,188	148,433	368,306	13,635	24,084	2,650	25,564
1909	186,298	269,161	123,361	305,159	5,822	10,282	4,614	45,205
1910	187,085	277,210	179,261	452,911	7,072	18,308	526	29,004
1911	187,006	261,743	207,926	591,550	[b] 4,124	8,754	1,389	13,728
1912	343,656	393,994	200,560	581,383	5,938	13,003	3,199	32,518
1913			188,601	521,398	6,153	13,402	2,491	27,242
1914			132,114	400,164	6,355	13,847	2,211	25,836
1915			52,532	184,621	4,983	10,706		
1916			18,546		7,864			

Year.	Austria-Hungary.		Russia.		Venezuela.		Mexico.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1906	10,633	$778,781	[c] 12,517	$110,294	[e] 24,783	$98,250	1,531	$17,174
1907	11,335	727,892	[c] 14,116	101,705	[e] 42,153	167,938	4,945	182,265
1908	12,239	768,162	[c] 24,961	491,302	[e] 35,324	141,912	5,811	330,903
1909	11,179	663,246	[d] 2,665	4,599	[e] 41,767	180,061	6,031	106,484
1910	9,070	702,022	[d] 27,544	176,518	[e] 35,717	[f] 151,000	3,140	39,681
1911	[d] 8,312	652,603			[e] 56,183	[f] 238,000	8,912	125,322
1912	[d] 11,439	664,778			[e] 73,780	[f] 312,000	33,611	462,230
1913					[e] 93,884	[f] 400,000		
1914					[e] 49,941			
1915					[e] 31,949			
1916					[e] 49,176			
1917					[e] 54,410			

[a] Only about 7 per cent of the quantity given represents asphalt, the remainder being bituminous sandstone and limestone.
[b] Figures for 1911 do not include 7,165 tons of bituminous rock for which no value was reported. Figures for 1913 do not include 5,112 tons of bituminous rock, valued at $5,833.
[c] Includes mineral pitch.
[d] Includes ozokerite.
[e] Exports.
[f] Estimated.

TRINIDAD.

The following table, presented through the courtesy of the Barber Asphalt Paving Co., shows the trend of the asphalt industry in Trinidad in the last five years:

Asphalt exported from Trinidad, 1913–1917, in long tons.

Year.	To United States.			To Europe.			To other countries.			Grand total.
	Lake.	Land.	Total.	Lake.	Land.	Total.	Lake.	Land.	Total.	
1913	123,873	1,400	125,273	104,153		104,153	605		605	230,031
1914	67,357	2,950	70,307	75,297		75,297				145,604
1915	118,001	1,250	119,251	18,025		18,025				136,026
1916	117,719		117,719	13,380		13,380				131,099
1917	119,149		119,149	11,496		11,496				130,645

Although shipments of native asphalt from Pitch Lake to the United States increased moderately in 1917, the increase was insufficient to offset the decrease in shipments to European countries, as a consequence of which gross exports decreased about 3.5 per cent, compared with 1916.

VENEZUELA.

Statistics of asphalt exported from Venezuela in 1917, on page 246, indicate for the asphalt industry of that country a gradual return to prewar conditions. Shipments of asphalt from the famous Bermudez "Pitch Lake" in 1917 were 11 per cent in excess of shipments in 1916 and 70 per cent in excess of shipments in 1915.

CUBA.

The following table, compiled from data furnished by the Pan American Union, shows the extent of foreign shipments of asphalt from Cuba in the last seven years:

Asphalt exported from Cuba, 1911–1917.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1911	3,248	$21,629	1915	434	$11,247
1912	15,410	86,303	1916	481	12,486
1913	1,562	30,935	1917 (six months)	272	7,354
1914	865	19,491			

CANADA.

Research work looking to the utilization of the vast deposits of bituminous sand in northern Alberta, Canada, chronicled in the report of this series for 1916, was postponed in 1917 because of the entrance into military service of S. C. Ells, who was in charge of the investigation of this subject for the Canada Department of Mines.

ITALY.

According to the Mining Journal [1] the asphalt industry in Italy suffered severe depression in 1916 as a consequence of the war. The production, mostly by the Neuchatel Co., aggregated 16,829 metric tons (18,546 short tons), and exports from Sicily amounted to only 15,322 metric tons, compared with 20,339 metric tons in 1915 and 83,241 metric tons in 1914. Stocks of asphalt on Sicily at the end of 1916 were reported at 59,000 metric tons. Statistics for 1917 are not available.

The following notes on the asphalt industry of Italy are abstracted from a recent discussion [2] of that subject:

There is no doubt that the asphalt industry in Italy has a bright future when one considers the rapid progress that this industry has made in recent years, particularly as a source of paving material.

It is safe to say that when the war in Europe is over Italian asphalt will occupy a strong position in the European markets and will be in demand throughout the Continent. Though not excessively rich in asphaltic materials Italy, nevertheless, possesses valuable deposits, some of which, both in Abruzzi and in Sicily, are as yet unexploited.

Until about three years ago the exploitation of asphalt in Italy was in the hands of a single company, the officials of which were, for the

[1] Mining Jour. (London), vol. 120, No. 4307, p. 148.
[2] Les mines italiennes d'asphalte: Journal du pétrole, 18th year, No. 4, pp. 9–10, April, 1918.

greater part foreigners. With the present awakening of the nation it is hoped that the necessity of rescuing this industry from Teutonic control will be realized.

The production of the quarries in Sicily has been exported chiefly through the ports of Syracuse, Pozzalo, and Catania, to the following countries: America, about 500 metric tons; Austria, 5,500 metric tons; Ceylon, 140 metric tons; Denmark, 980 metric tons; Egypt, 1,500 metric tons; France, 3,500 metric tons; Germany, 31,500 metric tons; Greece, 400 metric tons; England, 22,700 metric tons Holland, 8,790 metric tons; Rumania, 1,000 metric tons; and Turkey, 200 metric tons. The quantity retained in Italy did not exceed 6,500 metric tons. The principal asphalt deposits in Italy are as follows:

District of Caltanissetta.—For more than two years no new researches have been made in the district of Caltanissetta. Among the unexploited deposits of rich asphalt of high bitumen content one at Gaztelluccio de San Antonio is particularly notable. Laboratory tests have proved the value of this deposit and active development on a large scale is planned at the end of the war. Besides the mining industry itself, there are in the Province of Syracuse two plants for the manufacture of asphalt products, the principal products of which are powdered asphalt and asphalt mastic. In 1915 the production consisted of 500 metric tons of powdered asphalt, valued at $43,998, and 150 metric tons of asphalt mastic, valued at $6,590.

District of Rome.—The deposits of bituminous limestone of Abruzzi are found in the Province of Chieti. They were the first Italian deposits to be exploited and for that reason they are today producing less than the Sicilian deposits. The first exploitation was conducted by a German firm, Rek & Co., and accomplished results of notable importance. These deposits have been taken over by the Valle Romano Co., which is at present doing but little work.

The second firm to work the mines in the District of Rome was the Neuchatel Asphalt Co., capitalized at 15,000,000 lire (about $781,500). Since 1915 this company has been less active than in the preceding years, but it furnished, nevertheless, the greater part of the production in 1916. Two-thirds of the asphalt mined by this English firm was taken from the quarries at Gese. At the Piana Monaci property exploratory boring begun in 1916 to determine the extent of the Ponte leads has been suspended and abandoned because of the failure to discover rock of value. At the Pilono opening, that is to say, along the service roads of the San Giorgio mine, well directed boring has revealed the presence of good asphalt rock in advance of the Cusano lead. The San Giorgio mine has recently opened a quarry near Torretta.

There has been a notable decrease in the output of the three asphalt manufacturing plants at Chietino, which produced a total of 11,310 metric tons of asphalt mastic, valued at 452,400 lire ($23,571); 10,780 metric tons of powdered asphalt at an increase of 263,788 lire ($13,743); 2,190 metric tons of asphalt blocks, valued at 146,015 lire ($7,608); and 775 metric tons of refined bitumen, valued at 198,760 lire ($10,356).

In the other Italian districts no exploitation of consequence has taken place.

District of Naples.—In the District of Naples exploitation has been carried on only at intervals at the asphalt deposits at Colle. In San Magno some work has been done in separating the bitumen from the material quarried, but this work has been deterred by various causes, especially by conditions created by the war.

STREET AND ALLEY PAVING IN THE UNITED STATES.

The following statistics collected by Engineering and Contracting[1] show the status of street and alley improvement in 185 typical municipalities in the United States and "indicate that American cities have much work to do before they have a 100 per cent paved street mileage."

Paved and unpaved streets in 185 cities in the United States in 1918.

State and city.	Total miles of streets.	Total miles of alleys.	Miles of paved streets.	Miles of paved alleys.
California:				
Alameda	70.0	0.2	65.0	0.1
Bakersfield	86.0	33.0	17.2	1.4
Long Beach	208.0	100.0	52.0	20.0
Los Angeles	2,624.0	....	465.0	16.6
Oakland	543.7	5.0	395.4	1.0
Pomona	123.0	....	24.4	.3
Redlands	150.0	20.0	126.0	2.0
Riverside	200.0	....	90.7	.5
San Francisco	[a]825.0	....	[a]495.0	....
Santa Barbara	80.0	2.0	25.0	.2
Colorado:				
Boulder	61.0	28.8	17.6	.2
Grand Junction	40.0	20.0	3.0	1.0
Connecticut:				
Bridgeport	192.0	....	109.9	....
Hartford	160.0	....	15.0	....
Wallingford	33.9	....	9.8	....
District of Columbia:				
Washington	638.1	....	356.0	150.0
Florida:				
Tallahassee	30.0	....	4.0	....
Georgia:				
Brunswick	77.0	15.0	27.0	....
Savannah	110.0	80.0	53.0	....
Idaho:				
Pocatello	62.0	30.0	22.0	.2
Illinois:				
Belleville	80.0	36.0	38.0	....
Cairo	34.4	2.5	23.0	....
Canton	48.0	27.0	15.0	2.0
Chicago	3,248.8	1,699.5	2,175.5	270.6
East St. Louis	177.0	99.8	59.0	.6
Galesburg	108.0	....	32.1	....
Granite	35.0	20.0	12.0	....
Kankakee	61.0	22.0	35.1	.5
La Salle	26.5	22.0	16.0	7.0
Moline	85.4	31.9	43.7	2.1
Murpheysboro	35.0	10.0	15.0	....
Oak Park	98.2	45.6	82.3	2.0
Quincy	108.0	27.0	41.2	5.0
Springfield	167.3	154.7	76.0	5.0
Taylorsville	35.3	27.3	10.8	.6
Indiana:				
Elkhart	115.0	100.0	23.8	1.5
Frankfort	48.8	32.7	28.9	1.2
Fort Wayne	214.0	150.0	104.0	7.0
Huntington	51.0	42.0	29.0	1.1
Lafayette	89.0	84.0	55.7	13.0
Richmond	69.2	....	34.4	....
South Bend	217.3	200.0	75.1	5.0
Terre Haute	200.0	200.0	56.0	5.0
Iowa:				
Boone	80.0	40.0	14.5	.5
Cedar Rapids	172.0	98.0	66.8	3.0
Creston	65.0	20.0	14.5	1.0
Davenport	173.0	62.0	80.0	15.0
Dubuque	131.0	34.0	55.0	10.4

[a] Includes alleys.

[1] Engineering and Contracting, vol. 49, No. 18, p. 426, May 1, 1918.

Paved and unpaved streets in 185 cities in the United States in 1918—Continued.

State and city.	Total miles of streets.	Total miles of alleys.	Miles of paved streets.	Miles of paved alleys.
Iowa—Continued.				
Grinnell	36.9		13.0	
Oelwein	33.0	18.0	9.0	.6
Oskaloosa	45.0	20.0	13.0	1.0
Sioux City	300.0	200.0	90.0	10.0
Waterloo	58.0		20.7	2.8
Webster City	30.0	24.0	12.0	2.0
Kansas:				
Coffeyville	58.0	28.0	28.0	2.0
Independence	62.8	28.5	29.7	5.5
Leavenworth	100.0	50.0	32.0	3.0
Manhattan	50.0	24.0	22.0	.1
Wellington	60.0	15.0	15.0	1.0
Wichita	300.0	250.0	70.0	5.0
Kentucky:				
Ashland	38.4	8.4	28.0	2.8
Louisville	339.3		238.7	
Louisiana:				
New Orleans	750.0	31.0	350.0	1.7
Shreveport	153.0	71.0	46.0	3.0
Maine:				
Portland	156.2		46.7	
Maryland:				
Cumberland	40.0	26.0	22.0	2.0
Massachusetts:				
Amherst	88.0		6.0	
Andover	175.0	1.0		
Arlington	65.4		18.3	
Beverly	71.0	17.0	15.0	
Boston	595.3	5.8	555.2	5.3
Brockton	131.5		44.0	
Brookline	75.0		65.0	
Fall River	155.4		41.8	
Fitchburg	141.2		28.3	
Haverhill	215.5	4.4	59.4	.2
Lawrence	108.0	10.0	41.0	
Lowell	217.0		71.0	
Maynard	25.0	2.0	15.0	2.0
Medford	92.0		52.0	
Newton	225.0		94.0	
Saugus	75.0		1.2	
Waltham	96.4		39.6	
Watertown	57.3		38.3	
Westfield	102.0	2.0	12.8	
Worcester	312.0	6.2	117.7	.8
Michigan:				
Battle Creek	110.0	5.0	21.0	
Cadillac	58.0	21.0	18.0	.7
Detroit	836.0	700.0	634.0	90.0
Flint	243.0		42.3	
Grand Rapids	317.7	195.0	63.3	2.9
Kalamazoo	86.0	4.0	17.7	1.0
Pontiac	50.0	5.0	1.5	
Three Rivers	125.0	6.5	30.0	.5
Minnesota:				
Albert Lea	30.5	10.0	3.0	.5
Austin	43.5	8.6	4.2	.5
Cloquet	36.0	7.0	1.0	
Duluth	1,100.0	900.0	86.8	3.5
Mankato	43.0	21.0	9.5	2.0
Minneapolis	881.0	290.0	175.0	27.0
Owatonna	46.7	8.8	1.5	.3
Virginia	22.0	12.0	13.7	.5
Mississippi:				
Vicksburg	60.0	9.0	13.0	
Missouri:				
Cape Girardeau	39.0	19.0	15.0	.2
Columbia	59.5	8.9	26.4	.5
Hannibal			9.2	1.5
Kansas City	1,100.0	200.0	500.0	50.0
Springfield	145.0	97.0	56.4	3.0
Montana:				
Billings	63.2	29.8	9.5	1.0
Bozeman	42.0	35.0	9.0	.3
Butte	97.4	49.1	8.2	1.3
Great Falls	112.0	49.5	17.5	3.5
Nebraska:				
Fairbury	22.0	10.0	1.0	
Fremont	60.0	11.5	10.5	.7
Lincoln	205.0	95.0	76.9	6.3

[a] Includes alleys.

Paved and unpaved streets in 185 cities in the United States in 1918—Continued.

State and city.	Total miles of streets.	Total miles of alleys.	Miles of paved streets.	Miles of paved alleys.
New Hampshire:				
Concord	180.0		15.0	
Keene	43.7		10.1	
New Jersey:				
Camden	173.0		86.8	
East Orange	72.0		65.0	
Irvington	55.0		18.0	
Montclair	84.5		14.0	
Morristown	22.0	.5	15.0	
North Plainfield	18.5		12.0	
Passaic	63.8		41.1	
Paterson	207.0	1.0	110.3	1.0
Plainfield	88.0	1.0	66.6	.5
South Orange	30.0		26.0	
New York:				
Auburn	87.3	2.0	66.0	.3
Binghamton	98.0	1.0	30.3	.5
Buffalo	631.0	7.2	424.2	4.6
Gloversville	52.5		11.7	
Jamestown	341.6	4.7	119.3	1.2
Johnstown	48.0		11.0	
Kingston	73.9		73.9	
Mount Vernon	88.0		68.0	
Niagara Falls	135.0	38.0	51.0	3.0
Norwich	19.0		6.9	
Ogdensburg	36.0	2.0	26.0	.7
Olean	52.0		15.0	
Oneonta	35.6		6.0	
Oswego	84.6		15.3	
Rochester	a 401.0		a 282.0	
Schenectady	130.0	2.2	79.6	
Syracuse	280.0	.5	110.0	.2
Utica	a 131.3		a 74.7	
North Carolina:				
Asheville	75.0	5.0	50.0	1.0
Greensboro	58.6		23.5	
North Dakota:				
Devils Lake	15.0	6.0		
Ohio:				
Canton	200.0	200.0	67.5	
Cincinnati	a 960.0		a 615.0	
Cleveland	a 916.3		a 601.8	
Conneaut	50.0	4.0	10.0	
Defiance	75.0	60.0	12.0	3.0
Fremont	49.0	8.0	16.0	1.0
Lakewood	79.0	1.0	60.0	
Lima	110.0		45.0	
Lorain	91.0	60.0	28.0	1.0
Mansfield	73.0	30.0	40.0	2.0
Marietta	45.5	40.0	28.0	4.0
Sandusky	86.0	10.0	30.5	1.0
Tiffin	40.0	25.0	27.0	1.5
Toledo	450.0	192.0	242.0	10.0
Warren	95.5	2.5	36.5	
Zanesville	78.0	78.0	34.3	6.0
Oklahoma:				
Durant	35.0	35.0	5.0	
El Reno	30.0	10.0	12.0	.5
Oregon:				
Eugene	51.0	15.0	39.0	5.7
Medford	60.0		20.0	
Portland	1,350.0		438.0	
Pennsylvania:				
Allentown	a 110.0		a 40.4	
Altoona	104.0	48.5	49.0	4.3
Bangor	20.0	10.0	14.0	
Bradford	24.5	.5	16.3	.2
Carlisle	25.0	20.0	16.7	5.0
Carnegie	20.0	9.0	13.0	1.2
Coatesville	14.5	8.8	7.0	
Dubois	33.0	37.0	7.0	1.0
Greensburg	28.3	16.3	20.6	2.6
Harrisburg	a 118.8		a 85.0	
Lebanon	34.4	14.8	3.8	.3
Norristown	46.6	9.0	28.8	9.0
Oil City	48.0	14.0	22.0	2.0
Rankin	9.0	4.0	5.0	.7
Reading	90.0		66.0	

a Includes alleys.

FULLER'S EARTH.[1]

By Jefferson Middleton.

GENERAL CONDITIONS.

The quantity, value, and average price per ton of fuller's earth sold in 1917 were the largest ever recorded by the United States Geological Survey, the increase in quantity being 4,745 short tons, or 7 per cent, and in value $65,136, or more than 9 per cent, over 1916, the previous leading year. Almost from the beginning of the industry in this country the quantity and value and the average price per ton of the domestic product have exceeded those of the imports. The quantity and the value of the earth produced in the United States in 1917 were more than four times as great as those of the earth imported, and the average price per ton of the domestic earth was 26 cents more than that of the imported earth. The apparent consumption—production plus imports—increased from 84,623 short tons in 1916 to 89,561 tons in 1917, and the domestic fuller's earth formed 81 per cent of the consumption in 1917, against 80 per cent in 1916.

This industry, in common with others, suffered from bad conditions in labor and transportation, which hindered production.

OCCURRENCE.

Fuller's earth has been reported in Alabama, Arizona, Arkansas, California, Colorado, Florida, Georgia, Massachusetts, Minnesota, Mississippi, Missouri, Nebraska, New York, South Carolina, South Dakota, Texas, Utah, Virginia, and Washington; but it was mined and marketed in 1917 in only six States—Arkansas, California, Florida, Georgia, Massachusetts, and Texas—the same as in 1916. The Southern States produced nearly 99 per cent of the domestic fuller's earth marketed in 1917.

USES.

Fuller's earth obtains its name from its original use in fulling cloth, but only a little domestic earth is now used in this country for that purpose. It is used principally in bleaching and in clarifying or filtering fats, greases, and oils. It is also used in the manufacture of pigments for printing wall papers, in detecting certain coloring matters in some food products, and as a substitute for talcum powder.[2]

[1] The statistics in this report were compiled by Miss L. M. Jones, of the United States Geological Survey.
[2] Bur. Mines Bull. 71, p. 19, 1913.

PRODUCTION.

The growth of the industry since 1895, when it assumed commercial importance, is shown in the first of the following tables. The steady growth of the industry is evident, the production being nearly 11 times as great and the value nearly 19 times as great in 1917 as in 1895. The lowest price per ton ($5.72) was in 1904, and the average price per ton in 1917 ($10.64) was the highest attained for domestic earth and was 22 cents higher than in 1916.

Fuller's earth produced and marketed in the United States, 1895–1917.

Year.	Quantity (short tons).	Value.	Average price per ton.	Year.	Quantity (short tons).	Value.	Average price per ton.
1895	6,900	$41,400	$6.00	1907	32,851	$291,773	$8.87
1896	9,872	59,360	6.01	1908	29,714	278,367	9.18
1897	17,113	112,272	6.56	1909	33,486	301,604	9.03
1898	14,860	106,500	7.17	1910	32,822	293,709	8.95
1899	12,381	79,644	6.43	1911	40,697	383,124	9.41
1900	9,698	67,535	6.96	1912	32,715	305,522	9.34
1901	14,112	96,835	6.86	1913	38,594	369,750	9.58
1902	11,492	98,144	8.54	1914	40,981	403,646	9.85
1903	20,693	190,277	9.20	1915	47,901	489,219	10.21
1904	29,480	168,500	5.72	1916	67,822	706,951	10.42
1905	25,178	214,497	8.52	1917	72,567	772,087	10.64
1906	32,040	265,400	8.28				

Fuller's earth produced and marketed in the United States, 1916–1917.

States.	1916				1917			
	Number of operators.	Quantity (short tons).	Value.	Average price per ton.	Number of operators.	Quantity (short tons).	Value.	Average price per ton.
Florida, Georgia, and Massachusetts	7	66,311	$690,598	$10.41	7	67,397	$709,187	$10.52
Arkansas, California, and Texas	3	1,511	16,353	10.82	4	5,170	62,900	12.17
	10	67,822	706,951	10.42	11	72,567	772,087	10.64

The small number of producers makes it impossible to publish totals for some States without disclosing confidential reports; consequently the distribution of output is grouped as above. The Eastern States continue to produce by far the larger part of the fuller's earth marketed, their seven operators reporting approximately 93 per cent of the quantity and value of the entire output in 1917. Named in the order of their rank, the producing States were Florida, Georgia, Texas, Arkansas, Massachusetts, and California. Florida, which has been the leading State in the production and value of fuller's earth since the beginning of the industry, reported more than three-fourths of the total output and value in 1917.

IMPORTS.

The imports of fuller's earth for consumption in 1917 showed a small increase in quantity—193 tons—and a considerable increase in value—$36,753, or 26 per cent, compared with 1916. The increase in quantity was entirely in the unwrought or unmanufactured earth, the wrought or manufactured earth showing a decrease. Both varieties showed large increase in value. The average price per ton for all imported earth increased $2.07, for unwrought earth $1.29, for wrought earth $2.16.

Fuller's earth imported and entered for consumption in the United States, 1908–1917.

Year.	Unwrought or unmanufactured.			Wrought or manufactured.			Total.		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
1908	2,363	$16,242	$6.87	9,803	$77,171	$7.87	12,166	$93,413	$7.68
1909	1,802	12,492	6.93	10,950	88,659	8.10	12,752	101,151	7.93
1910	2,160	14,399	6.67	14,427	118,146	8.19	16,857	132,545	7.86
1911	1,881	10,877	5.78	16,343	132,717	8.12	18,224	143,594	7.88
1912	1,970	11,619	5.90	17,139	133,718	7.80	19,109	145,337	7.61
1913	1,916	12,344	6.44	16,712	133,657	8.00	18,628	146,001	7.84
1914	1,468	9,283	6.32	23,509	185,800	7.90	24,977	195,083	7.81
1915	850	5,176	6.09	18,591	147,317	7.92	19,441	152,493	7.84
1916	1,132	7,742	6.84	15,669	131,922	8.42	16,801	139,664	8.31
1917	1,441	11,718	8.13	15,553	164,699	10.58	16,994	176,417	10.38

PEAT.

By C. C. Osbon.

INTRODUCTION.

Stimulated by the war and by the consequent high price of nitrates, the output of peat in the United States in 1917, both as a direct fertilizer and as a culture medium for nitrifying organisms, was almost double the quantity produced in any other year in the history of the domestic industry. This unprecedented growth was due to the progress recently made in the application of bacteriology to soil fertilization and to the demand for large crops wherewith to feed both our own people and our Allies. This requirement necessitates the intensive cultivation of the soil, which implies a greater use of fertilizer and a consequent greater production of peat. In fact, the virtual commandeering by the Government for use in the explosives industries of practically all nitrate imported from Chile or produced in this country in retort ovens, makes the peat deposits of the United States one of the few domestic sources of nitrogen that can be converted into plant food at a price that is economical to the farmer. In response to the demand for live stock the producers of stock-food peat also materially increased their output in 1917. In view of these conditions and of the shortage of coal at the end of the year in the Eastern and Central States, the significance of our vast undeveloped peat deposits, pointed out by Davis, Bottomley, and others, is becoming more widely appreciated, so that peat promises soon to take an active part in the industrial progress of the United States.

PEAT INDUSTRY.

GENERAL CONDITIONS.

The year 1917 was one of great prosperity for the peat industry of the United States. The quantity of peat produced and sold exceeded the quantity marketed in any preceding year, and, with the exception of the manufacture of peat for use as fuel, all branches of the industry shared in the general prosperity. The most striking development, however, was the greater use made of peat as a culture medium for nitrifying and other bacteria in the manufacture of bacterial fertilizer.

The total number of individuals and companies engaged in the production of peat in 1917 was 18, an increase of 5 over the number operating in 1916. All the producers that were operating in 1916 except two contributed to the output of peat in 1917, and seven companies that were not represented in 1916 reported commercial production. Many new companies were organized in 1917 but did not complete their plants in time to contribute to the year's output. The plants known to be at work in 1917 were distributed as follows: California 2, Florida 2, Illinois 2, Indiana 1, Massachusetts 1, New Jersey 5, New York 3, Pennsylvania 1, and Virginia 1.

All the producers reported that the demand for peat in 1917 exceeded the supply, and some stated that, owing to railroad embargoes and scarcity of labor, they were unable to fill the orders of their regular customers. Substantially all the peat plants that operated in 1917 made improvements to increase production in 1918.

The prosperity in the peat industry in 1917 was a direct consequence of the increase in the acreage of crops grown in that year, of the intensive cultivation of those crops, and of the shortage and high price of inorganic fertilizers. The demand for peat fertilizer is steadily increasing as its value becomes better appreciated and the outlook for still greater expansion in all branches of the peat industry is good. The prices for peat products averaged higher in 1917 than in 1916.

PRODUCTION.

RAW PEAT.

The quantity of raw peat marketed in the United States in 1917 was 97,363 short tons, a quantity greater by 44,857 tons, or about 85 per cent, than the output in 1916 and by 42,220 tons, or nearly 77 per cent, than the record output of 55,143 tons in 1911.

Nearly all producers of raw peat in the United States refine their entire output, and it was therefore impossible to determine accurately the value of the raw product. However, the average price for all refined products received at the point of consumption was a little more than $7.29 a ton, and the gross market value was $709,900, a gain of 26 cents in average price per ton and of $340,796, or approximately 92 per cent, in gross market value.

Peat produced in the United States, 1908–1917.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1908	[a] 24,800	[a] $133,000	1913	33,260	$197,200
1909	29,167	127,042	1914	47,093	309,692
1910	37,024	140,209	1915	42,284	288,537
1911	55,143	272,114	1916	52,506	369,104
1912	47,380	228,572	1917	97,363	709,900

[a] Estimated.

REFINED PRODUCTS.

FERTILIZER AND FERTILIZER FILLER.

The manufacture of fertilizer is the largest and most successful industry based on peat in the United States. All the individuals and companies that produced peat in 1917 also manufactured peat fertilizer or fertilizer filler, the output of which, as reported to the

United States Geological Survey, amounted to 92,263 short tons. Compared with the production in 1916 this quantity is greater by 44,157 tons, or almost 92 per cent, and exceeds the record established in 1911 by 40,530 tons, or about 78 per cent.

The average price received for the material in 1917 at the point of consumption was $7.14 a ton, a gain of 14 cents a ton over the average price received in 1916. These gains in output and price were sufficient to make the total market value of the production in 1917, amounting to $658,500, exceed the value of the output in 1916 by $322,496, or nearly 96 per cent.

Of the total quantity of peat fertilizer and fertilizer filler marketed in 1917, 26,850 short tons, or about 29 per cent of the entire output, valued at $256,000, was bacterized.

The notable growth of the peat-fertilizer industry in 1917 was due mainly to the increase in the acreage of land tilled, the more intensive cultivation of crops, the lack of commercial fertilizer, and the application of bacteriology to soil fertilization. The condition of the commercial fertilizer market, the unprecedented expansion of the peat industry in 1917, and the good results reported by many who used peat for the cultivation of crops in that year warrant the expectation that the peat industry will soon occupy a high position among the mineral industries of the United States.

Peat fertilizer and fertilizer filler marketed in the United States, 1908–1917.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1908	23,000	[a] $121,210	1913	28,460	$169,600
1909	26,768	118,891	1914	37,729	249,899
1910	37,024	140,209	1915	38,394	258,447
1911	51,733	257,204	1916	48,106	336,004
1912	41,080	186,022	1917	92,263	658,500

[a] Estimated.

STOCK FOOD.

The quantity of peat used in compounding stock feed in the United States in 1917 was 5,100 short tons, valued at $51,400, or an average price of $10.08 a ton. Compared with 1916, the output in 1917 was greater by 800 tons, or almost 19 per cent, and the value was greater by $19,150, or about 59 per cent. Three peat producers manufactured stock food in 1917, compared with two in 1916.

Peat used in compounding stock food in the United States, 1912–1917.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1912	3,000	$18,000	1915	3,980	$30,090
1913	4,800	27,600	1916	4,300	32,250
1914	([a])	([a])	1917	5,100	51,400

[a] Not available.

FUEL.

Although small quantities of peat were prepared for experimental purposes and by the owners of small bogs for home use, no peat fuel was produced on a commercial scale in the United States in 1917. The one operator that reported a small output in 1916 was inactive in 1917, and the company experimenting with the Herbein briquetting process, mentioned by the Survey in 1916,[1] has not yet reached the stage of commercial production.

The construction of several peat-fuel plants was begun in 1917 in the New England States, where the recent coal shortage was felt keenly, but they were not completed in time to operate in that year. It is probable that the year 1918 will record the resumption of the production of peat fuel in this country. One of the difficulties reported by persons interested in this enterprise was the lack of peat-fuel machinery, which is scarce in the United States.

OTHER USES.

Small quantities of peat and peat moss of unknown value were also produced and used in 1917 in the manufacture of paper, for stable litter, packing material, and insulation, but as this output was used largely for experimental purposes it was not included in the statistics of production for the year.

IMPORTS.

Peat litter imported for consumption in the United States, 1913–1917.

Year.	Quantity (short tons).	Average price per ton.	Value.
1913	10,983	$5.07	$55,719
1914	9,921	5.80	57,542
1915	7,514	6.41	48,142
1916	3,042	9.16	27,859
1917	506	9.81	4,966

The foregoing table indicates that all the peat imported by consumers in the United States consists of litter, known to the trade as "peat moss." In 1917 it was only 506 short tons, valued at $4,966, an increase in value per ton over 1916 of $0.65, but a decrease in total quantity of 2,536 tons. In previous years peat litter was imported into this country from Holland and Germany, but in 1917 it was entered from Canada. It is apparent that imports of peat litter have been rapidly declining in recent years. This condition is not due to a decrease in the demand for peat litter but is doubtless chargeable to the situation brought about by the war.

CONSUMPTION.

The succeeding comparative table has been compiled from reports of sales filed by manufacturers of peat products and from the records of the Bureau of Foreign and Domestic Commerce.

[1] Turp, J. S., Peat: U. S. Geol. Survey Mineral Resources, 1915, pt. 2, p. 1028, 1916.

Peat products manufactured, imported, and sold in the United States in 1916 and 1917.

Kind of product.	Production.		Imports.		Sales.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value
1916						
Fertilizer and fertilizer filler	48,106	$336,004			48,106	$336,004
Stock food	4,300	32,250			4,300	32,250
Miscellaneous [a]	100	850			100	850
Moss litter			3,042	$27,859	3,042	27,859
	52,506	369,104	3,042	27,859	55,548	396,963
1917						
Fertilizer and fertilizer filler	92,263	658,500			92,263	658,500
Stock food	5,100	51,400			5,100	51,400
Moss litter			506	4,966	506	4,966
	97,363	709,900	506	4,966	97,869	714,866

[a] Includes peat used by florists and for fuel.

OCCURRENCE, PROPERTIES, AND USES.

Owing to the increased interest in the larger use of peat, indicated by the increasing number of requests received by the United States Geological Survey for information on the subject, and in order that the public may be fully informed of the value of peat as a raw material upon which many important industries may be based, a brief statement of the occurrence, properties, and uses of peat is given herewith. Much of the information presented is based upon the work of Davis, Shaler, Bottomley, and others, and liberal use has been made of the results of their experiments.

DEFINITION.

Peat is a dark-brown or black residuum produced by the partial decomposition and disintegration of mosses, sedges, trees, and other plants that grow in marshes and like wet places. It may be identified as the dark-colored soil found in bogs and swamps, commonly called muck, although technically the term "muck" should be restricted to such decayed vegetable matter as is impure and contains too much ash to burn readily. True peat consists principally of carbon, hydrogen, and oxygen, in varying proportions, and because of its high carbon content, it will ignite and burn freely when dry. If plant refuse is exposed to the air for long periods of time true peat is not formed, but advanced decomposition takes place and results in the formation of humus or in the disappearance of all the plant material except the ash or mineral part.

CONDITIONS OF FORMATION.

The accumulation of peat is dependent on conditions favorable to the profuse growth of water-loving plants and the escape of their remains from complete decomposition and disintegration by the action of fungi and bacteria. Hence, it is clear that climate and topography govern the formation of this material. If the land surface contains numerous depressions or poorly drained areas in which water may collect and stand permanently, and if the temperature of the air and the soil is low in summer and the relative humidity of the air is high enough to prevent rapid evaporation, peat-forming plants will flourish. In the process of growth plants form cellulose, the chief constituent of plant tissue, which they derive from gases taken from the air and minerals supplied through their roots. If, after maturity, the remains of a plant fall on dry earth, the carbon in the cellulose is released as carbon dioxide and the minerals are returned to the soil, and in a relatively short time the dead vegetable matter disappears. When, however, vegetation falls into water or on soil saturated with moisture it undergoes a different change. The water protects it from the attacks of fungi and bacteria, a large proportion of the carbon is retained, decay is arrested, and chemical changes blacken and soften the vegetable matter. The material may remain in this state indefinitely unless the land surface rises and decomposition again begins, or unless the surface subsides and the material is buried beneath later deposits and becomes a coal bed.

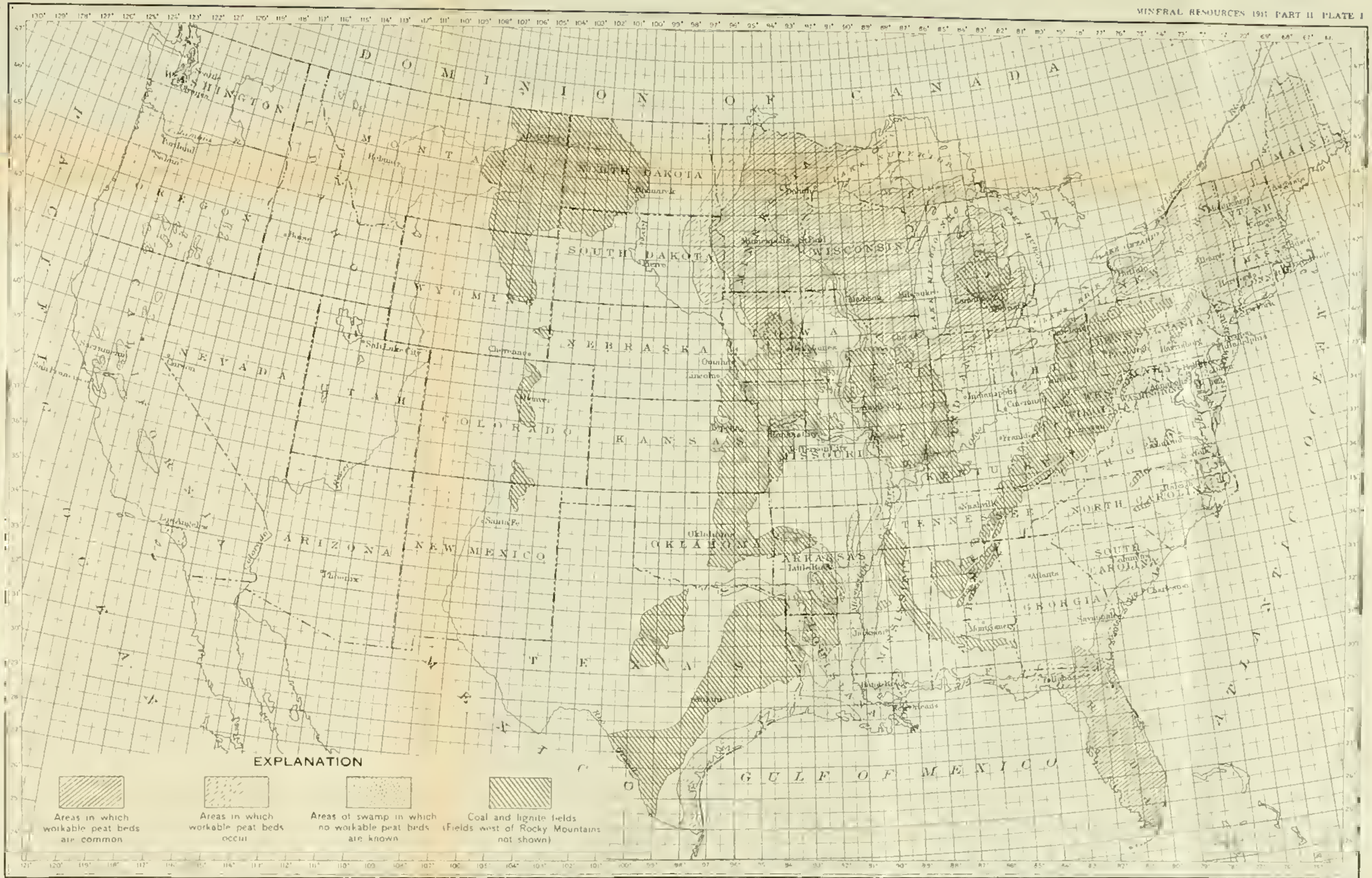
There are two kinds of peat deposits—the lake bog, in which the dead vegetable matter accumulates below water level, and the climbing bog, in which the level of moisture may never rise above the surface of the peat but is progressively elevated as the plant remains collect. In the lake bog, which is the more common kind in this country, the peat is usually formed in a lake or marsh by the successive growth and decay of algae, cryptogamic mosses, pond weeds and lilies, bulrushes, sedges, grasses, shrubs, and sphagnum moss. The climbing bog is found on level areas or gentle slopes in regions of heavy rainfall, where the drainage is so greatly interrupted that the soil becomes permanently saturated with water and is generally built up by sedges, herbs, sphagnum, shrubs of the heath family, and certain trees.

DISTRIBUTION AND QUANTITY.

The most extensive peat deposits in the United States are found in a region which lies east of the 97th meridian and north of an irregular line drawn eastward through the northern sections of Iowa, Illinois, Indiana, Ohio, Pennsylvania, and New Jersey and approximately includes the area covered by the Wisconsin or last glacial drift. (See Pl. I.) Many workable peat beds occur also in areas extending 25 to 50 miles inland on the Atlantic coast from New Jersey to southern Florida and along the Gulf coast to the Mexican boundary, and there are a few workable beds of peat in the Pacific Coast States.

The areas of peat accumulation in this country may therefore be roughly assigned to two regions, the northern and the coastal, and this subdivision, though mainly geographic, expresses in some degree differences in manner of formation and in the quality of the peat.

The northern region includes the New England States, Minnesota, Wisconsin, Michigan, and New York, and the northern sections of Iowa, Illinois, Indiana, Ohio and Pennsylvania. This region is characterized by the presence of numerous small lakes and marshes



MAP OF THE UNITED STATES SHOWING DISTRIBUTION OF PEAT DEPOSITS

(After Davis.)

Scale

Miles

and by relatively low temperature and high humidity and the peat deposits are generally of the lake-bog kind. Moss, sedge, and grass peat are abundant, and much sphagnum is found growing on bogs in Maine and in the northern counties of Minnesota, Wisconsin, Michigan, and northeastern Pennsylvania. In New England there are many climbing bogs, but the deepest and most extensive deposits are of the lake-bog kind and lie east of the Berkshire Hills and the Green Mountains.

The coastal region embraces the eastern sections of New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, and Georgia, all of Florida, the southern districts of Alabama, Mississippi, and Louisiana, and coastal Texas. The nearness of the ocean causes heavy rainfall and high relative humidity in this region, and the deposits are found in drowned valleys and lagoons formed by the gradual subsidence of the Coastal Plain and by wave action, and on flat, imperfectly drained areas farther inland. It is typified by many fresh and salt water marshes, in which the deposits have been formed largely by marsh grasses, and other plants, some of which tolerate salt water around their roots. On the Gulf coast, owing to the hot climate, dead vegetation decays rapidly, and as the peat therefore accumulates slowly it contains much ash. The most extensive peat deposits in the coastal region occur in Florida.

The known workable peat beds of the Pacific coast are found in Orange and Los Angeles counties, Cal., and in the basins of several of the lakes and rivers of Washington and Oregon; but on account of the rapid run-off in this section of the country peat deposits of commercial extent are comparatively rare and are not of sufficient importance for the section to be considered a major region.

Although there are a few peat deposits on the New England coast that are related in origin and composition to those classed in the coastal region, by far the most numerous bogs of the Northeastern States are of the glacial-lake kind, and the region as a whole should be so considered in a classification of the major areas of peat accumulation.

Although it is impossible with the data at hand to determine accurately the quantity of peat in the United States, it is estimated[1] that 11,000 square miles of swamp land contains peat beds of good quality and that the total available peat suitable for commercial use in these deposits would amount to more than 12,000,000,000 tons.

PHYSICAL AND CHEMICAL PROPERTIES.

Native peat consists chiefly of decayed vegetation and water in varying proportions, the usual ratio being 10 per cent of the former to 90 per cent of the latter. In specific gravity it ranges from 0.1 to 1.06 and in weight from 7 to 65 pounds per cubic foot. Aside from its high water content this substance is extremely variable, scarcely any two deposits containing material that is exactly similar in physical properties. This diversity is due to many factors, the most important of which are the great variety of plants from which the peat is formed, difference in climate, in the ages of the deposits,

[1] Davis, C. A., Peat resources of the United States, exclusive of Alaska: U. S. Geol. Survey Bull. 394, pp. 65–66, 1909.

in water level, and in quantity of sediment deposited during the accumulation of the peat.

Peat ranges in color from light yellow through various shades of brown to jet-black, the color representing in a measure the degree of decomposition. If the deposit is new or has been well protected from the air the peat is usually light yellow or brown; thoroughly decomposed, humified peat is jet-black. Upon drying in the air most peats become brighter in color, except the very light varieties, which usually change to dark brown or black after being macerated and dried. Peat that is red, gray, or white in spots or feels very gritty when crushed between the teeth contains too much inorganic mineral for commercial use as a fuel.

The texture of peat depends upon the kinds of plants from which it was formed and the physical conditions under which it accumulated. Peat formed from algae and mosses is fine grained and comparatively homogeneous, whereas peat produced by the decay of grasslike or woody plants will generally be found fibrous and poorly decomposed unless very old. Peat formed by the decomposition of shrubs and trees is woody in structure. Dead vegetation of any kind that is exposed for long periods to the free action of fungi and bacteria will become thoroughly disintegrated and of fine texture. In moist areas like New England and the vicinity of the Great Lakes peat is generally less variable in texture than it is in areas of alternate drought and heavy rainfall, such as are found farther west. Peat that accumulates in river valleys and lakes whose water contains much sediment is usually too impure and contains too much ash for commercial use.

The following classification[1] of peats by physical characteristics includes all types found in the United States:

(*a*) *Turfy peat.*—Consisting of slightly decomposed mosses and other peat-producing plants, having a yellow or yellowish-brown color, very soft, spongy, and elastic; specific gravity, 0.11 to 0.26, the full English cubic foot weighing from 7 to 16 pounds.

(*b*) *Fibrous peat.*—Unripe peat which is brown or black in color, less elastic than turfy peat, the fibers either of moss, grass, roots, leaves, or wood, distinguishable by the eye, but brittle and easily broken; specific gravity, 0.24 to 0.67, the full cubic foot weighing, accordingly, from 15 to 42 pounds.

(*c*) *Earthy peat.*—Nearly or altogether destitute of fibrous structure, drying to earthlike masses which break with more or less difficulty, giving lusterless surfaces of fracture; specific gravity, 0.41 to 0.90, the full cubic foot weighing from 25 to 56 pounds.

(*d*) *Pitchy peat.*—Dense; when dry, hard; often resisting the blows of a hammer, breaking with a smooth, sometimes lustrous fracture into sharp-angled pieces; specific gravity, 0.62 to 1.03, the full cubic foot weighing from 38 to 65 pounds.

Peat consists of carbon, hydrogen, oxygen, and relatively small quantities of nitrogen. Although the exact atomic relations of its principal elements are not known and probably are not constant, the formula $C_{62}H_{72}O_{24}$ is typical. The composition of peat is illustrated by the following analysis (ash omitted):

Composition of peat.

Carbon	59.50
Hydrogen	5.50
Oxygen	33.00
Nitrogen	2.00

[1] Johnson, S. W., Peat and its uses, pp. 95–96, New York, 1866.

The ash found in native peat, which renders it more or less impure, constitutes from 3 to 30 per cent of its dry weight and is traceable either to the plant cells or to the mineral carried in suspension or solution by the water in which the peat formed. The inorganic impurities of peat are silica, alumina, iron oxide, magnesia, lime, soda, potash, sulphuric acid, chlorine, and phosphoric acid. If the ash content exceeds 8 per cent, it is due to the mineral matter in the water that covered the peat during formation, and it usually consists of silica in the form of sand or silt or of alumina and silica in the form of clay. Mineral constituents other than silica and alumina in excess of 8 per cent are not common in peat and where found may be traced to the local water supply. If the inorganic impurities of decayed vegetation are much in excess of 30 per cent, the material should be classed as muck rather than peat.

USES.

The uses of peat are numerous and varied. In the countries of northern Europe it is used for fuel and as the basis for many manufacturing industries. Gas, charcoal, coke, and a number of valuable by-products are produced from it. Owing to the scarcity of raw materials in Europe peat and peat moss are also employed as substitutes for absorbent cotton in the preparation of surgical dressings, for wood, and for cotton and woolen cloth.

In the United States peat is utilized chiefly as fertilizer and fertilizer filler, as stable litter, and as an absorbent for the uncrystallized residues of beet and cane sugar refineries in the manufacture of stock feed.

PEAT AS FUEL.

GENERAL FEATURES.

Peat, because of its high carbon content and the fact that it will ignite and burn freely when dry, yielding an intense heat, is used for fuel in countries where the coal supply is below normal requirements. In Europe between 15,000,000 and 20,000,000 tons of hand-cut and machine peat are consumed annually. The hand-cut peat is produced by the peasants for domestic use and the machine peat is sold in the form of blocks for both domestic and industrial use. Many attempts have been made both in Europe and in the United States to manufacture peat briquets for commercial use, but, though these are more efficient than hand-cut or machine peat, the process, on account of the high cost of production, has never advanced beyond the experimental stage, so far as the United States Geological Survey is aware.

Peat in an undrained bog contains about 90 per cent of water, which must be reduced to 30 per cent before the peat can be used for fuel. By thoroughly draining the deposit approximately 10 per cent of the original water contained in the peat may be eliminated, but the remainder, which is held in the microscopic plant cells and minute intercellular spaces, can not be reduced below 70 per cent without drying in the open air or in a heated chamber. However, artificial drying requires the expenditure of so much heat in comparison with the heat obtainable from the fuel prepared by this method that it has not proved commercially feasible.

The value of a given deposit of peat as a source of fuel is dependent upon many factors, most important of which are degree of decomposition, heating value, and ash content. Coarse-textured fibrous peat is inferior for fuel to the black, compact, thoroughly decomposed kind, unless the latter contains too large a proportion of ash. The maximum quantity of ash that is usually considered allowable in peat for commercial use has been placed between 20 and 25 per cent, but if it exceeds 20 per cent of the total dry weight the peat is scarcely worth the labor of production.

The following table shows the calorific value of peat as used commercially compared with other mineral fuels:

Comparative calorific value of peat and other fuels.

	British thermal units.
Wood	5,760
Air-dried cut peat	6,840
Air-dried machine peat	7,290
Lignite	7,500
Bituminous coal	14,000
Anthracite	13,000

Cut peat is bulky, is easily crushed, and burns rapidly with considerable waste. It is superior to wood in heating value but is unfitted for commercial use. However, despite the disadvantages of cut peat, machine peat is suitable for both domestic and industrial use, and powdered peat is well adapted for use under steam boilers with forced draft. In calorific value a ton of machine peat is equal to about 1.3 tons of wood, 0.5 ton of good bituminous coal, and 0.6 ton of anthracite. It is clean to handle and burns freely, yielding an intense heat and producing no soot or other objectionable deposit. For open grates this fuel is nearly ideal, and it is said that peat may be burned in the same stoves as coal and wood. However, the best results for household use could probably be obtained by burning it in a stove with relatively small grate openings and a restricted draft.

PEAT FUEL IN THE UNITED STATES.

Although in Europe between 15,000,000 and 20,000,000 tons of this fuel are produced and consumed annually in generating heat and power, in the United States, because of the abundance in normal times of coal, which is more efficient and can be cheaply prepared and more readily transported to the consumer, only small quantities of peat fuel have been produced, and the interest shown in previous years in its possibilities has been largely scientific and experimental. The attempts that have heretofore been made in this country to produce peat fuel on a commercial scale have not been successful, but the failure appears to have been due not to a lack of market for the product but to the lack of sufficient capital, to the inexperience of operators, and to preventable engineering errors. It is said that air-dried machine peat can be produced in the United States at a cost ranging from 75 cents to $2.50 a ton, the exact figure depending on the size and efficiency of the plant, and it is believed that in some parts of the country it could successfully compete with other fuels for both domestic and industrial use. In many places where peat fuel has been used in this country it has proved very satisfactory and has found ready sale as fast as produced.

In recent years the increasing cost of producing coal and the failure of the operators to keep pace with the ever-expanding demand have led to a general advance in price. This condition, aggravated by an appreciable reduction in the visible coal supply and the rapid exhaustion of our forests, has made a marked impression upon economists and others and has created a desire to conserve these materials by investigating and substituting other fuels and sources of power wherever they can be more economically used.

Van Hise[1] in urging the conservation of our wood and coal reserves says:

So far as practicable other products should be substituted for wood. The original forests of the United States contained not less than 850,000,000 acres, having not less than 4,800,000,000,000 feet of merchantable saw timber. This was our magnificent original heritage. The United States as a Nation has existed a century and a quarter, and what have we now? In that brief time approximately one-half of the value of our forests has gone.

So far as practicable substitutes should be used for coal. Even if all possible economies and substitutes are introduced, the most sanguine can not hope that the supply of fuels will be sufficient to meet the needs of the people for more than a small fraction of the time we look forward to as the life of this Nation.

The shortage of coal in the Eastern and Central States that began toward the end of 1917 has also stimulated a wide interest in the peat deposits of the United States and their potentialities as a source of auxiliary fuel, and from the increasing number of requests received by the United States Geological Survey for information on the subject, it seems that the public is willing to consider seriously the use of peat to prevent a recurrence in some localities of the suffering caused by inadequate fuel supplies last winter. The lack of coal in many European countries that has existed since the beginning of the war is being supplied in part by the increased use of peat, and there is no reason why the United States should not utilize its vast deposits of this fuel.

It will be noted from Plate I that in the northern peat region there are no known coal fields, except in small sections, notably in Michigan, and that the peat deposits are largely confined to States which, because of their cold climate and extensive manufacturing industries, consume large quantities of fuel. In the southern part of the coastal region, although the climate is mild and the demand for fuel relatively small compared with that in the Northern States, there are no local sources of other mineral fuels. The preparation and storage of peat fuel taken from these deposits would not only increase the local fuel supply and in many communities prevent a recurrence of the suffering caused by the coal shortage in 1917, but would release railroad cars which will be vitally needed for other purposes during the war.

Although peat fuel may not be extensively produced in the United States in normal times as long as there is an abundant supply of

[1] Van Hise, C. R., The conservation of natural resources in the United States, pp. 210, 256, 359, New York, Macmillan Co., 1910.

coal, except possibly in localities where conditions are peculiarly favorable, it has great potential value as a source of heat and power and may be utilized to conserve our reserves of coal and wood and also, during economic and industrial crises, may be used locally in some States to prevent a fuel shortage.

METHODS OF PREPARATION.

Cut peat.—In the United States the season for drying peat begins about April 15, or as soon as the frost is out of the ground, and ends approximately September 15, except in the southern peat region, where it is somewhat longer. Peat intended for domestic use may be economically prepared by the owners of small deposits either by hand or by small-capacity peat machines. The heating value and ash content of prospective peat fuel for home consumption may be determined by a simple practical test. A typical sample should be taken from the bog, thoroughly macerated, dried, and weighed. If when burned in an ordinary heating stove the heat generated is almost equal to that produced by ordinary bituminous coal and if after complete combustion the weight of the accumulated ash does not exceed 20 per cent of the weight of the dry peat put into the stove, its usefulness as domestic fuel is established.

For home use the preparation of peat by hand, which is the method so widely used in Ireland, seems most practicable for the owners of small deposits in the United States. Before this process can be used the deposit must be thoroughly drained and cleared and the turf removed from its surface. Bogs of the built-up type, that is, those which were formed by the deposition of the remains of plants that grow near the ground-water level, can usually be drained to the bottom by a simple system of surface ditches. Lake bogs in which deposits have accumulated below a permanent water level can not generally be drained far below the surface of the peat without incurring great expense, and hence are not so well adapted as built-up bogs to hand digging. However, many lake bogs in the northern peat region, where most of the marshes in which this material has accumulated were formed by the Wisconsin or last glacial drift, may be sufficiently drained for peat recovery by means of a short drainage canal connecting the edge of the basin at the lowest level with an adjacent stream.

After the surface of the bog has been cleared the peat is dug in brick form with a special tool called a slane. This instrument, which can be made by a blacksmith, consists of a narrow spade with a sharp steel lug welded on one side and at right angles to the edge of the blade. The blocks range from 8 to 10 inches in length, from 4 to 7 inches in width, and from 3 to 6 inches in thickness, depending on the size of the slane. As they are dug they should be removed to the drying grounds or placed on covered racks. At the end of about four weeks, during which they should be frequently turned until the moisture content is reduced to about 30 per cent, the blocks are usually ready for storage. As cut peat absorbs water rapidly, extreme care should be taken to protect the dry blocks from rainfall.

Machine peat.—If it is desired to produce peat fuel of better quality and in larger quantities than is possible by hand, the machine method should be adopted. This process is, so far as known by the United States Geological Survey, the only one that has proved commercially successful in Europe. The machinery for a small plant is simple and easily operated. It consists essentially of an excavator and a macerator. The steam shovel could be used for digging peat from drained deposits, and the dipper dredge is admirably adapted to removing this mineral from deposits which can not be economically drained. The purpose of the macerator is to grind the constituents of the wet peat into a homogeneous pasty mass which may be shaped into compact blocks. In principle and form the latest types of peat machines are similar to the pug mill or grinding machine for plastic clay. Many of the experimental plants in the United States have used brickmaker's pug mills very slightly changed to grind peat and have found them well suited for the purpose. After being thoroughly macerated the peat is shaped into compact blocks as it comes from the machine or is spread in a layer from 8 to 12 inches thick on the drying grounds, and the bricks are marked off by hand as the spreading proceeds. When partly dry the bricks are loosely stacked or placed on drying racks and thereafter handled in the same manner as cut peat.

Machine peat which is allowed to dry slowly contracts into a dense mass covered by a gelatinous skinlike substance called hydrocellulose. After the moisture has been reduced to about 25 per cent this coating renders the machine peat impervious to water, even when immersed.

A specially designed and constructed machine is used for the commercial production of peat fuel. Such a machine consists of a receiving hopper attached to a vertical or horizontal cast-iron body, in which revolve one or two knife-armed shafts. These shafts are also provided with spirally arranged flanges for moving the peat to the grinding knives and advancing it to the device for cutting the peat pulp into bricks of uniform length as it issues from the orifice of the machine. The principal types of peat machines of modern construction are fully described and illustrated in a publication of the Canada Department of Mines.[1]

Powdered peat.—If raw peat is allowed to lie in heaps until natural drainage and evaporation has reduced the moisture content to about 50 per cent, it may be prepared for use under steam boilers by driving off about half of the remaining moisture with waste heat from flues and pulverizing the resulting material. According to E. A. Beals, of Hartford, Conn., who has been experimenting with this process, the powdered peat may then be blown with compressed air into the furnace, where, by means of a forced draft, ignition is almost instantaneous, and instead of burning on the grate, the peat forms a gas which gives a uniform fire throughout the entire combustion chamber.

Good peat thus treated, when burned in furnaces designed to give the most complete and efficient combustion, is said to give nearly as

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[1] Nystrom, E., Peat and lignite; their manufacture and uses in Europe, Canada Dept. Mines, Mines Branch, 1908.

much energy in the form of live steam as the same weight of produced coal.

Peat powder may also be prepared for fuel by pulverizing machine peat blocks after they have been air dried to about 40 per cent of moisture and then screening and heating the material thus obtained in rotary driers until it contains about 15 per cent of moisture. However, this process is so expensive that it is doubtful whether peat so prepared could successfully compete with powdered coal.

According to reports of tests in this country powdered peat has great possibilities, not only for boiler firing but for metallurgic work and for use in cement and other kinds of kilns in which powdered coal has been successfully burned.

Producer gas and by-products.—Peat consumed in a properly designed gas producer yields gas of good quality and in abundant quantity in comparison with the yield from coal, and also many valuable by-products. This is perhaps the most effective utilization of peat fuel for generating heat and power, because peat that is to be used in this way does not need to be so carefully prepared nor so thoroughly dried as peat that is to be consumed for domestic purposes or under steam boilers. Gas-producing plants using peat fuel are operated in England, Ireland, Germany, Sweden, Italy, and Russia; but in the United States, although experiments have been made, no gas-producing plants are operated with peat.

Analyses of the peats of the United States show that they are very rich in combined nitrogen, from 70 to 85 per cent of which—a proportion that in some peats amounts to more than 2 per cent of their dry weight—could be recovered in the form of ammonium sulphate in by-product gas-producing plants operated with peat.

PEAT IN AGRICULTURE.

DRAINED PEAT LAND.

Large areas of land in the United States overlain with peat beds less than 5 feet deep could be profitably drained and utilized for the cultivation of crops. There is approximately 15,000,000 acres of peat and muck land supporting a growth of shrubs, tamarack, white cedar, birch, water maple, gum, and cypress in the eastern section of this country, and only about 750,000 acres, or 5 per cent of the total area, has been reclaimed for agricultural purposes. Peaty soils that have been drained, cleared, and freely exposed to the air by plowing are well adapted to the production of vetch, buckwheat, corn, potatoes, carrots, the cranberry, and improved forms of the blueberry. When properly treated with potash salts or with lime they are neutralized or made slightly alkaline and will then yield large quantities of red clover, wheat, oats, and other alkaline-soil crops. Many regions in the United States are underlain by beds of marl, consisting chiefly of shells of lime carbonate deposited by organisms and later covered by peat in land-locked bays, or of shells and lime carbonate precipitated through the agency of blue-green algae and stoneworts (*Chara*) in bodies of fresh water, in which peat has subsequently accumulated. In these areas the land could be economically treated with lime from these deposits and the yield of alkaline soil crops might thus be materially increased.

However, the greatest values derived from the cultivation of peat and muck have arisen from their use as special-crop soils. Cabbage, onions, celery, lettuce, spinach, carrots, beets, turnips, and peppermint are the most valuable crops that are grown on farmed areas of peat and muck. The acreage values of these crops so far surpass those of the general farm crops that the reclamation of any large areas of peat or muck should be undertaken with the special object of their production. For the profitable sale of these special crops it is desirable that such areas of peat and muck as are easily accessible to large city markets or to rapid transportation should first be reclaimed.

FERTILIZER AND FERTILIZER FILLER.

Peat has long been used in fertilizing the soil, having been either applied as a direct fertilizer or used as a filler for commercial fertilizer. Analyses of the peats of the United States show an average nitrogen content of about 2 per cent, a proportion somewhat higher than that found in some commercial fertilizers. The value of peat in soil fertilization is found in its nitrogen content and in the beneficial mechanical effect it produces upon certain lands. Black, thoroughly decomposed peats are most satisfactory for fertilizer, as such peats are generally heavier and more compact and contain more nitrogen and less fibrous material than the brown types.

Davis thus briefly describes the process by which peat fertilizer is prepared:[1]

> The processes of preparing peat for fertilizer are comparatively simple. The bog is drained thoroughly, and the surface layers are carefully plowed and cultivated for one or more seasons before digging begins. The peat is prepared for sale by reducing it to the state of a powder containing about 10 per cent of moisture. When an area is considered ready for gathering the peat the surface is repeatedly harrowed either by ordinary harrows or by special machinery for the purpose of drying the surface layers as much as possible. When sufficiently dry the harrowed peat is scraped into windrows and loaded on tram cars, which, in the larger plants, are drawn to the drying plant by small locomotives operated by electricity or gasoline. The unloading is done from a trestle over the stock pile, from which the peat is elevated as needed to the inlet hoppers of large rotary cylindrical driers. The driers used are of the directly heated single-tube type—that is, they consist of a single shell of boiler iron, with a large furnace at one end and a settling chamber, from which the smokestack or chimney arises, at the other. The cylinder is slightly inclined from the inlet to the outlet end and is revolved on its long axis by mechanical means. Iron flanges, running spirally the length of the inside of the cylinder, raise the peat to the top of the tube and drop it to the bottom through the heated air and gases, as these pass from furnace to smokestack, and at the same time move it steadily forward to the outlet, where it is automatically discharged. Usually a fan blower or an exhaust fan increases the draft through the drier, and this can be regulated to meet the requirements of the peat. After the peat has passed through the drier it is elevated by mechanical conveyers of considerable length to permit proper cooling, screened to remove coarse and lumpy material that has not been completely disintegrated in drying, and immediately shipped or stored in fireproof storage bins. * * * When the peat is to be applied directly to the soil as a source of humus and of organic nitrogen, the drying is not carried so far.

Bacterized peat is said to be an even more prolific source of soluble nitrates than the crude material. A culture bed of peat, if treated with a dilute solution of ammonium sulphate and then inoculated

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[1] Davis, C. A., Peat: U. S. Geol. Survey Mineral Resources, 1914, pt. 2, pp. 382–383, 1915.

with nitrifying organisms, is said to yield after one treatment 0.82 per cent of nitrates, and after repeated treatment about 4 per cent. It has not yet been shown that this process is adapted to the production of nitrates on a commercial scale, but in view of the rare occurrence and present shortage of these salts, which are so essential to agriculture, the process strongly invites further and larger experiment. If the only change effected, however, is to convert to a nitrate the nitrogen supplied to the peat in the ammonium sulphate, the value of the process is questionable.

A more practicable method of increasing the nitrogen content of soils by means of peat is proposed by Bottomley.[1] It is well known that if peat is exposed to the air for about two years it is neutralized by the formation of ammonia, and a large proportion of the insoluble material is converted into food available for plant life. By inoculating the peat with aerobic bacteria it is found possible greatly to accelerate this change and to increase materially the quantity of plant food. The problem, however, was not to discover a fertilizer, but to find a medium in which nitrogen-fixing organisms could be cultivated and placed on the soil. This medium is found in the peat treated with aerobic bacteria. To prepare it for inoculation the peat is kept moist at a temperature of 26° C. for about a week. Steam is then forced through it to insure that all organisms, bacterial or otherwise, are destroyed, and the result is a sterile medium, neutral or slightly alkaline, suitable for the cultivation of plants or of nitrifying bacteria. The sterilized peat is then inoculated with a mixed culture of *Bacillus radicicola* and *Azotobacter chroococcum*, which multiply rapidly and soon permeate the entire culture bed. After complete saturation the bacterial growth is arrested by drying the peat, and it is then ready for use. It is reported that the bacteria in this material enrich the soil to which they are applied by extracting nitrogen from the air and converting it into soluble plant food and that, owing to continuous bacterial action, frequent subsequent treatment is unnecessary.

Still further progress in the application of bacteriology to soil fertilization has recently been reported by Earp-Thomas, of Richmond, Va. According to his process the peat is mixed with tricalcium phosphate and used as a culture medium for nitrifying and other bacteria which produce phosphorus compounds and which, when applied to the soil, react upon and free its natural potash content from insoluble chemical combinations.

Bacterized peat is being used for fertilizer in England with varying degrees of success. In the United States commercial quantities have been manufactured and sold, and it is reported that crops grown upon soil enriched by it yielded a much greater output than could be obtained from the same land treated with commercial fertilizer.

STOCK FOOD.

Black, humified peat is used both in Europe and in the United States for compounding stock food. The method of preparing the peat is substantially the same as for fertilizer. After being air-

[1] Knox, G. D., The spirit of the soil, 242 pp., 17 figs., London, Constable & Co. (Ltd.), 1916.

dried and partially carbonized the peat is screened and reduced to a powder containing about 10 per cent of moisture. The powdered peat acts as an absorbent for the uncrystallized residues from beet and cane sugar refining, which, because of their viscidity, are otherwise difficult to feed. This valuable food material may thus be economically fed to cattle and other live stock without causing gastric disorders. It is said that the peat also stimulates the digestive organs, contributes proteid substance, and is an excellent substitute for charcoal. Charred dried peat is also frequently used as an ingredient of poultry and other commercial stock feed. In European countries peat mull and fiber prepared from moss and sedge peat are used as the bases for stock feed.

ABSORBENT AND DISINFECTANT.

Peat mull may be profitably employed as an absorbent of the valuable nitrogenous liquids of stables, which are ordinarily wasted. When so used it not only absorbs liquids but checks decomposition and absorbs gases, so that it should be an effective deodorizer and disinfectant. For this use it is superior to lime, ashes, and some of the more expensive disinfectants, and it is a nearly ideal material for use in earth closets and other receptacles for moist waste organic matter. Peat mull and litter are successfully used in this country as bedding for stock.

PEAT AS AN ANTISEPTIC.

Certain varieties of sphagnum or peat moss are so antiseptic and absorbent that they are widely used as a substitute for medicated cotton in dressing cuts and wounds. This fact was first recognized in the British Isles, but the reputation of sphagnum as a surgical dressing soon spread to the European Continent, where it is now extensively utilized by the French Red Cross in the hospitals of Boulogne and elsewhere. It is also reported that sphagnum has been used in Malta, Alexandria, Gallipoli, and Serbia.

It is understood that experimental work with a view to utilizing sphagnum is being done in this country by the American Red Cross.

In some ways sphagnum is superior to cotton for surgical dressings. It is more resilient, lighter, and cooler, and has inherent antiseptic properties that can be given to cotton only by special treatment. Native sphagnum is about 90 per cent water, and when thoroughly dry it is said to be capable of absorbing moisture to the extent of about 22 times its own weight, whereas cotton absorbs less than 11 times its weight. In England the long-leaved variety *Sphagnum cymbifolium* is in greatest demand for surgical use, but in the United States *Sphagnum papillosum* is said to be the best.

According to E. K. Soper[1] there are many square miles of sphagnum bog in Oregon and in the northern counties of Minnesota, Wisconsin, and Michigan that would supply material suitable for this purpose. Sphagnum is also abundant in Maine, and some is found in New York and northeastern Pennsylvania. It would not be necessary to incur the expense of excavation, for immense quantities of sphagnum could be taken from the surface of the bogs.

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[1] Official correspondence.

The following quotation[1] explains briefly the preliminary method of preparing sphagnum for medical use:

> The moss should be picked by hand in strands 6 or 7 inches long without wringing the water from it, and should be so spread on near-by bushes or rocks that the air can have free access to it from both above and below. When so arranged it bleaches white and becomes thoroughly dry in a few days. Impurities such as grass, rushes, etc., are then removed, and after being sterilized it is packed in clean cotton bags.

PEAT INDUSTRY IN PRINCIPAL FOREIGN COUNTRIES.

GENERAL CONDITIONS.

The shortage of coal and fertilizer that has prevailed in Europe since the war began became acute in 1917 and created an unprecedented demand for peat. Individuals, corporations, and governments erected plants for its production. Peat will probably be so widely used in northern Europe before the war ends that even with the resumption of normal conditions a greatly increased demand for it will continue. Prospects for the development of a peat industry of large proportions are therefore very good.

It is estimated[2] that in Europe, exclusive of Russia, there are 212,700 square miles of peat bog, in Russia 70,000 square miles, and in Canada 50,000 square miles. European countries annually consume between 15,000,000 and 20,000,000 tons of peat fuel. Of this quantity Russia produces about 5,000,000; Germany, 3,000,000; Denmark, 1,500,000; Holland, 1,000,000; and Sweden, 1,000,000 tons, and the remainder is manufactured and sold in Norway, the British Isles, Austria-Hungary, France, Switzerland, and Italy. It is apparent, therefore, that peat is a resource vast in extent and that the peat industry is still young.

RUSSIA.

To meet the coal shortage created in Russia by the war a committee was organized in 1915 and given power to regulate the production and price of fuels. Since that time measures have been adopted to stimulate the output of peat and increase its use in the industries. A company capitalized at 9,000,000 rubles was recently organized in Moscow for the production of peat fuel.

GERMANY.

The depletion of Germany's forests at a comparatively early date, while agriculture was the principal occupation of the people, led to the widespread use of peat in that country, especially among the peasants. Later, after the method of preparing peat had been improved, it was used in Germany for both domestic and industrial purposes, and in recent years improvements in gas-producing plants and gas engines that permit the utilization of low-grade fuels has greatly stimulated the peat industry. Before the war the peasants produced large quantities of sphagnum, which was sold to German chemists

[1] Lay, J. G., Continental substitutes for absorbent cotton: Commerce Repts., No. 216, p. 1307, Sept. 15, 1915.
[2] Knox, G. D., The spirit of the soil, p. 37, London, Constable & Co. (Ltd.), 1916.

and exported to England. Since 1914 German manufacturers have been weaving with a yarn spun from peat moss, shoddy, and Swedish wool a cloth resembling cheviot, which is said to make durable clothing. It is estimated that the peat bogs of Germany cover approximately 5,683,400 acres.

DENMARK.

The beneficial effect of the European war on the peat industry of Denmark is shown by the following table based upon data furnished by John Olsen, of Arlington, Mass.:

Air-dried machine peat produced and consumed in Denmark, 1914–1917.

Year.	Number of producers.	Quantity (short tons).	Average price per ton.	Value
1914	65	95,734	(a)	(a)
1915	69	104,878	$3.70	$388,191
1916	160	130,605	5.83	761,852
1917	561	438,546	6.99	3,063,414

a Not available.

Producers of hand-cut peat fuel reported an output of 1,002,292 short tons in 1917, but as large quantities manufactured by the owners of small deposits for home consumption were not reported it is impossible to compute accurately the value of hand-cut peat produced in Denmark in that year. The quantity of peat coke produced in 1917 was 220 tons and of peat litter 364 tons; the litter was valued at $8,019, or an average price per ton of $22.03. Approximately 131,564 tons of machine peat, or about 30 per cent of the entire output, was used in manufacturing plants, gas-producing plants, locomotives, and steamboats, and the remainder was sold to domestic consumers and to hospitals. It is reported that peat containing 60 per cent of moisture yielded 14,000 cubic feet of gas per metric ton and that Diesel engines were driven with this gas. A basic price of $8.65 a metric ton for peat fuel having a combined ash and moisture content of not more than 35 per cent was fixed by the Danish Government. A reduction from this figure of 15 cents per ton for each per cent of ash and moisture in excess of 35 was allowed to consumers. Through the Danske Hedeselskab the Government subsidized 225 private peat plants to the extent of 50 per cent of the total cost of each plant, and constructed about 15 miles of narrow-gage railroad connecting the peat bogs with established routes of transportation.

HOLLAND.

Although the moors of Holland contain more than 100,000,000 tons of peat, even fuel from this source has become scarce and has doubled in price since the war began. The peat industry of that country has greatly expanded in recent years, and although peat is not so scarce as coal, the Dutch Government, on account of the acute fuel shortage, has limited the quantity consumers may purchase and has established a maximum price for peat in order to protect the poor classes from profiteering.

SWEDEN.

Owing to difficulties in importing coal the directors of the Swedish state railways early in 1916 began a series of experiments with peat powder as locomotive fuel. Two peat experts were selected and preliminary cost data were compiled. The peat used was taken from a large bog located at Hästhagen, about a mile and a half from Vislanda. Comparative tests were made with two locomotives of the same type, one being fired with peat averaging 7,920 British thermal units in calorific value and the other with coal capable of generating 13,030 British thermal units. A hopper was mounted on the tender to hold the peat, from which it was blown through a pipe into the fire box. It is said that the temperature of the fire box on the peat-burning locomotive averaged 1,670° C. and that the efficiency of the boiler was 73 per cent, whereas on the coal-burning engine the temperature of the fire box averaged 1,510° C. and the efficiency of the boiler was 68.8 per cent. The tests proved conclusively that powdered peat could be successfully used as locomotive fuel and several large peat-powder plants costing $350,000 each were immediately erected by the Swedish Government. It is estimated that the Hästhagen fields alone are capable of yielding more than 200,000 tons of powdered peat. All the locomotives on the Falköping-Nässjö Railroad, a line 60 miles in length, are burning peat. The cost of producing peat powder for use in locomotives in Sweden is said to be about $3.91 a metric ton.

It is reported that a process was perfected in Sweden in 1917 for manufacturing cloth from peat moss and that a factory designed to produce it in commercial quantities is planned. The peat cloth is alleged to be durable and cheaper than artificial wool. Clothing made from the material is being worn by the inventor and many others.

Sphagnum was also produced and marketed in Sweden in commercial quantities in 1917.

NORWAY.

Conditions in Norway in 1917 were decidedly favorable to the expansion of the peat industry. Marketed production of machine peat amounted to approximately 100,000 short tons, an increase of 78,000 tons, or nearly 355 per cent, compared with the output of 22,000 tons in 1916. Large quantities of hand-cut peat were also produced by owners of deposits for consumption in their own homes and were not reported.

According to United States Commerce Reports[1] 216 peat fuel machines were in operation in Norway in 1917, compared with 55 in 1916 and 36 in 1914. Among these were two automatic machines, each of which cost $13,400, has a daily capacity of 30 to 40 tons of fuel, and requires only two men for its operation.

Many new deposits were located, and plants which had been idle for several years resumed operations. A bog estimated to contain 8,000,000 tons of peat was discovered on the island of Smolen in the Romsdalsfjord. Vast deposits are found in the northern part of the

[1] Dunlap, M. P., Peat production in Norway: Commerce Repts., August, 1917.

country and measures have been taken by the Government to develop those near Christianssund in order to supply peat to the Norwegian state railways. The marsh known as Store Mose, with an area of 250 acres and an average depth of 15 feet, which has been undeveloped for centuries, was opened in 1917 by the municipality of Stavanger, and in August of that year a local manufacturer was constructing 10 peat-fuel machines.

A company, capitalized at $268,000, to produce peat fuel by the Rosendahl method was formed in 1917. It is alleged that the product, which resembles English coal, has been tested by both industrial and domestic consumers of fuel in Christiania and found satisfactory. Another company obtained the right to produce peat from a small bog near Naerstrand and installed two peat plants.

The maximum price for peat established by the Norwegian Government was $5.63 a metric ton.

BRITISH ISLES.

IRELAND.

In Ireland peat has been the only domestic fuel of the common people from the traditional time when that country was deforested. It is one of the essential elements of Irish national life, and in many villages remote from modern routes of transportation hand-cut peat is the only fuel available. The peat fire on the hearth, like the jaunting car, typifies Irish environment, and when the tourist seeks a memento of his visit to that country he usually selects some souvenir carved from the black oak that has lain for centuries protected by strata of peat from the attacks of fungi and bacteria. The production of machine peat in Ireland is also constantly increasing, and the Government is encouraging the industry by appropriating funds to aid in the perfection of new processes.

According to the Statist[1] approximately one-seventh of Ireland's surface, or a little over 3,000,000 acres, is covered with peat bogs, a quantity unequaled in any country of the same size. Three-sevenths of this acreage is located in the mountain districts, and four-sevenths on the plains. As the upland peat contains relatively little ash it is higher in calorific value than that in the flat bogs but is not so deep and is less accessible. Most of the flat bogs are found in the great central plain within an area bounded on the north by a line drawn from Dublin to Sligo and on the south by a line extending from Wicklow to Galway. The average depth of the flat bogs is 25 feet, although in many places they are from 40 to 50 feet deep, and it is estimated that the quantity of peat amounts to nearly a billion tons.

The British Fuel Research Board has appointed a committee to study the methods of preparing peat in Ireland and to suggest means by which it may be more extensively used in the industries.

ENGLAND AND SCOTLAND.

Prof. W. B. Bottomley, of Kings College, London, has offered to the city of Manchester a free license to manufacture bacterized peat

[1] Irish peat: The Statist, London, Mar. 16, 1918, p. 451.

as long as the war lasts. As the municipality owns extensive peat land it is thought that if the offer is accepted the shortage of fertilizer in the agricultural district surrounding Manchester will be materially relieved. It is reported that the demand in England for bacterized peat, or "humogen," as this preparation is sometimes called, exceeds the supply and that it is quoted at $73 a ton.

The manufacture of surgical dressing from sphagnum is another branch of the British peat industry that has been stimulated by the war. Many tons of sphagnum are gathered from the moors of Scotland and sent to the military hospitals of Edinburgh for use in place of absorbent cotton. Smaller quantities produced in the lake district of England are utilized in the London hospitals.

FRANCE.

Peat has been produced by hand and used locally by domestic consumers in France for many years. Stimulated by the high prices of other mineral fuels, the output of peat in 1917 was materially increased and much interest was shown in its potentialities. Peat fuel proved its value even at the battle front, where it was widely used by the French Army in Alsace and in the Vosges for heating and cooking. In Alsatian districts women were engaged in its manufacture and in other sectors it was produced by French soldiers and German prisoners of war.

SWITZERLAND.

The lack of domestic coal fields and the curtailment of imports from Germany have compelled the Swiss people to resort to peat fuel. The quantity of peat available in Switzerland and the proposed method of preparing it for fuel are discussed in substance by the Société coopérative suisse de la tourbe, of Berne, a semiofficial association created by the Government to stimulate production, as follows:

> It is estimated that 12,355 acres contain peat of good quality and that the total available fuel in this area would amount to about 1,507,990 cubic yards. By using modern machines that homogenize the raw peat and shape it into compact blocks the imperfections of the hand-cutting process are avoided and large quantities of fuel can be produced in a relatively short time. Cut peat is bulky, easily crushed and quickly reabsorbs moisture, whereas machine peat is compact and resists the absorption of water even when immersed.

The Swiss Government has reserved the right to requisition stocks of prepared peat as well as all the peat deposits and will fix maximum prices when the output reaches proportions that warrant the action.

About 30 years ago an attempt was made in Switzerland to produce peat in large quantities, but on account of the cheapness of German coal the project was abandoned.

ITALY.

That the peat industry of Italy prospered in 1917 is indicated in the following excerpt:[1]

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[1] Indian Engineering, vol. 59, p. 201, 1917.

Peat is now produced from numerous bogs in Italy to supplement the coal supply. Attention has also beeen directed to peat as a source of gas and of by-product ammonium sulphate. The latest experiments were conducted at Codigoro, where it is alleged a successful process has been discovered. Crushed peat is fed into the furnace of a gas producer in which combustion is regulated by steam and hot air. The peat burns at the bottom of the feed shaft, and, reacting upon the steam, forms water gas and ammonia. These gases are next cleansed of tar by means of a scrubber and are subjected to a fine shower of sulphuric acid, which converts the ammonia into ammonium sulphate and purifies the water gas. After being cooled the water gas may be used under steam boilers, in internal-combustion engines, and for other purposes. It is said that peat containing 2.5 per cent of combined nitrogen, when treated by this process, yields 170 pounds of ammonium sulphate per ton. The first gas producer in which this process was used produced 50 tons of ammonium sulphate from 45,000 cubic feet of peat, as well as a large volume of gas, which was consumed in an 800-horsepower electric plant. Other gas producing plants were erected, and it is reported that the promoters of the process are annually manufacturing more than 3,500 tons of ammonium sulphate from about 17,000 tons of dried peat.

CANADA.

Although Canada contains a large number of workable peat deposits little is being done to develop them commercially. According to Director Haanel[1] of the Canadian Commission of Conservation, the Mines Branch has examined approximately 175,000 acres of peat bog, estimated to contain 115,000,000 tons of peat fuel. Despite these vast peat resources there was no commercial production of peat in Canada in 1917. In 1916 the production of peat fuel amounted to only 300 short tons, valued at $1,500, compared with 300 tons, valued at $1,050, in 1915 and 685 tons, valued at $2,470, in 1914. This condition of inactivity is accounted for by the fact that Canada has thus far been able to supplement her own inadequate output of coal with imports from the United States.

The possibilities of utilizing peat to solve the fuel problem of Canada is well summed up by R. O. Wynne-Roberts[2] in substance as follows:

It is somewhat remarkable that, while Canada has had much difficulty in obtaining coal from the United States, we have great deposits of peat that could be utilized. This situation is doubtless due to our more intimate acquaintance with coal and to the lack of practical experience in preparing peat. * * * The problem which confronts Canada is not one of conservation, but to determine the best means of making domestic supplies of low-grade fuels available. The great coal measures of Canada are situated in the extreme western and eastern parts of the country, and lying between these points is a vast territory devoid of coal-fields, which is now dependent on foreign sources for fuel. In one sense conservation is being practiced to a high degree, because in certain parts of the country practically all the coal required for industrial and domestic use is being imported from the United States, while valuable local fuel deposits are lying undeveloped. However, this kind of conservation never leads to commercial or industrial prosperity, and can not, therefore, be recommended.

NEW ZEALAND.

It is reported that a company was organized in New Zealand in 1917 to extract kauri gum oil from the peat deposits in the northern part of the island. Several years ago a company formed for the

[1] Haanel, E., Peat as a source of fuel: Canadian Commission of Conservation Ninth Ann. Rept., p. 4, 1918.
[2] Peat and its utilization: Canadian Min. Eng., vol. 32, pp. 216–218, 1917.

same purpose abandoned the project after a short time because the methods and machinery were unsuited for the enterprise. It is said that the peat yields from 20 to 25 gallons per ton of light-gravity oil suitable for motor fuel, as well as several varieties of heavy oil, some of which can be used in the manufacture of varnishes. Extensive deposits of peat containing large quantities of kauri gum are located in northern New Zealand.

CHINA.

A peat deposit in Fuiken Province, about 80 miles from Amoy, China, has recently been examined by chemists. Analysis of a sample of the peat from this bog is as follows:

Analysis of peat from Fuiken Province, China.

Volatile matter	61.52
Fixed carbon	24.77
Sulphur	1.19
Ash	12.52

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BARYTES.

By James M. Hill.[1]

CRUDE BARYTES.

PRODUCTION.

During 1917 the domestic crude barytes marketed amounted to 206,888 short tons, valued at $1,171,184. As will be seen from the table below, this was a decrease in quantity of 15,064 tons, or about 7 per cent, from the very large production of barytes in 1916, but an increase in value of $159,952, or nearly 16 per cent. The average price of $5.66 a short ton in 1917 exceeded by $1.10 the price in 1916 and by a still larger amount the price in any preceding year. With the exception of South Carolina, all producing States showed a marked increase in price. In Missouri the average price was approximately $6.60 a ton, but in the other States the averages ranged from $4.50 to $5.80 a ton. The smallest advance was 12 cents a ton, in Virginia; the greatest was $1.58 a ton, in Georgia.

Georgia maintained first rank as a producer of barytes, a position which she won in 1916; Missouri was the second largest producer, and Tennessee was the third. No sale of barytes was reported for 1917 from the mines in Alaska and Colorado.

Crude barytes produced and marketed in the United States, 1915–1917.

State	1915			1916			1917		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton
Alabama	(a)	(a)	....	7,631	$27,198	$3.56	1,976	$8,868	$4.49
Colorado	....	....	....	481	3,005	6.25	....	....	....
Georgia	31,027	$102,825	$3.31	104,784	401,295	3.83	111,300	601,895	5.41
Kentucky	7,753	28,427	3.67	11,068	54,995	4.97	6,720	36,084	5.37
Missouri	39,113	158,597	4.05	58,223	365,111	6.27	59,046	391,363	6.63
North Carolina	(a)	(a)	....	878	3,246	3.70	1,019	5,080	4.99
Tennessee	25,074	71,390	2.85	32,416	123,986	3.85	16,972	79,058	4.66
Other States b	5,580	19,793	3.55	6,471	32,396	5.01	9,855	48,836	4.96
	108,547	381,032	3.51	221,952	1,011,232	4.56	206,888	1,171,184	5.66

a Included in "Other States."
b Includes, 1915: Alabama, Alaska, California, North Carolina, South Carolina, and Virginia: 1916 and 1917: California, Nevada, South Carolina, and Virginia.

[1] The statistical data in this report were prepared by Miss L. M. Jones.

STOCKS.

Apparently about 20,000 short tons of barytes remained in stock in the hands of mine operators on December 31, 1917, as compared with approximately 9,000 short tons on December 31, 1916. These figures do not include stocks held by makers of barium products at their mills, as the barytes held by these companies has entered the market and is, therefore, included in the statement of marketed production of barytes. The largest stocks reported to the Geological Survey in 1917 as held at mines were in Georgia, Missouri, and Tennessee. In general, barytes is marketed as quickly as possible, but car shortage and in some of the States railroad embargoes made it impossible in 1917 for some operators to market their product as promptly as could be desired.

MARKETS.

The principal market for barytes is with makers of lithopone, ground barytes, and barium chemicals. The chief markets are in the manufacturing region of the United States east of the Mississippi and north of the Ohio and in St. Louis, Mo., though within the last few years good markets have developed at Charleston, W. Va., Sweetwater and Bristol, Tenn., and Cartersville, Ga. There are small markets for crude barytes at Denver, Colo., and San Francisco, Cal.

The output of most of the small mines is sold to local dealers who, in turn, sell to the larger buyers. Thus in the Southern States much of the barytes produced by small operators is eventually sold through Thompson, Weinman & Co., of Cartersville, Ga., and in Missouri the consumers appear to deal more often with Nulsen, Klein & Krausse Manufacturing Co. or J. C. Finck Mineral & Milling Co., of St. Louis, or Point Milling & Manufacturing Co., of Mineral Point, Mo.

IMPORTS.

As will be seen from the following table the imports of crude barytes for the last two years have been practically negligible.

Crude barytes imported for consumption, 1912–1917.

Year.	Quantity (short tons)	Value.	Year.	Quantity (short tons).	Value.
1912	26,186	$52,467	1915	2,504	$4,877
1913	35,840	61,409	1916	17	245
1914	24,423	46,782	1917	6	63

CONSUMPTION.

The apparent consumption of crude barytes in the United States during 1917 decreased about 15,000 short tons, or 6.8 per cent, below the consumption in 1916, as will be seen from the following table:

Crude barytes apparently consumed in United States, 1912–1917, in short tons.

Year.	Sales of domestic barytes.	Imports for consumption.	Apparent consumption.
1912	37,478	26,186	63,664
1913	45,293	35,840	81,133
1914	52,747	24,423	77,170
1915	108,547	2,504	111,051
1916	221,952	17	221,969
1917	206,888	6	206,894

Comparison of the preceding and the following tables discloses a discrepancy in 1917 of 10,855 tons between the sales and the consumption of crude barytes in the three industries that consume the largest quantities. This discrepancy is believed to be due largely to accumulated stocks at the plants of the manufacturers of finished barium products—that is, to lag in treatment—but it may be due in part to consumption of small quantities of crude barytes in industries not circularized and to losses in handling and transportation.

Crude barytes used in the manufacture of barium products, 1915–1917, in short tons.

Year.	For barium chemicals.	For ground barytes	For lithopone.	Total.
1915	10,216	53,903	44,503	108,622
1916	38,283	75,507	71,898	185,688
1917	49,842	60,132	86,065	196,039

THE BARYTES INDUSTRY BY STATES.

Alabama.—The barytes marketed from Alabama in 1917 was 1,976 short tons as compared with 7,631 short tons in 1916, a decrease of 74 per cent. Mines near Angel, in Calhoun County, produced a large part of the barytes sold in 1917, though several hundred tons was produced near Wilsonville, Shelby County, and Leeds, Jefferson County.

California.—The deposits near El Portal, Mariposa County, were the only ones operated in California during 1917. The output from the deposits was used for the manufacture of chemicals.

Georgia.—The barytes marketed from deposits near Cartersville, Bartow County, Ga., in 1917 amounted to 111,300 short tons, valued at $601,895, an increase of 6,516 tons, or 6 per cent, over the production of 1916. At the end of the year there were stocks of approximately 6,000 short tons of barytes unshipped from the district.

Thompson, Weinman & Co., of Cartersville, continue to be the largest operators in the district through their buying activities. Several of the lithopone companies that have acquired properties during the last two years are very active.

Illinois.—No shipments were reported from the barytes deposits near Golconda, Ill., in 1917, though it is reported that the mines have been put in shape for shipping during 1918.

Kentucky.—The barytes deposits of Kentucky do not appear to have been worked to their capacity during 1917, for the quantity marketed in that year was only 6,720 short tons, valued at $36,084, as compared with 11,068 short tons, valued at $54,995, in 1916, a decrease of about 4,300 short tons, or nearly 39 per cent. The principal operations in 1917 were in Fayette County, though a small quantity was produced in Garrard, Jessamine, Lincoln, and Woodford counties. The reorganized Central Pigment Co. was apparently a large buyer of Kentucky barytes in 1917.

Missouri.—The barytes marketed in Missouri in 1917 amounted to 59,046 short tons, valued at $391,363, as compared with 58,223 short tons in 1916—an increase of about 1.5 per cent. As usual, the largest output, about 41,000 short tons, was from Washington County deposits. Jefferson County produced approximately 2,500 tons. The remainder was fairly distributed among Cole, Franklin, Miller, Morgan, and St. Francois counties, the output from Miller County being the smallest.

The principal buyers of Missouri barytes continue to be J. C. Finck Mineral & Milling Co., Nulsen, Klein & Krausse Manufacturing Co., of St. Louis, and the Point Milling & Manufacturing Co., of Mineral Point, Mo.

Nevada.—A few hundred tons of barytes was shipped during 1917 from deposits near Hawthorne, Mineral County, Nev., to consumers on the Pacific coast.

North Carolina.—The barytes marketed from Madison County, N. C., in 1917 was 1,019 short tons, valued at $5,080, a slight increase over the shipments in 1916. There are fairly large stocks of barytes at the mines in North Carolina.

South Carolina.—The deposits of barytes at Kings Creek, Cherokee County, S. C., were in continuous operation during 1917 and made a greater production than in 1916.

Tennessee.—The barytes marketed from Tennessee in 1917 amounted to 16,972 short tons, valued at $79,058, a decrease from the output in 1916 of approximately 15,500 short tons, or nearly 48 per cent. This is a considerable reduction in the output of this important producing section, and is difficult to understand, especially as during the year one of the large lithopone makers acquired barytes land in the district.

An excellent account of the Sweetwater region, giving details of the more important mines, has recently been published.[1]

Virginia.—The quantity of barytes marketed from Virginia deposists in 1917 was slightly greater than in 1916. Figures of production can not be given without disclosing individual production.

BARIUM PRODUCTS.

PRODUCTION.

As will be seen from the following table, the sales of barium chemicals and lithopone was larger in 1917 than in 1916, the expansion of the barium chemical industry being particularly marked. The sales of ground barytes, however, declined considerably.

[1] Gordon, C. H., Barite deposits of the Sweetwater district, east Tennessee: Tennessee Geol. Survey Resources of Tennessee, vol. 8, pp. 48–82, 1918.

Barium products of domestic manufacture sold, 1915–1917.

Product.	1915 Quantity (short tons).	1916 Quantity (short tons).	1917 Quantity (short tons).
Barium chemicals [a]	8,823	16,792	22,503
Ground barytes	51,557	65,440	52,694
Lithopone	46,494	51,291	63,713
	106,874	133,523	138,910

[a] In order to avoid duplication of figures, barium chemicals manufactured from secondary product bought in open market are not included in table.

GROUND BARYTES.

Barytes was ground by 7 companies during 1916, the total sales amounting to 52,694 short tons, as compared with 65,440 short tons in 1916. The average price per ton received for the output in 1917, however, was $18.05 a ton, as compared with $14.74 in 1916; and, although the quantity of ground barytes marketed in 1917 was 12,746 short tons below that marketed in 1916, the value of the output was only $13,582 less in 1917 than it was in 1916.

The largest grinders of barytes are in Missouri, from whose plants about 40,000 short tons of ground barytes was marketed. There are grinding plants also in California, Georgia, Kentucky, South Carolina, and Virginia.

Domestic ground barytes of fine white grade was quoted at $25 to $35 a ton during the first two months of 1917; but in March the minimum quotation advanced to $28, while the maximum fell to $32. Prices remained at this level until September, when the maximum rose to $36 and stayed at this figure the remainder of the year. In October and November the minimum price quoted rose to $30, but fell again in December to $28. Off-color barytes was steady at $22 to $24 throughout the year.

LITHOPHONE.

During 1917 lithopone was made at 13 plants in the United States and the total marketed output was 63,713 short tons. The largest makers of lithopone are near Philadelphia and New York; but there are two companies in Illinois and also a new plant in Missouri which make this paint material.

The average price received by makers of lithopone in 1917 was approximately $116.06 a short ton, or 5.8 cents a pound, as compared with quoted wholesale prices which ranged from 6 to $9\frac{5}{8}$ cents a pound, being generally $6\frac{1}{2}$ to 7 cents a pound through the year.

The following list includes the domestic manufacturers of lithopone who reported production in 1917 or prospective production in 1918:

Butterworth-Judson Corporation, 61 Broadway, New York, N. Y.
Chemical Pigments Corporation, 825 Stock Exchange Building, Philadelphia, Pa.
E. I. du Pont de Nemours Co., Wilmington, Del.
Grasselli Chemical Co., Cleveland, Ohio.
Krebs Pigment & Chemical Co., Newport, Del.
Midland Chemical Co., 1531 Railway Exchange Building, Chicago, Ill.
Mineral Refining & Chemical Corporation, Carondelet Station, St. Louis, Mo.
New Jersey Zinc Co., 55 Wall Street, New York, N. Y.
Sherwin-Williams Co., 601 Canal Road, Cleveland, Ohio.

BARIUM CHEMICALS.

Barium chemicals were made in 1917 at 13 plants located in California, Illinois, New Jersey, New York, Ohio, Pennsylvania, Tennessee, and West Virginia. As will be seen from the following table, barium carbonate, blanc fixe, and barium chloride seem to be in chief demand, and the largest demand is from consumers in the Eastern States.

Barium chemicals of domestic manufacture sold, 1915–1917.

Chemical.	1915	1916	1917
	Quantity (short tons).	Quantity (short tons).	Quantity (short tons).
Barium binoxide	(a)	1,980	(a)
Barium carbonate	2,746	6,844	8,238
Barium chloride	2,106	3,643	4,870
Barium nitrate	971	446	165
Barium sulphate (blanc fixe)	(a)	3,337	6,314
Other barium chemicals [b]	3,000	542	2,916
	8,823	16,792	22,503

a Included under "Other barium chemicals."
b Includes, 1915: Binoxide, hydroxide, sulphate, sulphide, and other barium chemicals not specified; 1916: Hydroxide and sulphide; 1917: Binoxide, hydroxide, and sulphide.

Besides the barium chemicals made directly from barytes as reported above there is a production of binoxide, chlorate, nitrate, and sulphate from secondary products, but this production is not included in the foregoing tables, as to do so would involve duplication of figures, the secondary products from which the material is made having been already included in the chemicals enumerated above.

The value of barium chemicals reported to the Survey by different manufacturers varied so widely in 1917 that it is not considered an index of the market. The prices shown in the table below, prepared from the weekly quotations published by the Oil, Paint, and Drug Reporter, are believed to indicate the market trend with greater accuracy.

Monthly range of wholesale market prices, per pound, for barium chemicals, 1917.

Month.	Blanc fixe (dry).	Barium chlorate.	Barium nitrate.	Barium dioxide.	Barium chloride.
January	\$0.04–\$0.04½	a \$0.50–\$0.60	\$0.15–\$0.16	a \$0.38	\$0.04⅞–\$0.05⅛
February	.04– .04¼	a .50– .60	.15– .16	a .38	.04⅝– .05⅛
March	.04– .04¼	a .50– .60	.12– .14	a .38	.04¾– .05
April	.04– .04¼	a .50– .60	.13– .14	a .38	.04⅝– .05
May	.04– .04¼	a .50– .60	.12– .14	a .38	.04⅝– .05
June	.04– .04¼	a .50– .60	.12– .14	a .38	.04½– .04¾
July	.04– .04¼	a .50– .60	.12– .13	a .38	.04½– .04¾
August	.04– .04¼	a .50– .60	.12– .13	a .38	.04 – .04¾
September	.04– .04¼	a .50– .60	.12– .13	a .38	.04 – .04½
October	.04– .04¼	a .50– .60	.12– .13	a .38	.04 – .04½
November	.03¾– .04¼	a .50– .60	.12– .16	a .38	.04 – .04½
December	.03¾– .04	a .50– .60	.11– .16	a .38	.03¼– .05
Year	.03¾– .04½	a .50– .60	.11– .16	a .38	.03¼– .05

a Nominal.

The following domestic manufacturers reported to the Survey that they had made barium chemicals during 1917 or were about to begin the manufacture of one or more of the chemicals early in 1918:

American Barium Co., 57 Post Street, San Francisco, Cal.
Ault & Wiborg Co., Cincinnati, Ohio.
Barbour Chemical Works, 707 West Coast Life Building, San Francisco, Cal.
Block Chemical Works, Berkeley Heights, N. J.
Butterworth-Judson Corporation, 61 Broadway, New York, N. Y.
Chemical Products Co., 616 Majestic Building, Denver, Colo.
Chicago Copper & Chemical Co., 111 West Jackson Boulevard, Chicago, Ill.
Clinchfield Products Co., 120 Broadway, New York, N. Y.
Consolidated Chemical Products Co., Alton, Ill.
E. I. du Pont de Nemours Co., Wilmington, Del.
Durex Chemical Co., 320 Fifth Avenue, New York, N. Y.
Grasselli Chemical Co., Cleveland, Ohio.
Niasco Chemical Co., New Market, N. J.
Oakland Chemical Co., 10 Astor Place, New York, N. Y.
Oldbury Electro-Chemical Co., Niagara Falls, N. Y.
Port Morris Chemical Works, 92 William Street, New York, N. Y.
Rollin Chemical Co., Charleston, W. Va.
United Oil & Chemical Corporation, 61 Broadway, New York, N. Y.

IMPORTS.

According to statistics collected by the Bureau of Foreign and Domestic Commerce, Department of Commerce, and compiled by J. A. Dorsey, of the United States Geological Survey, the imports of barium products in 1917 were valued at only $53,150, a decrease of more than $400,000, or 88 per cent, from the imports in 1916. As is shown in the following table, the larger part of the imports consisted of lithopone and natural barium carbonate, though some ground barytes, precipitated barium carbonate, and blanc fixe were imported. It is believed that imports of barium products can be further restricted if necessary to release more shipping.

Value of barium products entered for consumption in the United States, 1912–1917.

	1912	1913	1914	1915	1916	1917
Manufactured barytes[a]	$26,848	$38,155	$30,483	$10,736	$2,072	$1,743
Lithopone	153,303	152,980	277,822	144,567	414,592	29,199
Barium carbonate:						
Natural	15,777	13,116	8,084	12,165	18,169	17,321
Manufactured	9,938	38,949	28,221	2,786	....	1,554
Barium binoxide	252,320	239,000	332,709	218,776	6,590	....
Barium chloride	27,655	37,620	68,866	31,295	608	....
Blanc fixe or artificial barium sulphate	70,327	62,785	32,619	18,501	17,810	3,333
	556,168	582,605	778,804	438,826	459,841	53,150

[a] "Manufactured barytes," as given by the Bureau of Foreign and Domestic Commerce, is believed to be the equivalent of ground and floated barytes as used by the Geological Survey.

FLUORSPAR AND CRYOLITE.

By Ernest F. Burchard.[1]

FLUORSPAR.

INTRODUCTION.

Fluorspar mining made another high record in 1917 on account of the strong demand for this mineral for use as flux in basic open-hearth steel furnaces and in the chemical, ceramic, and other industries. Prices reached the highest levels ever recorded and naturally stimulated prospecting and new developments. The number of operators who shipped fluorspar increased from 22 in 1916 to 52 in 1917, and this number does not include several very small producers who sold their output to companies that also mine fluorspar.

In the Jamestown district, Colo., once an important gold producer, activity was renewed as a result of the increase in value of fluorspar, which occurs there as a predominant gangue in some of the metalliferous veins. The following quotation pictures the situation in that locality about the middle of 1918.[2]

> One mineral that is actually bringing one of our old and formerly prosperous districts back into notice is totally different from the one that was first mined. A trip to this former gold producer, Jamestown, impresses one with the importance of mining fluorspar, the latest mineral. The road between "Jimtown" and Boulder is lined with auto trucks that two or three years ago ran over the road between Nederland and Boulder with tungsten ore. Most of the fluorspar from the district is purchased by one Boulder company that operates a concentrating mill, in which the ore is raised in grade from 82 to 98 per cent CaF_2, after which it is shipped to Mid-West and Eastern consumers. Fluorite is being mined also at Evergreen, in Jefferson County. Prices at the mines average around $6 per ton for 70 per cent ore, with 20 cents per unit above or below this. It is reported that a new company is about to take over the Wano gold mill at Jamestown and purchase custom fluorspar ore upon a schedule starting with $3 per ton for 50 per cent grade, and an additional 20 cents per unit above. This is substantially better than the present schedule, and indicates a strong tone in the fluorspar market. The fluorspar at Jamestown occurs in veins, with various strikes and dips, in a great mass of porphyry.

The mine near Wagon Wheel Gap, Colo., also increased its production to an important extent and reported having shipped spar as far east as Pittsburgh.

The demand for fluorspar in Canada, which prior to the war was supplied largely through importation, stimulated search for the development of deposits in that dominion. A note on the deposits at Madoc, Ontario, is given on page 300.

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[1] The statistics in this report were compiled by Miss L. M. Jones, of the United States Geological Survey.
[2] Min. and Sci. Press, July 13, 1918, p. 59.

DOMESTIC OUTPUT.

The total quantity of domestic fluorspar reported to the Survey as sold (shipped from mines) in 1917 was 218,828 short tons, valued at \$2,287,722, compared with 155,735 tons, valued at \$922,654, in 1916, an increase in quantity of 40.5 per cent and in value of nearly 148 per cent. The general average price per ton f. o. b. mines or shipping points for all grades of spar in 1917, according to these figures, was \$10.45, compared with \$5.92 in 1916, an increase of 76.5 per cent. These prices, however, are far below those that were paid for spar for prompt delivery, quotations at mines and furnaces ranging from \$21.50 early in 1917 to \$38 and \$40 in 1918.

The production of all grades of fluorspar showed an increase in 1917. Gravel spar, the grade used principally for flux in the manufacture of open-hearth steel, constitutes the bulk of the output. The shipments of gravel spar amounted to 183,144 short tons, valued at \$1,759,920, or \$9.61 a ton, in 1917, an increase in quantity of 37 per cent and in value of 146.6 per cent compared with 1916. The shipments of lump spar in 1917 were 25,548 short tons, valued at \$349,460, an average of \$13.68 a ton, compared with 14,489 tons valued at \$114,993, or \$7.94 a ton in 1916, an increase in quantity of 76 per cent and in value of nearly 204 per cent. Ground fluorspar was marketed to the extent of 10,136 short tons, valued at \$178,342, in 1917, an average price of \$17.59 a ton, compared with 7,595 tons, valued at \$94,039, or \$12.38 a ton in 1916, an increase in quantity of nearly 33.5 per cent and in value of 89.7 per cent in 1917.

Fluorspar was mined and shipped in Arizona, Colorado, Illinois, Kentucky, and New Hampshire in 1917, these five States having also produced the output in 1916. Other States, notably Tennessee and New Mexico, have in earlier years produced fluorspar, and deposits have been discovered in still other States, among which might be mentioned Nevada, Utah, and Washington. The largest producing district in the United States and probably in the world is in adjoining portions of southern Illinois and western Kentucky, separated by Ohio River. There was greatly increased activity in 1917 in this district, the number of shipping mines in Illinois having increased from 2 to 7 and of operators who shipped spar in Kentucky from 16 to 36. Colorado showed an increase from 1 to 6, and the total increase in fluorspar shippers in the United States was from 22 to 52.

The total quantity of crude fluorspar reported to the Survey as mined in the United States in 1917 was 280,825 short tons compared with 175,165 tons mined in 1916, an increase of more than 60 per cent. The total stocks of marketable spar reported at mines or at shipping points, December 31, 1917, were 21,655 short tons compared with 3,666 tons on hand at the close of 1916. The stocks in 1917 consisted of 10,587 tons of gravel spar, 1,661 tons of lump spar, 317 tons of ground spar, and 9,090 tons of crude spar not distributed by grades.

In connection with the annual canvass for statistics of the fluorspar industry at the end of 1917 a supplementary questionnaire was sent to all producers in order to ascertain the maximum capacity of their mines and plants for the fourth quarter of the year, the actual production of spar for that quarter, and the causes for the deficiency, if any. The maximum capacity for this quarter was reported as 119,218 short tons, the actual production as 53,589 tons, and the difference, or deficiency in production, as 65,629 tons. The actual production was therefore only about 45 per cent of the capacity. According to the reports the deficiency in production was apportioned according to various causes, as follows: Labor shortage (not strikes), 18 per cent; shortage of freight cars and boats, 22 per cent; shortage of mining and milling supplies, 10 per cent; unfavorable weather, 22.5 per cent; lack of roads and milling facilities, 5 per cent; limited demand, less than 0.5 per cent; and other causes not specified, about 22 per cent. The Illinois-Kentucky field was affected most adversely by unfavorable weather conditions such as flooding of mines, freezing of water used in milling, and the blocking of Ohio River by ice.

Such details of the fluorspar sales (shipments) as may be published by the Survey without revealing statistics of individual producers are given in the following table for the years 1913 to 1917. Of these years all but 1913 were "war" years, 1914 showing decidedly subnormal conditions and 1915 to 1917 probably abnormal conditions.

Domestic fluorspar sold, 1913–1917.

State.	Gravel.			Lump.			Ground.			Total.		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
1913.												
Illinois	91,663	$525,456	$5.73	5,676	$39,059	$6.88	8,137	$100,203	$12.31	85,854	$550,815	$6.42
Kentucky										19,622	113,903	5.80
Other States [a]	[b] 10,104	[b] 71,568	7.08	([b])	([b])					10,104	71,568	7.08
	[b] 101,767	[b] 597,024	5.87	[b] 5,676	[b] 39,059	6.88	8,137	100,203	12.31	115,580	736,286	6.37
1914.												
Illinois	77,048	397,913	5.16	8,842	74,708	8.45	6,998	82,428	11.78	73,811	426,063	5.77
Kentucky										19,077	128,986	6.76
Other States [a]	[b] 2,228	[b] 14,992	6.73	([b])	([b])					2,228	14,992	6.73
	[b] 79,276	[b] 412,905	5.21	[b] 8,842	[b] 74,708	8.45	6,998	82,428	11.78	95,116	570,041	5.99
1915.												
Illinois	112,769	547,415	4.85	12,033	90,337	7.51	10,757	116,161	10.80	135,559	753,913	5.56
Kentucky												
Other States [a]	[b] 1,382	[b] 10,562	7.64	([b])	([b])					1,382	10,562	7.64
	[b] 114,151	[b] 557,977	4.89	[b] 12,033	[b] 90,337	7.51	10,757	116,161	10.80	136,941	764,475	5.58
1916.												
Illinois	123,983	660,714	5.33	14,489	114,993	7.94	7,595	94,039	12.38	146,067	869,746	5.95
Kentucky												
Other States [a]	[b] 9,668	[b] 52,908	5.47	([b])	([b])					9,668	52,908	5.47
	[b] 133,651	[b] 713,622	5.34	[b] 14,489	[b] 114,993	7.94	7,595	94,039	12.38	155,735	922,654	5.92
1917.												
Colorado	11,140	94,365	8.47	5,964	102,268	17.15				17,104	196,633	11.50
Illinois	136,954	1,111,348	8.11	19,584	247,192	12.62	10,136	178,342	17.59	156,676	1,373,333	8.77
Kentucky	33,641	534,017	15.87							43,639	697,566	15.98
Other States [a]	[b] 1,409	[b] 20,190	14.33	([b])	([b])					1,409	20,190	14.33
	[b] 183,144	[b] 1,759,920	9.61	[b] 25,548	[b] 349,460	13.68	10,136	178,342	17.59	218,828	2,287,722	10.45

[a] Includes, 1913: Arizona, Colorado, New Hampshire, and New Mexico; 1914: Colorado and New Hampshire; 1915: Colorado, New Hampshire, and New Mexico; 1916: Arizona, Colorado, and New Hampshire; 1917: Arizona and New Hampshire.
[b] Some lump spar is included with gravel.

In the following table, summarizing the annual output of domestic fluorspar from 1883 to 1917, the quantities from 1883 to 1905 represent quantity mined; beginning with 1906 they represent quantity shipped from mines.

Fluorspar output in the United States, 1883–1917.

Year.	Quantity (short tons.)	Value.	Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1883	4,000	$20,000	1896	6,500	$52,000	1909	50,742	$291,747
1884	4,000	20,000	1897	5,062	37,159	1910	69,427	430,196
1885	5,000	22,500	1898	7,675	63,050	1911	87,048	611,447
1886	5,000	22,000	1899	15,900	96,650	1912	116,545	769,163
1887	5,000	20,000	1900	18,450	94,500	1913	115,580	736,286
1888	6,000	30,000	1901	19,586	113,803	1914	95,116	570,041
1889	9,500	45,835	1902	48,018	271,832	1915	136,941	764,475
1890	8,250	55,328	1903	42,523	213,617	1916	155,735	922,654
1891	10,044	78,330	1904	36,452	234,755	1917	218,828	2,287,722
1892	12,250	89,000	1905	57,385	362,488			
1893	12,400	84,000	1906	40,796	244,025		1,525,524	10,237,443
1894	7,500	47,500	1907	49,486	287,342			
1895	4,000	24,000	1908	38,785	225,998			

Figure 10 shows graphically the course of the production of fluorspar in the United States from 1883 to 1917. Two periods of fluctuation in output—between 1889 and 1897 and between 1902 and 1908—are in strong contrast with the large and steady increase in production in the periods 1897 to 1902 and 1908 to 1912. The decline from 1912 to 1914, although the greatest in actual tons, is not so great in proportion to the current production as that from 1905 to 1906, and the increase from 1914 to 1917 is clearly the largest in any similar period. For convenience of comparison the imports, beginning with the first full year for which records are available, 1910, are shown on the same diagram.

IMPORTS.

The imports of fluorspar into the United States entered for consumption in 1917 were 13,616 short tons, valued at $114,598, compared with 12,323 short tons, valued at $54,000, in 1916. This represents an increase of about 10.5 per cent in quantity and of more than 112 per cent in value. The price assigned to the imports in 1917 averaged $8.42 a ton, as compared with $4.38 a ton in 1916, an increase of $4.04 a ton, or about 92 per cent. The imports of fluorspar in 1917 were equivalent to about 7.4 per cent of the domestic production of gravel spar, as compared with about 9.2 per cent in 1916. The average reported price of imported spar at dock, exclusive of the duty, was equivalent to about 88 per cent of the average price of domestic gravel spar at mines or nearest shipping points in 1917, compared with 82 per cent in 1916. According to the prices reported, including the duty of $1.50 a ton but excluding freight charges, the average cost of imported spar at the docks was $9.92 a ton in 1917, compared with $9.61 for domestic gravel spar at the mines or mills; in 1916 the cost of the imported material including the duty of $1.50 a ton, was $5.88, compared with $5.34 for domestic gravel spar. The distances that domestic spar must be transported from mines to points where it is consumed are generally much greater than the distances that foreign spar must be carried from the docks to eastern steel plants, so that a slight advantage in price on account of a saving in freight charges may be enjoyed by the imported spar at eastern steel plants. Foreign spar is, however, not generally of so high grade as the mechanically treated spar from Illinois and

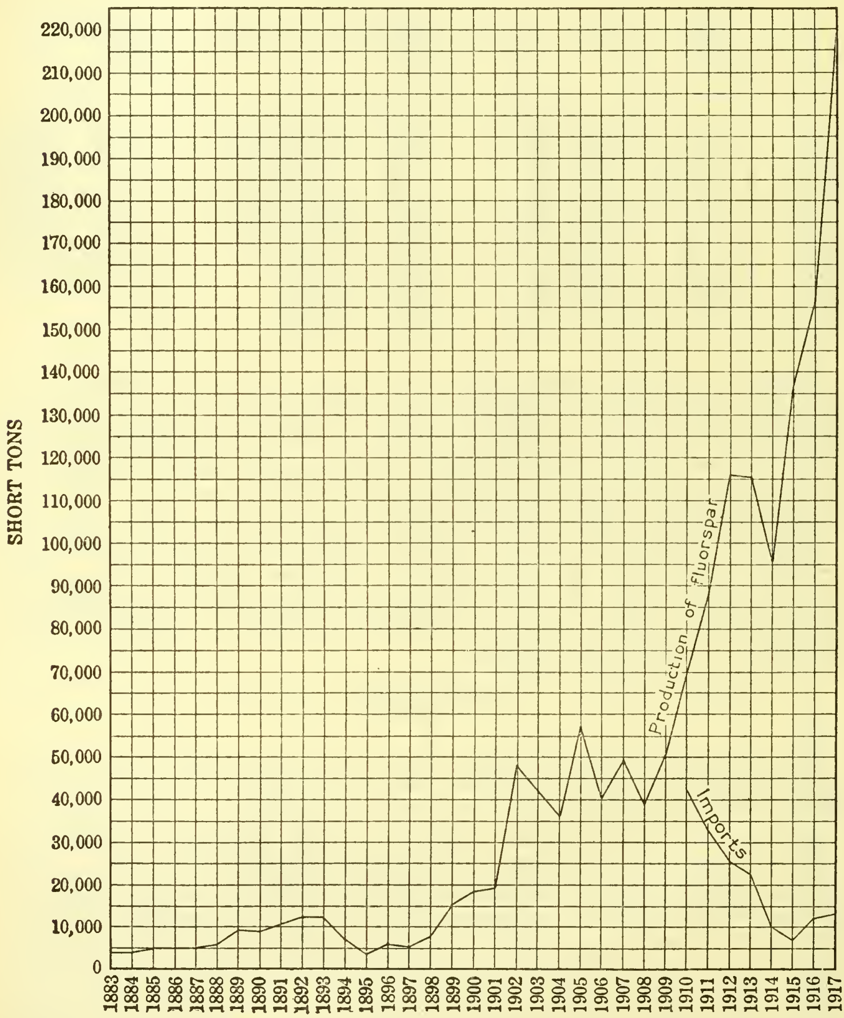

FIGURE 10.—Diagram showing production of fluorspar in the United States, 1883-1917, and imports 1910-1917.

Kentucky, and as fluorspar is of value chiefly according to its purity, purchasers should find that the purer American spar is more efficient and consequently cheaper in the end. Recently difficulties in getting supplies of fluorspar from American mines when needed, on account of freight embargoes, lack of cars, difficulties of transportation on Ohio River, and labor troubles, have led steel manufacturers to accept readily whatever foreign spar was available.

Fluorspar imported and entered for consumption, 1909–1917.[a]

	Quantity (short tons).	Value.	Average price per ton.
1909	6,971	$26,377	$3.78
1910	42,488	135,152	3.18
1911	32,764	80,592	2.46
1912	26,176	71,616	2.74
1913	22,682	71,463	3.15
1914	10,205	38,943	3.82
1915	7,167	22,878	3.19
1916	12,323	54,000	4.38
1917	13,616	114,598	8.42

[a] Statistics compiled from records of Bureau of Foreign and Domestic Commerce, Department of Commerce.

CONSUMPTION.

The market for the bulk of the fluorspar sold in the United States depends on the steel industry, and the demand fluctuates with the rise and fall in the production of steel. Both gravel and lump spar are consumed as flux in basic open-hearth steel furnaces and to a smaller extent in other metallurgic operations. From 1914 to 1917 the sales of gravel spar have constituted between 83 and 86 per cent of the total marketed output of domestic fluorspar. Fluorspar is used also as a flux in iron blast furnaces, iron foundries, and in gold, silver, copper, and lead smelters; in the manufacture of fluorides of iron and manganese for steel fluxing and of sodium fluoride for wood preservation; in the manufacture of glass, of enameled and sanitary ware, and of hydrofluoric acid; in the electrolytic refining of antimony and lead; and in the production of aluminum. Other miscellaneous uses of fluorspar that have been reported are as a bonding for constituents of emery wheels, for carbon electrodes, in the extraction of potash from feldspar, and in the recovery of potash in the manufacture of Portland cement.

A close estimate of the annual consumption of fluorspar in the United States can not be made without a knowledge of the stocks maintained by consumers. These stocks are variable, but were known to be low at the end of 1917 at the plants of some of the largest consumers. The sales of domestic spar plus the imports (there are no considerable exports at present, and the figures are not listed separately by the Bureau of Foreign and Domestic Commerce) should give from year to year an index to the quantity entering into consumption and should indicate the relative increase or decrease in consumption. The apparent consumption of spar in 1917 was 232,444 short tons, as compared with 168,058 short tons in 1916, an increase of more than 38 per cent.

The general relation between the consumption of fluorspar and the output of open-hearth steel may be noted by comparison of the following two tables.

Apparent consumption of fluorspar, 1910–1917, in short tons.

	Sales of domestic spar.	Imports for consumption.	Apparent consumption.
1910	69,427	42,488	111,915
1911	87,048	32,764	119,812
1912	116,545	26,176	142,721
1913	115,580	22,682	138,262
1914	95,116	10,205	105,321
1915	136,941	7,167	144,108
1916	155,735	12,323	168,058
1917	218,828	13,616	232,444

Open-hearth steel produced in 1910–1917, in long tons.[a]

	Basic.	Acid.	Total.
1910	15,292,329	1,212,180	16,504,509
1911	14,685,932	912,718	15,598,650
1912	19,641,502	1,139,221	20,780,723
1913	20,344,626	1,255,305	21,599,931
1914	16,271,129	903,555	17,174,684
1915	22,308,725	1,370,377	23,679,102
1916	29,616,658	1,798,769	31,415,427
1917	32,087,507	2,061,386	34,148,893

[a] Statistics for 1910 and 1911 according to annual reports of the American Iron and Steel Association and since 1911 from reports of American Iron and Steel Institute.

PRODUCTION OF FLUORSPAR IN CANADA.[1]

High prices have stimulated the mining of fluorspar at Madoc, Ontario, and production has increased from 1,284 short tons, valued at $10,238, or an average of $7.97 a ton, in 1916 to 4,249 short tons, valued at $68,756, or an average of $16.08 a ton, in 1917. The annual consumption of fluorspar in Canadian steel furnaces is from 10,000 to 15,000 tons.

The fluorspar at Madoc occurs in veins associated with much calcite and a little quartz and they are reported to cut all the rock formations from the older crystalline rocks to the later Paleozoic limestones.[2]

In the Matachewan area fluorspar has been found in small quantities in a number of quartz veins in Cairo and Alma townships. It has also been found in a barite vein. All the veins are reported to occur in syenite.[3]

PRODUCTION OF FLUORSPAR IN GREAT BRITAIN.

According to the official report[4] of output of mines and quarries issued by the Home Office at London, there were produced in Great Britain in 1916, the latest year for which statistics are available, 54,731 long tons of fluorspar, valued at $90,989, or $1.66 a ton, compared with 33,123 long tons, valued at $55,887, or $1.69 a ton, in 1915.

Authentic information on the fluorspar resources of Great Britain was published in a special report on fluorspar by the Geological Survey

[1] Preliminary report on the mineral production of Canada during the calendar year 1917, Canada Dept. Mines, Mines Branch.
[2] Eng and Min. Jour., July 20, 1918, p. 104.
[3] Canadian Min. Jour., June 15, 1918, p. 201.
[4] Mines and quarries: General report for 1916, pt. 3, 1917.

of Great Britain in 1916, and abstracts from this interesting paper were published in the report on fluorspar in Mineral Resources for 1916, Part II, pages 317–322.

OPTICAL FLUORITE.

Mention was made in this report of Mineral Resources for 1916 of the need for fluorite, or fluorspar, suitable for optical purposes. During the last year hardly a week has passed in which one or more specimens of fluorspar have not been received by the Geological Survey for consideration as to their value for optical use. Of these several have proved of sufficient promise to warrant careful testing at the Bureau of Standards, and a few have been found to be of value. The Bureau of Standards has issued the following statement concerning the properties and requirements of optical fluorite:[1]

Optical properties and uses.—Fluorite is very transparent to infra-red and ultra-violet rays. It has a low refractive power and a weak color dispersion. It is, therefore, useful in correcting the color and spherical aberration errors in lenses; especially for microscopes, small telescopes, etc.

Quality of material required.—Fluorite suitable for optical instruments must be as clear as glass, that is, it must be free from cloudiness, inclusions, cracks (incipient cleavage marks), etc. Colorless material is most desired, but samples which are faintly tinged with yellow or green may be valuable. To assist in examining for cracks, inclusions, etc., the samples may be placed in a glass vessel and covered with glycerine or kerosene which reduces the reflection from the surface of the crystal.

Size of material.—At present this bureau requires a small amount of material from which clear pieces 15 to 50 millimeters (½ to 2 inches) in diameter can be cut. The price varies from $1 to $5 per pound, while a particularly fine specimen, fulfilling the above requirements, might have a value of $10 or more.

While fluorite is a common mineral, specimens of optical quality are uncommon. Those engaged in mining this material should, therefore, keep on the lookout for clear material, which, in smaller sizes than above specified, may be used by manufacturers of microscopes.

In connection with a recent examination of the fluorspar deposits of southern Illinois the State Geological Survey has given special attention to the presence of optical fluorite in that region, and has published its conclusions.[2] This pamphlet should be obtained by all who are endeavoring to produce this grade of spar. It discusses the properties, uses, and value of optical flourite, and its occurrence in southern Illinois, and gives suggestions as to development and a list of prospective purchasers. Pogue believes that the fluorite region of southern Illinois is capable of supplying the needs of the country with respect to optical fluorite, and if, in addition, all other fluorspar-mining districts in the United States are considered there should be no doubt that the United States will be able to maintain its independence of foreign sources of supply in time of war. His suggestions as to development have such general application that the following paragraphs are quoted from them:

This will be accomplished if the mining interests of the region will give instructions to their mining staffs to search for and save all clear, glassy-looking specimens. No special knowledge is required to recognize material of promise. As compared with developed mines, the small mine or prospect has an equal if not a better chance of yielding good material, and hence the matter concerns the one-man operator as well as the larger mining company. * * * Great care should be exercised in breaking large specimens for examination; also in further handling, packing and shipping.

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[1] Circular letter, dated May 8, 1918.
[2] Pogue, J. E., Optical fluorite in southern Illinois: Illinois Geol. Survey Bull. 38 (extract), 6 pp., 1918.

Specimens for shipment should be packed in cotton, excelsior, or other resilient material, and placed in wooden and not pasteboard boxes. Samples of material of promise should be submitted to prospective purchasers before shipments are made. Particularly fine specimens will find a sale as single items; but the general run of optical fluorite should be offered for sale only in lots of several pounds or more.

For the proper development of this resource, which, though of limited value from a financial standpoint, is of considerable importance to society, the optical companies will bear in mind that the producers must be encouraged by a consistent price and at the outset be helped in discriminating between material of optical and common quality; while the producers will appreciate the fact that they are handling a highly specialized product, whose value can be more substantially enhanced by encouraging an enlarged demand through a suitable production than by limiting the supply and holding out for prices discouraging to the manufacturer.

For the information of prospective producers of optical fluorite, the following names may be given as among the possible purchasers of this material:

Bausch & Lomb Optical Co., Rochester, N. Y.
Spencer Lens Co., Buffalo, N. Y.
Bureau of Standards, Washington, D. C.
Ward's Natural Science Establishment, Rochester, N. Y.

CONSUMERS OF FLUORSPAR.

The consumers of fluorspar include manufacturers of iron, aluminum, steel, brass and other metals and alloys, metal products, chemicals, glassware, enameled ware, and Portland cement. Many of these concerns buy spar direct and others buy through dealers. In response to many inquiries for purchasers of fluorspar the following list has been prepared, mainly from reports of producers who are in touch with the markets. Any additions or revisions that the reader may send to the Director of the United States Geological Survey, Washington, D. C., will be appreciated.

Buyers of fluorspar.[1]

A. D. Mackay, 130 Pearl Street, New York, N. Y.
Alan Wood Iron & Steel Co., Philadelphia, Pa.
Allegheny Steel Co., Pittsburgh, Pa.
Aluminum Ore Co., East St. Louis, Ill.
Aluminum Co. of America, Pittsburgh, Pa.
American Cyanamid Co., New York, N. Y.
American Stamping & Enameling Co., Bellaire, Ohio.
American Steel & Wire Co., Cleveland, Ohio.
American Tube & Stamping Co., Bridgeport, Conn.
Bethlehem Steel Co., Bethlehem, Pa.
Binney & Smith Co., 81 Fulton Street, New York, N. Y.
Brier Hill Steel Co., Youngstown, Ohio.
L. H. Butcher & Co., San Francisco, Cal.
Cambria Steel Co., Pittsburgh, Pa.
Carnegie Steel Co., Pittsburgh, Pa.
Central Pigment Co., Strand Building, Forty-seventh Street and Broadway, New York, N. Y.
George W. Chesebro, Boulder, Colo.
Chrome Steel Works, Chrome, N. J.
J. G. Clark, Boulder, Colo.
Colorado Fuel & Iron Co., Denver, Colo.
Commercial Chemical Co., 1100–1110 Wabash Avenue, Chicago, Ill.
Debevoise-Anderson Co. (Inc.), 56 Liberty Street, New York, N. Y.
Eagle Glass & Manufacturing Co., Wellsburg, W. Va.
Engineers Corporation, Boulder, Colo.
Ferro-Alloy Co., Denver, Colo.

[1] For a complete list of the steel manufacturers in the United States see Directory of the iron and steel works of the United States and Canada, published by the American Iron and Steel Institute, 61 Broadway, New York, N. Y.; also A. B. C. of iron and steel, published by the Iron Trade Review, Cleveland, Ohio.

Feuchtwanger & Co., New York, N. Y.
Ford Motor Co., Detroit, Mich.
Fostoria Glass Co., Moundsville, W. Va.
Franco-American Chemical Co., New York, N. Y.
General Chemical Co., Pittsburgh, Pa.
Glover Machine Works, Marietta, Ga.
Gulf States Steel Co., Birmingham, Ala.
Hamilton Facing Mill Co. (Ltd.), Hamilton, Ontario.
Hazel-Atlas Glass Co., Wheeling, W. Va.
Harshaw-Fuller & Goodwin Co., Cleveland, Ohio.
Illinois Steel Co., Chicago, Ill.
Inter-State Iron & Steel Co., Chicago, Ill.
J. M. Jackson, Rosiclare, Ill.
Jones & Laughlin, Pittsburgh, Pa.
Kentucky Fluor Spar Co., Marion, Ky.
La Belle Iron Works, Steubenville, Ohio.
La Clede Steel Co., Alton, Ill.
Lackawanna Steel Co., Lackawanna, N. Y.
E. J. Lavino Co., Philadelphia, Pa.
Lee Mineral Co., 201 Park Avenue, Baltimore, Md.
Lower California Metals Co., Nogales, Ariz.
Lukens Iron & Steel Co., Coatesville, Pa.
Matthew Addy Co., Cincinnati, Ohio.
McKinney Steel Co., Cleveland, Ohio.
Metalores Corporation, 56 Pine Street, New York, N. Y.
Midvale Steel & Ordnance Co., 14 Wall Street, New York, N. Y.
National Enameling Co., St. Louis, Mo.
National Ore & Metals Co., 601–602 Symes Building, Denver, Colo.
National Sales Co., Cincinnati, Ohio.
Noble Electric Steel Co., San Francisco, Cal.
Pacific Coast Steel Co., Seattle, Wash.
Penn Seaboard Steel Corporation, Philadelphia, Pa.
J. S. Perry, 520 South Canal Street, Chicago, Ill.
Pine Iron Works, Pine Forge, Pa.
Pittsburgh Crucible Steel Co., Pittsburgh, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.
A. H. Reed, Marion, Ky.
Republic Iron & Steel Co., Youngstown, Ohio.
J. C. Rice, Dome, Ariz.
Roberts Fluor Spar Co., Marion, Ky.
Rogers, Brown & Co., Cincinnati, Ohio.
Sizer Forge Co., Buffalo, N. Y.
Southern Minerals Co., Hopkinsville, Ky.
Frederick B. Stevens, Detroit, Mich.
J. D. Taylor, St. Louis, Mo.
Chas. S. Trench & Co., 81–83 Fulton street, New York, N. Y.
Trumbull Steel Co., Warren, Ohio.
Tungsten Products Corporation, Boulder, Colo.
United States Stamping Co., Moundsville, W. Va.
Whitaker-Glessner Co., Portsmouth, Ohio.
John C. Wiarda & Co., Green, Provost and Freeman Streets, Brooklyn, N. Y.
H. L. Wilson, Marion, Ky.
Woods, Huddart & Gunn, San Francisco, Cal.
Youngstown Steel Co., Youngstown, Ohio.

CRYOLITE.

Notes on the character, source, and uses of cryolite were given in the report on fluorspar and cryolite in Mineral Resources for 1916, Part II, pages 322–323.

PRODUCTION.

No cryolite is produced in the United States, the entire supply used in this country being imported from Greenland.

IMPORTS AND PRICES.

The quantity of cryolite reported to have been imported for consumption in the United States in 1917 was 4,383 long tons, valued at $218,500, as compared with 3,857 long tons, valued at $165,222, in 1916. The average price per ton declared in 1917 was apparently $49.85 as compared with $42.84 in 1916. Cryolite is imported free of duty.

The annual imports of cryolite, beginning in 1894, are shown in the following table, according to the records of the Bureau of Foreign and Domestic Commerce. They range from a minimum of 36 long tons in 1910 to 12,756 long tons in 1894, but are mostly between 1,000 and 6,000 tons a year. There are wide variations in average price per ton reported during this period, such as $10.58 in 1898 and $65.08 in 1910. The latter figure may be an error, as there seems to be no especial reason for so high a value in 1910, unless the shipment consisted of the white grade of cryolite. In 1916, in keeping with the increased prices of most mineral products due to the demands of war and especially of those dependent upon ocean transportation to centers of consumption, the price rose from $21 to $42.84 a ton, or more than 100 per cent as compared with that of 1915, with a still further increase in 1917.

Cryolite imported and entered for consumption in the United States, 1894–1917.

Year.	Quantity (long tons).	Value.	Average price per ton.	Year.	Quantity (long tons).	Value.	Average price per ton.
1894[a]	12,756	$170,215	$13.34	1906	1,505	$29,583	$19.66
1895	8,685	116,273	13.39	1907	1,438	28,902	20.10
1896	7,024	93,198	13.27	1908	1,124	16,445	14.63
1897	3,009	40,056	13.31	1909	1,278	18,427	14.42
1898	10,788	114,178	10.58	1910	36	2,343	65.08
1899	5,529	79,455	14.37	1911	2,007	47,093	23.46
1900	5,878	78,658	13.38	1912	2,126	48,293	22.72
1901	6,167	82,533	13.38	1913	2,559	52,557	20.54
1902	4,653	61,116	13.13	1914	4,612	94,424	20.47
1903[b]	7,708	102,879	13.34	1915	3,940	82,750	21.00
1904	959	13,708	14.29	1916	3,857	165,222	42.84
1905	1,600	22,482	14.05	1917	4,383	218,500	49.86

[a] Fiscal years, 1894–1902. [b] Calendar years, 1903–1917.

SODIUM SALTS.

By Roger C. Wells.[1]

INTRODUCTION AND SUMMARY.

The various salts of sodium, except common salt, are obtained chiefly by chemical processes, but in 1917 at least four firms in different parts of the country announced the production of so-called natural soda from natural deposits and two firms announced the production of sodium sulphate from natural deposits. Natural soda is also usually subjected to some refining process before it is used, so that every kind of soda may be considered a manufactured product. It should be remembered, however, that no report of the mining and utilization of natural sodium salts that does not include the total production of all the salts can adequately represent the industry.

It is gratifying to be able to acknowledge the cooperation of all the large producers in the preparation of this report, so that the statistics given are probably practically complete for the principal salts. The lists of producers of the minor salts, however, are probably not complete but can doubtless be made more nearly complete in another year. The figures reported in detail by individual companies to the United States Geological Survey are held in strict confidence; totals are made public for salts of which there are at least three producers. This rule has necessitated reporting the production of some of the salts in groups.

The table on page 306 summarizes the production in 1917 of the sodium salts included in this report and gives also for comparison certain figures for 1916 collected under the direction of H. S. Gale, of the United States Geological Survey.

It is obvious that there is some duplication in both the quantity and the value of the items of this table owing to the fact that a salt manufactured by one producer may be converted into another salt by another producer; for example, the sodium constituent in sodium fluoride made from soda ash purchased in the open market is reported and counted in both salts. The figures have therefore been recalculated as far as possible, with the particular aim of avoiding any such duplication, and the result shows that in 1917 approximately 7,800,000 short tons of sodium salts were manufactured into compounds valued at $128,000,000 at the point of shipment. These figures exclude any duplication in quantity of the sodium constituent, which, however, is all included and reckoned

[1] The statistics of production of sodium salts given in this report were collected by Miss. A. T. Coons, of the United States Geological Survey.

in the compounds having the highest values. Sodium chloride is the original source of most of the sodium in these salts, and the value added in manufacture represents interest, rents, profits, the cost of labor, power, and fuel as well as the value of the other constituents of the salts, such as iodine, boron, chromium, cyanogen, and sulphur.

Sodium salts produced in the United States in 1916 and 1917.

	1916		1917	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Sodium acetate	....	....	1,049	$225,828
Sodium bicarbonate	115,177	$2,303,540	119,177	4,029,499
Sodium carbonate:				
Soda ash	1,324,208	18,283,866	1,390,625	38,028,000
Monohydrate and sesquicarbonate	....	....	55,035	1,262,875
Sal soda	....	....	77,939	1,698,520
Sodium chlorate and sodium peroxide	....	....	4,522	2,119,626
Sodium chloride:[a]				
Salt in brine	2,539,717	831,841	2,890,588	1,083,586
Rock slat	1,368,353	2,665,270	1,605,025	3,897,595
Evaporated salt	2,454,836	10,148,836	2,482,564	14,959,261
Sodium chromate and sodium bichromate	....	....	21,881	8,985,133
Sodium cyanide and sodium ferrocyanide	....	....	12,051	7,290,063
Sodium fluoride	....	....	1,424	397,3[illegible]5
Sodium hydroxide (caustic soda)	391,597	17,425,066	488,056	29,402,689
Sodium iodide	....	....	7	490,000
Sodium nitrite	....	....	861	480,145
Sodium perborate and metallic sodium	....	....	4,594	2,119,100
Sodium phosphate (including all sodium phosphates)	....	....	13,305	711,283
Sodium silicate	....	....	254,011	3,317,547
Sodium sulphate:				
Salt cake	....	....	183,909	2,987,641
Glauber's salt	....	....	47,757	732,403
Niter cake	....	....	387,821	780,278
Sodium sulphide	....	....	49,494	1,905,473
Sodium sulphite and sodium bisulphite	....	....	13,707	300,668
Sodium tetraborate (borax)	....	....	32,089	4,717,532
Sodium thiosulphate ("hypo")	....	....	26,598	717,924
Miscellaneous sodium salts	....	....	49	....
	....	....	10,164,138	132,639,974

[a] Stone, R. W., Salt, bromine, and calcium chloride: U. S. Geol. Survey Mineral Resources, 1917, pt. 2, pp. 169-181, 1918.

The part of the production that was derived directly from natural salts is shown in the following table:

Sodium salts derived from natural sources in 1916 and 1917.

	1916		1917	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Sodium chloride:				
Salt in brine	2,539,717	$831,841	2,890,588	$1,083,586
Rock salt	1,368,353	2,665,270	1,605,025	3,897,595
Evaporated salt	2,454,836	10,148,836	2,482,564	14,959,261
Sodium carbonate, sodium bicarbonate, and sodium sulphate	13,231	545,000	21,743	895,602
	6,376,137	14,190,947	6,999,920	20,835,044

TRADE NAMES FOR VARIOUS SODIUM COMPOUNDS.

The name soda was originally used for the basic part of sodium compounds to mean the oxide, Na_2O, the name being analogous to those of other oxides. However, it has long been used in trade for the carbonate and in household economy for the bicarbonate and the hydrated carbonate, known as sal soda, and is frequently applied indiscriminately to all compounds of sodium, as "nitrate of soda." The better usage is to call such substances "sodium" compounds—for instance "sodium nitrate"—to prevent ambiguity.

The following table gives the various trade names, the chemical formula of the important constituent, the usual percentage of the compound designated in the marketed product, and the ordinary chemical name:

Trade names and formulas of sodium compounds.

Trade name.	Formula.	Percentage.	Chemical name.
Soda ash	Na_2CO_3	98–100 Na_2CO_3	Sodium carbonate.
Sodium carbonate monohydrate.	$Na_2CO_3.H_2O$	85-86 Na_2CO_3	Sodium carbonate monohydrate.
Sodium sesquicarbonate, trona.	$Na_2CO_3.NaHCO_3.2H_2O$	47 Na_2CO_3. 37 $NaHCO_3$	Hydrated sodium carbonate-sodium bicarbonate.
Sal soda, washing soda, crystal carbonate.	$Na_2CO_3.10H_2O$	37.1 Na_2CO_3	Hydrated sodium carbonate.
Bicarbonate of soda, baking soda, saleratus.	$NaHCO_3$	99.5–99.7 $NaHCO_3$	Sodium bicarbonate or acid sodium carbonate.
Caustic soda	$NaOH$	75-99 $NaOH$	Sodium hydroxide.
Soda lime	$NaOH+CaO$		Sodium hydroxide and calcium oxide.
Borax Tincal	$Na_2B_4O_7.10H_2O$	52.9 $Na_2B_4O_7$	Sodium tetraborate.
Sodium hyposulphite "Hypo."	$Na_2S_2O_3.5H_2O$	64 $Na_2S_2O_3$	Sodium thiosulphate.
Yellow prussiate of soda	$Na_4Fe(CN)_6.10H_2O$	62.7 $Na_4Fe(CN)_6$	Sodium ferrocyanide.
Red prussiate of soda	$Na_3Fe(CN)_6.H_2O$	94 $Na_3Fe(CN)_6$	Sodium ferricyanide.
Sodium nitroprusside	$Na_2Fe(CN)_5NO.2H_2O$	88 $Na_2Fe(CN)_5NO$	Sodium nitroprusside.
Salt cake	Na_2SO_4	98–100 Na_2SO_4	Sodium sulphate.
Niter cake	$NaHSO_4$	78 $NaHSO_4$	Sodium bisulphate or sodium acid sulphate.
Glauber's salt	$Na_2SO_410H_2O$	44.1 Na_2SO_4	Hydrated sodium sulphate.
Chile saltpeter Soda niter	$NaNO_3$	95–96 $NaNO_3$	Sodium nitrate.
Water glass	$Na_2O.4SiO_2$ (approx.)		Sodium silicate.

EXPORTS AND IMPORTS OF SODIUM SALTS.[1]

EXPORTS.

The domestic exports of sodium salts in 1917 were nearly 215 per cent larger than those of 1915, according to figures furnished by the Bureau of Foreign and Domestic Commerce of the Department of Commerce, as shown in the following tables:

Domestic exports of sodium salts, 1914–1917.

1914 (July 1 to Dec. 31)	$734,908
1915	7,111,187
1916	17,003,998
1917	22,384,196

The exports for 1917 are given in further detail as follows:

Domestic soda exported in 1917.

	Quantity (pounds).	Value.
All soda [a]		$9,322,233
Caustic soda [b]	89,992,773	5,832,598
Sal soda [b]	7,436,888	97,772
Sodium silicate [b]	14,549,574	216,828
Soda ash [b]	98,[illegible]21,008	2,884,569
All other salts of sodium [b]		4,030,196
		22,384,196

[a] Six months ending June 30, 1917. [b] Six months ending Dec. 31, 1917.

Besides these domestic exports, the exports of foreign sodium salts imported and reexported were as follows:

Foreign sodium salts reexported, 1915–1917.

	Sodium cyanide.		Sodium nitrate.		All other sodium salts.	Total value.
	Quantity. (pounds).	Value.	Quantity. (long tons).	Value.	Value.	
1915	1,897,727	$347,079	22,743	$1,123,761	$40,358	$1,511,198
1916	222,916	58,265	53,553	3,432,273	193,086	3,683,624
1917	276,801	115,067	68,998	5,317,297	4,145	5,436,509

[1] Figures compiled by J. A. Dorsey, of the U. S. Geological Survey.

IMPORTS.

Sodium salts imported for domestic consumption, 1916–17.

Salt.	1916		1917	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Sodium arsenate	36,166	$3,431	23,296	$2,404
Sodium benzoate	72,268	241,429	42,561	197,284
Sodium bicarbonate [a]	102,528	2,808	35,737	1,660
Sodium tetraborate or refined borax	703	135	110	7
Sodium carbonate or soda ash	1,015,010	29,134	2,063,571	70,080
Sodium chlorate	....	....	33,600	1,080
Sodium chromate and sodium bichromate	6,154	3,630	22,025	4,075
Crystal sodium carbonate [b]	62,768	1,316	45,650	1,179
Sal soda or soda crystals	22,400	121	100	5
Sodium cyanide	449,481	95,713	1,622,118	826,052
Sodium ferrocyanide (yellow prussiate of soda)	397,800	175,089	22,048	13,454
Sodium hydroxide or caustic soda	154,223	24,606	146,236	17,773
Sodium nitrate or Chilean nitrate	2,551,924,000	38,131,364	3,456,780,000	60,727,100
Sodium nitrite	3,630,074	255,755	8,767,415	349,111
Sodium phosphate	1,292	462	437	180
Sodium silicate	1,480,547	20,807	936,576	15,963
Sodium sulphate, crude, or salt cake, and niter cake	664,000	9,534	984,000	8,583
Sodium sulphate, crystallized or Glauber's salt	2000	33	....	....
Sodium sulphide	185,585	7,432	288,292	5,104
Sodium sulphite	68,547	1,272	1,268	30
Sodium thiosulphate or sodium hyposulphite	4,371	1,261	5,840	5,748

[a] Or supercarbonate, or saleratus, and other alkalies containing 50 per cent or more of bicarbonate of soda.
[b] Monohydrate and sesquicarbonate.

SODIUM SALTS IN RELATION TO THE WAR.

The war has stimulated the chemical industry in the United States to produce materials that were formerly imported and to supply them to foreign countries, as well as to devise new uses for chemical products and to replace more expensive by less expensive chemicals. The production of sodium salts has increased greatly since the war began. The need of chlorine for war purposes has increased the production of caustic soda, which is itself much in demand for making phenol, from which in turn the picrates are manufactured. Moreover, sodium compounds have replaced potassium compounds either wholly or in part in the manufacture of glass, soap, and matches, in photography, in medicine, in tanning, and in the manufacture of cyanide for extracting the precious metals from their ores.

If costs of production of sodium salts were equal to those of potassium salts per "molecule," the sodium salts would have a decided advantage in all freight shipments, as the atomic weights are 23 and 39, respectively. Unfortunately present prices of many sodium compounds do not compare favorably with those of corresponding potassium compounds before the war, as prices have responded to the increased demand caused by the restriction of imports and the scarcity of potash. Moreover, the war has made it hard to obtain suitable chemical apparatus, particularly good porcelain in large sizes, and this has tended to keep prices up.

The supply of sodium salts is constantly increasing, but so is the demand for them, and it would be rash to attempt to predict what course the demand is likely to take in the future.

DISTRIBUTION OF SODIUM IN NATURE.

The element sodium is very widely distributed in nature. It forms about 2.36 per cent of known terrestrial matter and is the most abundant of the alkali metals. It occurs in nature only in combination with other elements, if its reputed occurrence as the free element in blue rock salt is neglected.

Sodium is an important constituent of the feldspars and several other insoluble minerals from which sodium salts are not extracted commercially, but which are nevertheless regarded as the ultimate source of the salts that are soluble in water.

Sodium chloride is obtained from sea water, the water of the Great Salt Lake, and many natural brines by simple evaporation. Sodium carbonate and trona are thus obtained from the water of Owens Lake. The brine of Searles Lake yields on complete evaporation sodium chloride, sodium sulphate, sodium carbonate, and sodium borate, but the separation of these salts involves elaborate treatment.

The soluble salts above mentioned, as well as sodium nitrate, are found at or near the surface in dry desert regions, but elsewhere they are carried in solution to the sea. The deposits of sodium nitrate in northern Chile, and that of sodium carbonate at Magadi, British East Africa, are conspicuous instances of accumulation due to favorable geologic and climatic conditions. Many beds of rock salt, found in various regions, have probably originated similarly and have been preserved from solution by impervious covers. Large deposits of salt have been found at depth in Michigan, Kansas, Louisiana, Texas, and New York, in the Stassfurt region in Germany, at Salzburg in Austria, in the Province of Orenberg in southeastern Russia, at Northwich, in Cheshire, England, in Alsace and Lorraine, and in many other regions. From the soluble natural or crude salts are derived all the refined salts described in the following pages.

SODIUM (METAL).

As metallic sodium is used in making several sodium salts the production in 1917 would be of interest. Unfortunately, however, the figures can not be published, as there were only two producers. The figures have therefore been combined with those for sodium perborate. The total production of these materials in 1917 was 4,594 short tons, valued at $2,119,100.

Metallic sodium is used in the manufacture of sodium cyanide, sodamide, and sodium peroxide, as well as in the laboratory. It has been proposed to use it in desulphurizing petroleum, and some was formerly used in reducing such metals as magnesium and titanium from their chlorides.

It is made commercially by electrolyzing fused sodium hydroxide at about 330° C. The Darling process, formerly used at Philadelphia, employed sodium nitrate. Attempts have been made to use the chloride, but its high melting point (800° C.) introduces many difficulties.

Sodium may also be made by heating sodium carbonate or other sodium salts with charcoal, and when so made it is separated from the reaction mixture by distillation. Patents have been granted for producing metallic alloys by electrolysis, the alloys being run off and the sodium distilled.

Metallic sodium was produced in 1917 by the Niagara Electro Chemical Co., 100 William Street, New York, N. Y., and the Dow Chemical Co., Midland, Mich.

U. S. patent 1,214,808, dated February 6, 1917, issued to R. J. McNitt, claims the preparation of metallic sodium electrolytically from melted sodium chloride in a cell having a graphite anode and a cathode beneath a bell which catches the melted sodium.

SODIUM ACETATE.

The sodium acetate marketed in the United States in 1917 amounted to 1,049 short tons, valued at $225,828. This material, crystals of which have the formula $NaC_2H_3O_2.3H_2O$, is manufactured in the process of purifying acetic acid obtained in the distillation of wood. It is used in making acetic acid, in dyeing, in photography, and in medicine.

Sodium acetate was manufactured in 1917 by the Anderson Chemical Co., Wallington, N. J.; Grasselli Chemical Co., New York, N. Y.; Mallinkrodt Chemical Works, St. Louis, Mo.; McKesson & Robbins, New York, N. Y.

SODIUM BICARBONATE.

Sodium bicarbonate, which is the same as mono sodium carbonate, familiarly known as baking soda ($NaHCO_3$), if theoretically pure has the composition Na_2O, 36.90 per cent; H_2O, 10.72 per cent; CO_2, 52.38 per cent. It is commercially known in grades specifying the percentage purity of the salt itself, the greater part reported being 99.7 per cent.

The domestic production reported in 1917 was 119,177 short tons, which at an average price of $33.81 a ton represents a total value of $4,029,499; the output for 1916 was 115,117 short tons, valued at $2,303,540, or $20 a ton.

In the following table the production of sodium bicarbonate for the years 1899, 1904, 1909, and 1914 is taken from the report of the Bureau of the Census,[1] and for the years 1916 and 1917 the figures are supplied by the Geological Survey.

Sodium bicarbonate produced in the United States in certain years.

	Quantity (short tons).	Value.		Quantity (short tons).	Value.
1899	68,856	$1,332,765	1914	90,169	$1,439,014
1904	68,869	1,135,610	1916	115,117	2,303,540
1909	82,800	1,515,045	1917	119,177	4,029,499

Uses.—Sodium bicarbonate is used in medicine, in cooking, and in the preparation of soda water and other effervescent drinks.

Manufacture.—Sodium bicarbonate is the first product obtained in the manufacture of sodium carbonate by the ammonia process, as described on page 315. The bicarbonate made in this way, however, contains a small quantity of ammonia, which renders it unfit for many purposes for which sodium bicarbonate is used, and it must be

[1] Chemicals and allied industries: Census of manufactures, p. 18, U. S. Dept. Commerce Bur. Census, 1918.

treated further to obtain a pure salt—for example, it may be either partly calcined and recarbonated or entirely recrystallized or reprecipitated under suitable conditions.[1]

The sesquicarbonate ($Na_2CO_3.NaHCO_3.2H_2O$), which when found in nature is known as trona, is prepared by allowing a solution containing proper proportions of the two carbonates to crystallize at a temperature above 35° C. It is said to possess the advantage of being neither efflorescent nor deliquescent.

The following firms manufactured sodium bicarbonate in 1917:

Los Angeles Soap Co., Los Angeles, Cal.
Mathieson Alkali Works (Inc.), Saltville, Va.
Michigan Alkali Co., Wyandotte, Mich.
Solvay Process Co., Syracuse, N. Y.
Natural Soda Products Co., Keeler, Cal.

SODIUM BICHROMATE.

(See "Sodium chromate," p. 323.)

SODIUM BISULPHITE.

(See "Sodium sulphite," p. 337.)

SODIUM CARBONATE.

SODA ASH.

PRODUCTION.

Soda ash is the commercial term used for normal sodium carbonate, without water of crystallization (Na_2CO_3; theoretically Na_2O 58.49 per cent, CO_2 41.51 per cent). It is supplied commercially in various grades, described, according to reports of the Department of Commerce,[2] as 58 per cent, dense 58 per cent, 48 per cent, special 48 per cent, and 36 per cent. The percentages refer to the content of sodium (expressed as Na_2O). The figures reported by the producers in 1917 were all for the 58 per cent grade.

The soda ash produced and marketed as such in the United States in the calendar year 1917 amounted to 1,390,625 short tons, which at $27.35 a ton, the estimated average wholesale price at the point of manufacture, amounted in value to a total of $38,028,000. This is an increase of 5 per cent in quantity and of about 108 per cent in value over the production for 1916.

The following table gives such figures as are available for the annual production of soda ash to date:

Soda ash produced in the United States in certain years.[a]

	Quantity (short tons).	Value.		Quantity (short tons).	Value.
1899	390,653	$4,859,656	1914	935,305	$10,937,945
1904	518,954	8,204,545	1916	1,324,208	18,283,866
1909	646,057	10,362,656	1917	1,390,625	38,028,000

[a] The figures for 1899, 1904, 1909, and 1914 are from Chemicals and allied industries: Census of manufactures, p. 18, U. S. Dept. Commerce Bur. Census, 1918.

[1] Martin, Geoffrey: The salt and alkali industry, p. 79, London, 1916.
[2] Chemicals and allied industries: Census of manufactures, p. 23, U. S. Dept. Commerce Bur. Census, 1918.

This table shows a fairly normal increase until the beginning of the war. Since that time the increase has been rapid. It was estimated by Weldon [1] in 1883 that the entire soda trade of the world (sodium carbonate and sodium hydroxide in terms of sodium carbonate) amounted annually to only about 709,000 tons, a figure that shows, when compared with the present production in the United States alone, how rapidly chemical industry has advanced.

The manufacture of soda ash in the United States is confined almost entirely to New York, Ohio, Virginia, Michigan, California, and Kansas.

The following is a list of the producers of soda ash in 1917:

Columbia Chemical Co., Barberton, Ohio.
Diamond Alkali Co., Painesville, Ohio.
Mathieson Alkali Works (Inc.), Saltville, Va.
Michigan Alkali Co., Wyandotte, Mich.
Solvay Process Co., Syracuse, N. Y., Detroit, Mich., and Hutchinson, Kans.
West Virginia Pulp & Paper Co., New York, N. Y.
California Alkali Co., San Francisco, Cal.
Huff, Tebbe & Weed, Dunsmuir, Cal.
Inyo Development Co., Keeler, Cal.
Natural Soda Products Co., Keeler, Cal.

Of these 10 companies the first five companies manufacture their material from salt brine, the last four have deposits of the natural salt. Besides these companies, the Chemical Production Co., 312 Brockman Building, Los Angeles, Cal., is reported to be building a plant at Skinner, Cal., to produce soda ash, caustic soda, and potassium chloride from the water of Owens Lake.

IMPORTS AND EXPORTS.

The imports for consumption of soda ash into the United States in 1916 amounted, according to figures compiled from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce, to 507.5 tons, valued at $29,134, and in 1917 they were 1,032 tons, valued at $70,080.

The exports during the last six months of 1917 were 49,211 tons, valued at $2,884,569. The principal countries receiving this material, named in order of quantity exported to each, were Japan, Canada, Argentina, Cuba, Brazil, the Dutch East Indies, and Chile. Japan received about 19,000 tons, valued at about $1,400,000.

PRICES.

The price of soda ash in the United States was hardly affected by the European war until late in 1915 and early in 1916. Quotations then rose to five times the previous figures, but during the summer and fall of 1916 prices fell somewhat, fluctuating over a narrow range.

Prices for 1917 averaged about 75 per cent higher than for 1916. At the end of 1917 soda ash in bags was quoted in the New York market at about $3 a hundred pounds.

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[1] Sodium: Encyclopedia Britannica, 9th ed.

USES.

Sodium carbonate is very widely used as an alkali in many general chemical operations and in the preparation of other sodium salts. It is second only to lime and limestone in cheapness and general applicability as an alkaline substance. It is used directly in making glass and, after conversion into sodium hydroxide or other sodium compounds, it enters indirectly into nearly all of the chemical industries, especially into the manufacture of dyestuffs, explosives, and other chemical products. It is also used in removing ink from old waste paper in the paper industry, for making sodium hydroxide in the wood-pulp and soap industries, and in the preparation of bleach liquor from liquid chlorine.

MANUFACTURE.

GENERAL STATEMENT.

Sodium carbonate is present in the ashes of certain seaweeds and was long obtained from this source along the shores of France, Spain, and Great Britain. The origin of the name "soda ash" is doubtless thus explained. About 13 tons of ash is said to produce 1 ton of sodium carbonate and 30 pounds of iodine as a by-product. About 1775 the want of sodium carbonate was so greatly felt that the French Academy in that year offered a prize for the discovery of a profitable method of making it from common salt. This prize was won by Leblanc in 1791 for the process known by his name, which involves the preparation of sodium sulphate and its conversion into sodium carbonate. The Leblanc process was of great value to the chemical industries from the first quarter of the nineteenth century until recent years. It has been forced to give way gradually to the Solvay or ammonia process and to electrolytic methods of making chlorine and caustic soda. At present the ammonia process holds the field and increasing attention is being paid to natural soda, the utilization of which is determined very largely by costs of transportation. The Magadi deposit of natural soda in British East Africa has been estimated to contain 200,000,000 tons of soda, and enormous quantities of soda are known in certain areas in the western United States.

CONVERSION OF SODIUM SULPHATE INTO SODIUM CARBONATE.

Sodium sulphate, prepared either by heating salt with sulphuric acid or obtained in some other way, is heated with coal and limestone to form "black ash," the chemical changes being indicated by the following equation:

$$\underset{\text{sodium sulphate}}{2Na_2SO_4} + \underset{\text{calcium carbonate}}{3CaCO_3} + \underset{\text{carbon}}{9C} = \underset{\text{sodium carbonate}}{2Na_2CO_3} + \underset{\text{calcium oxide}}{CaO} + \underset{\text{calcium sulphide}}{2CaS} + \underset{\text{carbon monoxide}}{10CO}$$

Upon lixiviation of the black ash the calcium compounds remain mostly insoluble and sodium carbonate goes into solution together with various impurities. The solution usually carries considerable sodium hydroxide and may be worked for either sodium hydroxide or sodium carbonate.

If sodium carbonate is to be prepared, the solution (specific gravity 1.28) is carbonated, filtered, and evaporated, yielding, if evaporated at boiling heat, crystals having the formula Na_2CO_3. The crystals are removed from the solution and heated to dry them completely. The product, "soda ash," carries 98 to 99 per cent sodium carbonate, 0.8 per cent sodium sulphate, 0.1 per cent sodium chloride, 0.1 per cent sodium sulphite or sodium thiosulphate, a little insoluble matter, and about 0.7 per cent moisture.

The "alkali waste" left after the lixiviation of the black ash for sodium carbonate and sodium hydroxide, which contains unburned coal, calcium carbonate, and calcium sulphide, is now worked for sulphur by the Chance-Claus process. This process is summarized by the equation:

$$\underset{\text{calcium sulphide}}{CaS} + \underset{\text{carbon dioxide}}{CO_2} + \underset{\text{water}}{H_2O} = \underset{\text{calcium carbonate}}{CaCO_3} + \underset{\text{hydrogen sulphide}}{H_2S}$$

The calcium carbonate thus produced can be recovered and used again, and the sulphur is recovered either as sulphur or ultimately as sulphuric acid.

In England, where the Leblanc process is still used to some extent, it is generally customary to convert the black ash liquor directly into sodium hydroxide instead of sodium carbonate. This is done as described under "Sodium hydroxide," page 328.

AMMONIA PROCESS.

The manufacture of sodium carbonate by the ammonia or Solvay process occupies to-day a very prominent position in the chemical industry and probably has only natural soda to fear in competition, although the electrolytic production of caustic soda is a factor to be reckoned with.

The reactions on which the process depends were known as early as 1852, but the mechanical details of treatment were first perfected by Ernest and Alfred Solvay in the late sixties and have been constantly improved. The process rests on the slight solubility of sodium bicarbonate in ordinary salt brine containing ammonium bicarbonate. The brine is saturated with ammonia and subjected to the action of carbon dioxide when, in consequence of the formation of the bicarbonate ion in solution, sodium bicarbonate is precipitated. The latter salt is removed by filtration and the mother liquor containing ammonium chloride is treated to recover ammonia. The sodium bicarbonate is calcined to produce soda ash and carbon dioxide which is again used in the process. The final product is "light" soda ash which for certain purposes is converted into "heavy" ash, comparable with Leblanc soda ash, which is preferred by the glass-making industry. The ammonia soda ash is of exceptional purity, running 99 to 99.7 per cent of sodium carbonate (Na_2CO_3).

Plants for the manufacture of soda ash by the ammonia process must be situated near good supplies of salt and limestone in order to avoid excessive charges for transportation.

CRYOLITE PROCESS.

Sodium carbonate may be made from cryolite by heating it with limestone, when the reaction indicated by the following equation occurs:

$$\underset{\text{cryolite}}{3NaF.AlF_3} + \underset{\text{calcium carbonate}}{CaCO_3} = \underset{\text{sodium aluminate}}{Na_3AlO_3} + \underset{\text{calcium fluoride}}{3CaF_2} + \underset{\text{carbon dioxide}}{3CO_2}$$

The sodium aluminate resulting from this fusion is decomposed in aqueous solution by carbon dioxide as follows:

$$\underset{\text{sodium aluminate}}{2\,Na_3AlO_3} + \underset{\text{carbon dioxide}}{CO_2} + \underset{\text{water}}{3H_2O} = \underset{\text{sodium carbonate}}{3Na_2CO_3} + \underset{\text{aluminum hydroxide}}{2Al(OH)_3}$$

The sodium carbonate is separated in solution from the insoluble aluminum hydroxide and dehydrated to form soda ash. Soda ash made in this way is said to be very pure.

PATENTS.

The following patents issued in 1917 refer to soda ash:

U. S. patent No. 1249739, dated December 11, 1917, issued to H. A. Galt. The mud from the ammonia soda process is subjected to pressure to separate the steam, solution, and solids, the solution being evaporated for its salts and the solids dried and crushed for fertilizer.

U. S. patent No. 1221506, dated April 3, 1917, issued to J. E. Bucher. In making sodium bicarbonate by the ammonia process the reversibility of the reaction is counteracted by the addition of sodium cyanate, producing ammonium cyanate, which is converted into urea and thus separated from the reaction products.

U. S. patent No. 1225722, dated May 8, 1917, to A. Schaidhauf. Sodium percarbonate is made from soda ash and a mixture of hydrogen peroxide, sodium silicate, and gum arabic, the two latter substances serving as stabilizers.

SAL SODA.

Sal soda, hydrated sodium carbonate, washing soda, or crystal carbonate, having the chemical formula $Na_2CO_3.10H_2O$, is made from soda ash by dissolving it in water and allowing the solution to crystallize below 32° C.

The production of sal soda in the United States in 1917 was 77,939 short tons, valued at $1,698,520. The output for years for which figures are available is shown in the following table:

Sal soda produced in United States in certain years.[a]

	Quantity (short tons).	Value.		Quantity (short tons).	Value.
1899	63,249	$875,243	1914	106,591	$1,510,449
1904	59,548	831,869	1917	77,939	1,698,520
1909	86,644	1,156,882			

[a] The figures for 1899, 1904, 1909, and 1914 are taken from Chemicals and allied industries: Census of manufactures, p. 18, U. S. Dept. Commerce Bur. Census, 1918.

The imports for consumption of sal soda into the United States, according to the records of the Department of Commerce, were 11.2 short tons, valued at $121, in 1916, and 100 pounds, valued at $5, in 1917.

During the last six months of 1917 there was exported 3,718 short tons of sal soda, valued at $97,772, of which more than half went to Canada and more than 25 per cent to Argentina.

The following firms reported the production of sal soda in 1917:

California Soap Co., 2437 Ninth Street, east, Los Angeles, Cal.
Central Chemical Co., foot of Chapel Street, Newark, N. J.
Church & Dwight Co., 22 Cliff Street, New York, N. Y.
Citrus Soap Co., Ninth and K Streets, San Diego, Cal.
Columbus Crystal Co., 15 Arch Street, Newark, N. J.
Detroit Soda Products Co., 2595 Jefferson Street, west, Detroit, Mich.
Green Bay Soap Co., Green Bay, Wis.
E. Griswold & Co., Sixth and Parker Streets, West Berkeley, Cal.
Thomas Hersom & Co., Howland Avenue, New Bedford, Mass.
John Horstmann Co., 685 Bryant Street, San Francisco, Cal.
Humes Manufacturing Co., 110 Water Street, East Providence, R. I.
Iowa Soda Products Co., Detroit, Mich.
A. Lee Co., Lawrence, Mass.
Los Angeles Soap Co., 633 First Street, east, Los Angeles, Cal.
Mechling Bros. Manufacturing Co., Line Street and Coopers Creek, Camden, N. J.
Morton Salt Co., 80 Jackson Boulevard, east, Chicago, Ill.
Mount Hood Soap Co., 110 Fourth Street, north, Portland, Oreg.
National Soap Co., 111 Main Street, Leavenworth, Kans.
Newell & Bro., 1462 San Bruno Street, San Francisco, Cal.
O'Neil Oil & Paint Co., Milwaukee, Wis.
Pennsylvania Salt Manufacturing Co., Philadelphia, Pa.
C. T. Perry & Co., Helena, Mont.
Phenix Supply Co., Atlanta, Ga.
John Reardon & Sons Co., Allston Street, Cambridge "A," Mass.
Soda Refining Co., San Francisco, Cal.
Stauffer Chemical Co., 624 California Street, San Francisco, Cal.
Vera Chemical Co., Hopkins and Villard Avenues, North Milwaukee, Wis.
Warnock & Ralston, 429 Second Street, Rock Island, Ill.
John C. Wiarda & Co., 371 Green Street, Brooklyn, N. Y.

NATURAL SODA.

ANALYSES.

In the arid regions of western Nevada and southeastern California the soluble salts which accumulate by evaporation of surface waters in undrained basins in consequence of the deficient rainfall consist largely of sodium carbonate and sodium bicarbonate, together with sodium chloride and sodium sulphate. The largest accumulations are found in "playas" or "playa lakes," which are usually dry in summer but are covered with a few inches of water in winter. Many analyses of the incrustations deposited from playa lakes have been made, those given in the tables below being representative.

Analyses of incrustations deposited from playa lakes in California, Nevada, and Wyoming.

	1	2	3	4	5
Na_2CO_3	72.69	75.95	45.05	44.25	30.62
$NaHCO_3$			34.66	34.90	30.09
Na_2SO_4	17.49	4.67	1.29	.99	25.75
NaCl	2.53	1.46	1.61	1.10	2.13
$NaNO_3$		12,98			
NaH_2PO_4		4.94			
$Na_2B_4O_7$	4.15				
KCl	1.18				
SiO_2	1.96				
Insoluble			.80	2.81	2.61
H_2O			16.19	15.95	9.01
	100.00	100.00	99.60	100.00	100.21

1. Soluble part from surface of playa, north arm of Old Walker Lake, Nev.: U. S. Geol. Survey Bull. 616, p. 237, 1916. T. M. Chatard, analyst.
2. From the Merced bottoms, Merced County, Cal.: California Univ. Exper. Sta. Rept., App., 1890. Analysis reported by E. W. Hilgard.
3. Big Soda Lake, Ragtown, Nev.: U. S. Geol. Expl. 40th Par. Rept., vol. 2, p. 748, 1877. O. D. Allen, analyst.
4. Little Soda Lake, Ragtown, Nev.: Idem, p. 759.
5. Surface soda from Carbon County, Wyo.: U. S. Geol. Survey Mineral Resources, 1885, p. 553, 1886. Analysis reported by J. D. Weeks.

The following analyses are given in Chatard's paper in Bulletin 60 of the United States Geological Survey.

Analyses of incrustations deposited from alkaline waters.

	1	2	3	4	5	6	7	8
K_2SO_4	2.79	4.68	1.88					
Na_2SO_4	28.32	17.43	33.31	4.42	49.67	27.05	1.75	27.55
NaCl	2.11	38.01	24.51	7.24	20.88	59.32	85.27	18.47
Na_2CO_3	58.69	25.12	25.95	48.99	7.02	9.06	2.59	52.10
$NaHCO_3$	8.09	14.76	14.35	36.01	11.13			
$Na_2B_4O_7$				3.34	11.30	1.00		
KCl						1.39		
SiO_2						2.18	1.82	
H_2O							8.57	
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.12

1. Ruby Valley, Nev.: U. S. Geol. Expl. 40th Par. Rept., vol. 1, p. 503, 1877. R. W. Woodward, analyst.
2. Valley of Deep Creek, Utah: Idem, vol. 2, p. 474.
3. Antelope Valley, Nev.: Idem, vol. 2, p. 541.
4. Humboldt Valley, Nev.: Idem, vol. 2, p. 594.
5. Brown Station, Humboldt Lake, Nev.: Idem, vol. 2, p. 744.
6. Soluble part of incrustation near Black Rock Point, Black Rock Desert: U. S. Geol. Survey Mon. 11, p. 231, 1885. T. M. Chatard, analyst.
7. Quinn's River salts: U. S. Geol. Expl. 40th Par. Rept., vol. 2, p. 791, 1877. O. D. Allen, analyst.
8. Hardin City salts: Idem, p. 792. O. D. Allen, analyst.

The following analyses of alkaline lake waters are mostly selected from Water-Supply Paper 364 of the United States Geological Survey.

Analyses of alkaline lake waters.

	1	2	3	4	5	6	7
Cl	41.04	35.37	22.64	25.00	30.55	18.27	34.37
SO_4	5.25	10.51	12.47	9.74	.12	4.18	1.80
CO_3	14.28	7.79	19.76	19.58	20.42	35.57	15.33
HCO_3		8.10	5.93	4.29	1.72		9.03
Na	33.84	35.37	36.82	37.25	36.06	39.48	37.51
K	2.11	2.13	1.80	2.06	1.47	1.59	1.37
Ca	.25		.04		.03	Trace.	
Mg	2.28	.21	.10		.33	Trace.	
SiO_2	.95	.25	.14	.20	.01	.62	.59
Al_2O_3			Trace.		Trace.	.27	
B_4O_7		.26	.30	1.88	4.78		
Fe_2O_3			Trace.			Trace.	
Br					.03		
PO_4					.02		
Organic					4.46		
NO_3						.02	
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Salinity, parts per million	3,486	113,700	51,170	118,830	76,560	16,633	39,172

1. Pyramid Lake, Nev. Mean of four concordant analyses by F. W. Clarke.
2. The large Soda Lake, Ragtown, Nev. U. S. Geol. Survey Bull. 9, p. 25, 1884. Sample from a depth of 30.5 meters. T. M. Chatard, analyst. An earlier analysis of Soda Lake by O. D. Allen is given in the U. S. Geol. Expl. 40th Par. Rept., vol. 2, p. 748, 1877. It is less complete than Chatard's but otherwise is not very different. Specific gravity 1.101.
3. Mono Lake, Cal.: U. S. Geol. Survey Bull. 60, p. 53, 1890. Sample taken in 1882. Specific gravity 1.045. T. M. Chatard, analyst. An improbable analysis of Mono Lake water, by Winslow Anderson, is given in his Mineral springs and health resorts of California, p. 198, San Francisco, 1892. In it the calcium salts predominate over all others.
4. Owens Lake, Cal. Analysis in the laboratory of the U. S. Geol. Survey, 1913. Specific gravity 1.0977. W. B. Hicks, analyst. An analysis by J. G. Smith is given in U. S. Dept. Agr. Bull. 61, p. 80, 1914.
5. Borax Lake, Cal. Analysis by W. H. Melville, published by G. F. Becker in U. S. Geol. Survey Mon. 13, p. 265, 1888. In addition to the substances named in the table, the original residue contained 4.5 per cent of organic matter.
6. Summer Lake, Oreg. Analysis by W. Van Winkle, who cites two other analyses. Specific gravity 1.0162 at 15° C.
7. Abert Lake, Oreg. U. S. Geol. Survey Bull. 60, p. 55, 1890. T. M. Chatard, analyst. An earlier analysis by F. W. Taylor is not in accord with this. Specific gravity 1.03117 at 19.8° C.

Analyses of alkaline lake waters.

	1	2	3	4	5	6
Cl	6.45	30.40	12.50	10.78	0.87	10.13
SO_4	7.38	8.62	15.47	16.62	61.55	52.47
CO_3	9.89	19.77	22.77	32.75	1.00	1.08
HCO_3	18.81		11.55		7.99	6.10
B_4O_7	.89	Present.				
Na	34.40	39.43	37.27	39.85	20.00	25.03
K	1.84	1.50			1.22	
Ca	None.	.03	Trace.		1.05	Trace.
Mg	.06	Trace.	.04		6.06	5.19
SiO_2	.28	.14	.40		.21	Trace.
Al_2O_3	None.	.10			.05	Trace.
F_2O_3	None.	Trace.				
PO_4		Trace.				
NO_3		.01				
	100.00	100.00	100.00	100.00	100.00	100.00
Salinity, parts per million	10,427	22,383	28,195	119,700	6,708	11,623

1. Harney Lake, Oreg. Analysis in the laboratory of the U. S. Geological Survey, George Steiger, analyst. Sample taken August 5, 1902. See U. S. Geol. Survey Water-Supply Paper 364, p. 34, 1914.
2. Harney Lake, Oreg. W. Van Winkle, analyst. Collected Mar. 10, 1912. Specific gravity 1.0209.
3. Soap Lake, Wash.: U. S. Geol. Survey Bull. 113, p. 113, 1893. George Steiger, analyst.
4. Wilmington Lake, Wyo.: Wyoming Agr. Exper. Sta. Bull. 49, 1901. E. E. Slosson, analyst.
5. Lake De Smet, Wyo. Analysis in the laboratory of the U. S. Geol. Survey, W. T. Schaller, analyst. An analysis of its feeder, Shelle Creek, was also made. See U. S. Geol. Survey Water-Supply Paper 364, p. 17, 1914.
6. Devils Lake, N. Dak. North Dakota Univ. Quart. Jour., vol. 1, p. 225, 1911. H. W. Daudt, analyst.

UTILIZATION OF NATURAL SODA IN WESTERN STATES.

LOCALITIES OF COMMERCIAL PRODUCTION.

The United States Geological Survey long ago called attention to the value of the natural soda in the Western States.[1] The deposits have been worked commercially in a number of places, at first for local consumption and later for wider use as transportation facilities became available. Natural soda has been suggested as cheap and effective in all processes where purity is not a prime requisite as in treating ores by flotation. The extraction of potassium salts, principally potassium chloride and potassium sulphate, from natural brines and lake waters, has recently been carried out conjointly with the production of sodium salts, especially sodium chloride, sodium bicarbonate, and sodium tetraborate, but the processes are still largely in the experimental stage.

The firm of Huff, Tebbe & Weed, of Dunsmuir, Cal., shipped some crude natural soda to San Francisco in 1917, where it was refined and placed on the market by the Soda Refining Co., of San Francisco.

Natural soda has been produced commercially at the following places:

"Union Pacific Lakes,"[2] 13 miles south of Laramie, Wyo.
"Downey" lakes, 18 miles southwest of Laramie, Wyo.
Soda lakes, Ragtown, Nev.
Long Valley, southeast of Mono Lake, Cal.
Owens Lake, Inyo County, Cal.
Grant County, Wash.
Green River, Wyo.
Vernon, Cal.
Dorris, Cal.

OWENS LAKE.

Chatard[3] pointed out the favorable conditions that exist at Owens Lake for the production of sodium carbonate and studied the process of fractional crystallization of the dissolved material.

Analyses of salts deposited by fractional crystallization from the water of Owens Lake, Cal.

[T. M. Chatard, analyst.]

	1	2	3	4	5	6
H_2O		14.51	4.33	3.43	2.24	11.03
Na_2CO_3	34.95	43.75	22.84	18.19	12.51	55.04
$NaHCO_3$	7.40	30.12	10.53	4.06	3.88	4.09
Na_2SO_4	14.38	3.18	25.44	26.70	19.01	5.70
$NaCl$	38.16	7.44	35.06	45.59	60.99	19.16
$Na_2B_4O_7$	.63					
$Na BO_2$						2.01
KCl	4.07	1.07	1.12	1.14	1.21	2.93
$(Ca,Mg) CO_3$	.08	.14				
$(Al,Fe)_2O_3$	.05	.01			.01	.02
SiO_2	.28	.055			.05	.16
Organic matter		.032				
Insoluble		.078				
	100.00	100.385	99.41	99.17	99.90	100.14

1. The natural water of Owens Lake. Sp. gr. 1.062 at 25° C. Salinity 77.098 grams per liter. This analysis, which represents the composition of the anhydrous residue, is here stated in conventional form.
2. First crop of crystals. Water concentrated to a fifth its original volume. Specific gravity of the mother liquor 1.312 at 27.9° C.
3. Second crop of crystals. Specific gravity of mother liquor 1.312 at 25° C.
4. Third crop of crystals. Specific gravity of mother liquor 1.315 at 26.25° C.
5. Fourth crop of crystals. Specific graviy of mother liquor 1.327 at 35.75° C.
6. Fifth crop of crystals. Specific gravity of mother liquor 1.300 at 13.9° C. This crop was obtained by chilling the solution in order to determine the effect of cold.

[1] Chatard, T. M., Natural soda—its occurrence and utilization. U. S. Geol. Survey Bull. 60, pp. 27-101, 1890.
[2] Weeks, J. D., Glass materials: U. S. Geol. Survey Mineral Resources, 1885, p. 550-552, 1886.
[3] Chatard, T. M., op. cit., p. 63.

From these results it appears that the first crop of crystals consists largely of trona ($Na_2CO_3.NaHCO_3.2H_2O$). Variations of this process have been introduced from time to time, depending on the demand for different salts and the application of suitable equipment.

Sodium carbonate is the principal product of the Inyo Development Co., of Keeler, Cal. In 1915, however, the bitterns were worked for potassium salts, which were produced as a mixture of the carbonates, sulphates, and chlorides of sodium and potassium, free from magnesium salts. This mixture was said to carry from 29 to 34 per cent potassium chloride. No potassium salts were produced in 1916 or 1917.

The Natural Soda Products Co., of Keeler, Cal., reported the production of both sodium carbonate and sodium bicarbonate but not any potassium salts in 1917. The output of sodium carbonate in 1917 was more than three times the output in 1916. The sodium bicarbonate is reported as crude material containing 76 per cent $NaHCO_3$.

The California Alkali Co., of San Francisco., Cal., also produced sodium carbonate from the water of Owens Lake in 1917.

PATENTS FOR TREATING ALKALI BRINES.

That the separation and utilization of the several salts occurring in the deposits of natural soda in the Western States offers interesting problems in chemical engineering, is shown by the following list of patents issued in1917:

U. S. patent No. 1215574, dated February 13, 1917 issued to J. D. Pennock, L. C. Jones, and F. L. Grover. Brines such as are obtained from alkali lakes of the western United States are treated to produce sodium bicarbonate, sodium chloride, sodium sulphate, calcium carbonate, calcium borate, and potassium chloride.

U. S. patent No. 1215576, dated February 13, 1917, issued to J. D. Pennock, L. C. Jones, and F. L. Grover. Borax is produced from a mother liquor containing potassium chloride and borax by crystallization after suitable concentration.

U. S. patent No. 1215543, dated February 13, 1917, issued to L. C. Jones and F. L. Grover. Alkali brines are carbonated to produce sodium bicarbonate, and after further treatment, sodium carbonate, sodium chloride, sodium sulphate, and potassium sulphate.

U. S. patent No. 1215575, dated February 13, 1917, issued to J. D. Pennock, L. C. Jones, and F. L. Grover. Alkali lake brines are treated to remove sodium bicarbonate, sodium sulphate, sodium chloride, potassium sulphate, and finally potass ium chloride and borax.

U. S. patent No. 1215545, dated February 13, 1917, issued to L. C. Jones and F. L. Grover. Alkali lake brines are heated to convert borax compounds into sodium metaborate and the solution is evaporated to produce sodium carbonate, sodium chloride, and sodium sulphate, and after carbonation, sodium tetraborate.

U. S. patent No. 1215544, dated February 13, 1917, issued to L. C. Jones and F. L. Grover. Alkali lake brines are treated to recover sodium tetraborate and potassium chloride by evaporation and crystallization.

U. S. patent No. 1215546, dated February 13, 1917, issued to L. C. Jones, F. L. Grover, and J. L. Silsbee. Brines containing chlorides of sodium, potassium, and magnesium are evaporated until saturated with potassium chloride; the sodium chloride is removed; the brine is again evaporated until saturated with potassium chloride, which is then allowed to crystallize, and so on.

U. S. patent No. 1232156, dated February 13, 1917, issued to N. Wrinkle and W. W. Watterson. Alkali lake brines are treated to yield sodium bicarbonate, sodium chloride, sodium tetraborate, tetraboric acid, boric acid, and potassium chloride.

U. S. patent No. 1235202, dated July 31, 1917, issued to B. E. Hartsuch. Salt brines are purified by sodium hydroxide produced in them electrolytically, the chlorine being removed through unglazed porcelain tubes.

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LITERATURE DEALING WITH NATURAL SODIUM SALTS.

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1903. ——— Borax deposits of eastern California: U. S. Geol. Survey Bull. 213, pp. 401–405.

Eckel, E. C., Salt and gypsum deposits of southwestern Virginia: U. S. Geol. Survey Bull. 213, pp. 406–416.

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Kindle, E. M., Salt resources of the Watkins Glen district, N. Y.: U. S. Geol. Survey Bull. 260, pp. 567–572.

Richardson, G. B., Salt, gypsum, and petroleum in trans-Pecos Texas: U. S. Geol. Survey Bull. 260, pp. 573–585.

1909. Arnold, Ralph, and Johnson, H. R., Sodium sulphate in Soda Lake, Carrizo Plain, San Luis Obispo County, Cal.: U. S. Geol. Survey Bull. 380, pp. 369–372.

1910. Breger, C. L., The salt resources of the Idaho-Wyoming border, with notes on the geology: U. S. Geol. Survey Bull. 430, pp. 555–569.

Schultz, A. R., Deposits of sodium salts in Wyoming: U. S. Geol. Survey Bull. 430, pp. 570–589.

1911. McCoy, H. N., and Test, C. D., Equilibrium between sodium carbonate, sodium bicarbonate, and water: Am. Chem. Soc. Jour., vol. 33, p. 473, 1911.

1912. Free, E. E., Report of a reconnaissance of the Lyon nitrate prospect near Queen, N. Mex., Apr. 8, 1912: U. S. Dept. Agr. Bur. Soils Circ. 62, 6 pp.

——— Nitrate prospects in Amargosa Valley, near Tecopa, Cal.: U. S. Dept. Agr. Bur. Soils Circ. 73.

Gale, H. S., Nitrate deposits: U. S. Geol. Survey Bull. 523, 36 pp.

1913. ——— Borax in 1912: U. S. Geol. Survey Mineral Resources, 1912, pt. 2, pp. 839–846.

Dole, R. B., Exploration of salines in Silver Peak Marsh, Nev.: U. S. Geol. Survey Bull. 530, pp. 330–345.

Phalen, W. C., Salt and bromine in 1912: U. S. Geol. Survey Mineral Resources, 1912, pt. 2, pp. 909–929.

Yale, C. G., and Gale, H. S., Borax in 1912: Idem, pp. 839–846.

1914. Young, G. J., Potash salts and other salines in the Great Basin region: U. S. Dept. Agr. Bull. 61, 96 pp.

Knight, W. C., and Slosson, E.E., Alkali lakes and deposits: Wyoming Exper. Sta. Bull. 49.

Gale, H. S., Notes on the Quaternary Lakes of the Great Basin, with special reference to the deposition of potash and other salines: U. S. Geol. Survey Bull. 540, pp. 339–406.

——— Salt, borax, and potash in Saline Valley, Inyo County, Cal.: U. S. Geol. Survey Bull. 540, pp. 416–421.

——— Sodium sulphate in the Carrizo Plain, San Luis Obispo County, Cal.: U. S. Geol. Survey Bull. 540, pp. 428–433.

Richards, R. W., Niter near Melrose, Mont.: U. S. Geol. Survey Bull. 540, pp. 470–473.

1915. Gale, H. S., Salines in Owens, Searles, and Panamint basins, southeastern California: U. S. Geol. Survey Bull. 580, pp. 251–323.

1916. Hicks, W. B., The composition of muds from Columbus Marsh, Nev.: U. S. Geol. Survey Prof. Paper 95, pp. 1–11.

——— Evaporation of potash brines: U. S. Geol. Survey Prof. Paper 95, pp. 65–72.

——— Evaporation of brine from Searles Lake, Cal.: U. S. Geol. Survey Prof. Paper 98, pp. 1–8.

1916. MANSFIELD, G. R., Nitrate deposits in southern Idaho and eastern Oregon: U. S. Geol. Survey Bull. 620, pp. 19–44.
BARBOUR, E. H., A preliminary report on the alkali resources in Nebraska: Nebraska Geol. Survey, vol. A, pt. 28.
1917. RALSTON, O. C., and YUNDT, L. D., Chemicals used in flotation: Min. and Sci. Press, vol. 115, p. 545.

SODIUM CHLORATE.

Sodium chlorate ($NaClO_3$) is prepared from sodium carbonate and chlorine, or from sodium hydroxide and chlorine, or by the electrolysis of hot sodium chloride brine. This salt has recently supplanted potassium chlorate to a considerable extent in medicine and is also used in making dyes, matches, and explosives.

The production of sodium chlorate in the United States in 1917 was large, but the total is withheld at the request of one of the three producers, whose product was largely exported and therefore does not represent domestic consumption. The figures have, however, been combined with those for sodium peroxide, which could not be published separately. The total production of these two salts in 1917 was 4,522 short tons, valued at $2,119,626.

Sodium chlorate was produced in 1917 by the North American Chemical Co., Bay City, Mich.; the Oldbury Electro Chemical Co., Niagara Falls, N. Y., and the West Virginia Pulp & Paper Co., New York, N. Y. The average selling price was about 35 cents a pound.

SODIUM CHLORIDE.

The production and methods of utilization of sodium chloride ($NaCl$) are given in full in the chapter on salt in Mineral Resources by R. W. Stone,[1] of the United States Geological Survey, whose figures for the production in 1917 are 2,890,588 short tons in brine, 1,605,025 short tons of rock salt, and 2,482,564 short tons of evaporated salt, valued at $1,083,586, $3,897,595, and $14,959,261, respectively. The corresponding figures for 1916 are 2,539,717 tons in brine, 1,368,353 tons of rock salt, and 2,454,836 tons of evaporated salt, valued at $831,841, $2,665,270, and $10,148,836, respectively.

The known production of soda ash from salt and limestone and that of caustic soda from salt by electrolysis show that approximately 2,230,000 short tons of sodium chloride was used for making soda ash in the United States in 1917, compared with 1,910,000 in 1916, and that 185,000 tons of sodium chloride was electrolyzed for the production of caustic soda and chlorine or other products in 1917. In addition, at least 68,000 short tons must have been used in the production of hydrochloric acid and salt cake, and about 15,000 short tons in making other sodium compounds.

SODIUM CHROMATE AND SODIUM BICHROMATE.

Sodium chromate ($Na_2CrO_4.10H_2O$) is manufactured by the Mutual Chemical Co. of America, 55 John Street, New York, N. Y.

This salt has recently come into extensive use in tanning leather on account of the scarcity of potassium chromate, and, aside from its

[1] Stone, R. W., Salt, bromine, and calcium chloride: U. S. Geol. Survey Mineral Resources, 1917, pt. 2, pp. 169–181, 1918.

hygroscopic character, it is fully as satisfactory as the potassium salt.

Sodium chromate is made by heating the mineral chromite with soda ash and lime. The object of the lime is to prevent fusion and keep the mass porous to facilitate oxidation. The roasted mass is extracted with water containing some soda ash to convert any calcium chromate into sodium chromate, and after separation of the solids the solution is allowed to crystallize or is treated with sulphuric acid to form sodium bichromate, which is freed from the sodium sulphate by evaporation and crystallization.

The manufacture of sodium chromate from chromite is described by Harold French in Mining and Scientific Press, vol. 113, page 845, 1916.

Sodium bichromate ($Na_2Cr_2O_7.2H_2O$) is manufactured by the following firms: Sawyer Tanning Co., Napa, Cal.; Mutual Chemical Co. of America, 55 John Street, New York, N. Y.; National Electrolytic Co., Niagara Falls, N. Y.; Natural Products Refining Co., Jersey City, N. J.

The production of sodium bichromate and sodium chromate in 1917, as reported to the United States Geological Survey, was 21,881 short tons, valued at $8,985,133. In 1914, according to the Bureau of the Census, 11,824 short tons, valued at $1,125,398, was produced.

The imports for consumption in 1916 amounted to 6,154 pounds, valued at $3,630, and in 1917 to 22,025 pounds, valued at $4,075.

Sodium bichromate, as well as sodium manganate, is used in refining the precious metals obtained from the cyanide solution by means of zinc. The bichromate is also used as a mordant, principally in wool dyeing.

The manufacture of crude sodium manganate, used as a substitute for potassium permanganate in the flotation process, is described by F. Wartenweiler.[1]

SODIUM CYANIDE.

Sodium cyanide, since the war created a scarcity of potassium cyanide, has been largely substituted for it in the cyanide process of recovering gold and silver from their ores. It is manufactured by the Niagara Electro Chemical Co., Niagara Falls, N. Y.

In order not to reveal the production of individual firms the figures for the production of sodium cyanide in 1917 have been combined with those of sodium ferrocyanide. The total production of these two salts was 12,051 short tons, valued at $7,290,063.

The imports of sodium cyanide in 1916 amounted to 224.7 tons, valued at $95,713, and in 1917 to 811 tons, valued at $826,052. In 1917 this material was received principally from Scotland, Japan, and Salvador, named in the order of the quantity imported.

Prices.—Sodium cyanide was quoted at 44 to 46 cents a pound at point of shipment at the end of 1917. In 1916 it was obtainable in 100-pound lots at 28 cents a pound.

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[1] Chem. and Met. Soc. South Africa Jour., vol. 18, p. 161, 1918.

Analysts are accustomed to determine only the cyanide radical in cyanides, as their value depends on the cyanogen content, but it has long been customary to report the cyanogen as potassium cyanide. As pure potassium cyanide contains 40 per cent and sodium cyanide 53 per cent of cyanogen it follows that sodium cyanide may be reported as carrying more than 100 per cent of potassium cyanide. This also allows very impure sodium cyanide to be sold as 97 or 98 per cent potassium cyanide, but, needless to say, the potassium salt is not now largely used. Recently sodium cyanide has been selling on the basis of its actual sodium cyanide content, the highest grade being 96 to 98 per cent sodium cyanide (NaCN), or cyanogen 51 to 52 per cent. The old "98 per cent KCN" used to run about 39 per cent of cyanogen. Four pounds of sodium cyanide are therefore chemically equivalent as a solvent to about 5 pounds of the old "KCN."

Uses.—Sodium cyanide is widely used as a solvent of the precious metals in metallurgy and in electroplating, and also as a source of hydrocyanic acid for fumigation in orchards where gaseous hydrocyanic acid is applied as an insecticide to individual trees, which are covered with tents during the process. The great production of gold from low-grade properties in the last two decades, beginning in the Transvaal and extending all over the world is largely due to the "cyanide process." The effective solution in the cyanide process contains usually only about 0.20 per cent of sodium cyanide.

Manufacture.—The old methods of manufacturing cyanides began with ferrocyanide and ferricyanide or sulphocyanide obtained from coke and gas works. Beet-sugar wastes have also been used as a source of cyanide.

Sodium cyanide results from heating sodium ferrocyanide with sodium according to the reaction $Na_4Fe(CN)_6 + 2Na = 6NaCN + Fe$. The process is carried out in iron crucibles, the melted cyanide being filtered through spongy iron by means of compressed air. When made in this way the only impurities are small quantities of sodium cyanate, sodium carbonate, and sodium hydroxide.[1]

The Castner process of making sodium cyanide consists in heating together at the proper temperature charcoal, ammonia, and sodium in furnaces especially designed for that purpose. The intermediate products are sodamide ($NaNH_2$) and sodium cyanamide ($NaCN_2$). The final result is summarized by the equation $2NH_3 + 2Na + 2C = 2NaCN + 3H_2$.

Sodium cyanide may be made by heating commercial calcium cyanamide ($CaCN_2 + C$) for a few minutes with common salt at about 940° C. out of contact with air and then quickly cooling the mixture. The product contains from 20 to 30 per cent of sodium cyanide and may be used directly for the extraction of gold.

The manufacture of cyanides directly from atmospheric nitrogen has been the subject of much study and now offers promise of commercial development. The Bucher process consists in heating soda ash and powdered coke with iron ore in a furnace through which air is passed. This process is now under investigation by Government agencies.

[1] Martin, Geoffrey, and Barbour, William, Industrial nitrogen compounds and explosives, p. 72, New York, 1917.

Papers and patents.—The following papers and patents, published or issued in 1917, refer to the production of cyanides or the fixation of nitrogen:

Bucher, J. E., The fixation of nitrogen: Jour. Ind. and Eng. Chem., vol. 9, pp. 233–253, 1917.

Willmore, C. W., Solving the cyanide shortage: Metal Industry, vol. 15, p. 12–14, 1917.

Clevenger, B. H., Test of the Bucher process for making cyanide: Min. and Sci. Press, vol. 115, p. 537, 1917.

Hosmer, H. R., Literature of the nitrogen industries: Jour. Ind. and Eng. Chem. vol. 9, pp. 424–438, 1917.

Noyes, A. A., The nitrogen problem in relation to the war: Wash. Acad. Sci. Jour., vol. 8, pp. 381–393, 1918.

U. S. patent No. 1213921, dated January 30, 1917, issued to F. W. Sperr, jr. Gases containing hydrocyanic acid or soluble cyanides are treated with sodium zincate to form sodium-zinc cyanide.

U. S. patent No. 1214770, dated February 6, 1917, issued to H. Foersterling and H. Philipp. Sodium cyanide is formed by the action of the vapor sodium which is produced by electrolysis of melted sodium chloride, acting on charcoal in an atmosphere of nitrogen.

U. S. patent No. 1232471, dated July 10, 1917, issued to F. Abegg. Granules of sodium cyanide are made by spraying the molten cyanide against a metal plate exposed to the air.

U. S. patent No. 1235887, dated August 7, 1917, issued to H. Foersterling, H. Philipp, and R. N. Sargent. Sodium cyanide is made by introducing sodium vapor, nitrogen, and finely divided carbon, hydrocarbons, and peat or other carbonaceous material into a reaction chamber previously heated to 800° C., and thereafter regulating the supply of reacting materials.

U. S. patent No. 1249821, dated December 11, 1917, issued to H. Philipp and H. Foersterling. Sodium cyanide is formed by passing nitrogen through a hot sodium-lead alloy and leading the mixture of nitrogen and sodium vapor into a chamber containing hot charcoal.

SODIUM FERROCYANIDE.

Sodium ferrocyanide, yellow prussiate of sodium ($Na_4Fe(CN)_6.10H_2O$), is used in making certain blue colors, such as Prussian blue, Chinese blue, and Paris blue, which are employed extensively in making paint and printing ink.

Practically all ferrocyanide is now made from material obtained in purifying coal gas. Such material is mixed with lime; the soluble calcium ferrocyanide is leached out and subsequently converted into sodium ferrocyanide by treatment with soda ash.

Before the war a considerable quantity of this compound was imported from England and Germany, but the restriction of imports resulted in a greatly increased production in this country, owing to the decreased importation of ferrocyanides as well as to the supplanting of potassium ferrocyanide by sodium ferrocyanide on account of the scarcity of potash.

The data on production of sodium ferrocyanide in the United States in 1917 have been combined with those of sodium cyanide in order to avoid revealing the production of single firms. The combined figures are 12,051 short tons, valued at $7,290,063.

Sodium ferrocyanide was manufactured in 1917 by the Henry Bower Chemical Manufacturing Co., Philadelphia, Pa.; Morris Herrmann & Co., Port Elizabeth, N. J.; the Penman-Littlehales Co., Syracuse, N. Y.; the Portland Gas & Coke Co., Portland, Oreg.; the Seattle Lighting Co., Seattle, Wash.; and the Semet-Solvay Co., Syracuse, N. Y.

SODIUM FLUORIDE.

The total production of sodium fluoride and sodium acid fluoride in the United States in 1917 amounted to 1,424 short tons, valued at $397,305, or about $28 a ton.

Sodium fluoride (NaF) was formerly made by treating cryolite with NaOH, the NaF being sparingly soluble. It may also be made from hydrofluoric acid and soda ash. A recent British patent (103,118, Dec. 22, 1916) describes its preparation from sodium chloride and ammonium fluoride, the latter salt being prepared from calcium fluoride and ammonium sulphate. Ammonium chloride is recovered in the process.

Sodium fluoride is produced by the following firms, which also manufacture sodium acid fluoride: General Chemical Co., New York, N. Y.; John C. Wiarda & Co., 371 Green Street, Brooklyn, N. Y.; Harshaw, Fuller & Goodwin Co., 720 Electric Building, Cleveland, Ohio. Sodium fluosilicate is produced by the Virginia-Carolina Chemical Co., of Richmond, Va.

SODIUM HYDROXIDE.

Sodium hydroxide, or caustic soda (NaOH; theoretically Na_2O 77.48 per cent, H_2O 22.52 per cent), although strictly a base and not a salt of sodium, is included among the sodium salts in this report for convenience.

Production.—The production of sodium hydroxide reported for the calendar year 1917 was 488,056 short tons, valued at $29,402,-689, of grades quoted from 60 to 76 per cent. The percentages refer to the content of sodium (expressed as Na_2O). The output for 1916 was 391,597 short tons, valued at $17,426,066. The following table gives such figures as are available for the annual production of sodium hydroxide to date. These figures do not include the caustic soda made by soap makers for use in their own plants.

Sodium hydroxide produced in the United States in certain years.[a]

	Quantity (short tons).	Value.		Quantity (short tons).	Value.
1899	166,783	$3,170,280	1914	212,539	$6,657,514
1904	86,840	3,185,959	1916	391,597	17,426,066
1909	131,612	5,264,887	1917	488,056	29,402,689

[a] The figures for 1899, 1904, 1909, and 1914 are from Chemicals and allied industries: Census of manufactures, p. 18, U. S. Dept. Commerce Bur. Census, 1918.

In 1917 eight companies in the United States made caustic soda from soda ash and 27 others made it by electrolyzing sodium chloride, but the total production reported by the eight companies was 358,081 short tons valued at $21,086,766, against 129,975 short tons, valued at $8,315,923, for the 27 electrolytic companies. Some of the latter firms make pulp or paper, and all utilize the chlorine, some selling it directly, others converting it into bleach or other products. The reported production of caustic soda includes material carrying various percentages of sodium hydroxide. When the figures are recalculated to express actual sodium hydroxide the caustic soda made from soda ash in 1917 amounts to 341,793 tons, and that made from sodium chloride by electrolysis amounts to 119,030 tons, which is 26 per cent of the total sodium hydroxide made, 460,823 tons. This total output shows an increase of 63,883 tons or 16 per cent over the output of 1916. Of the total for 1917, 66,475 tons, or about 14 per cent, was consumed by the makers in their own plants and the rest was sold.

Exports and imports.—The exports of caustic soda for the last six months of 1917, according to statistics compiled by the Department of Commerce, amounted to 44,996 tons, valued at $5,832,598, or $130 a ton, of which Japan, Italy, Brazil, Argentina, Canada, Mexico, and France received the largest quantities, in the order of the quantity exported to each. About 12,708 tons, valued at $1,739,220, was exported to Japan. Altogether over 57 countries received caustic soda from the United States during this period.

Under the present war program of the United States there is a decided shortage of caustic soda and its exportation requires a Federal license. Moreover, the Government has recently commandeered the production of chlorine, which is the other principal product made by the electrolysis of salt. There is no lack of raw materials, however, and the solution of the problem seems to be entirely a matter of labor, skill, equipment, power, and transportation.

The imports for consumption of caustic soda in 1917 were 146,236 pounds, valued at $17,773.

Uses.—Sodium hydroxide has several uses for which sodium carbonate is inapplicable. It is used in large quantities in making soap and wood pulp. Sodium hydroxide is also used in mercerizing cotton, in purifying oils and fats, in making dyes, and in making phenol, which is used in the manufacture of certain explosives, such as ammonium picrate and trinitrophenol, that is, lyddite, melinite, and schimose. Caustic soda is also used in making pigments, cleaning metals for electroplating, and as lye in the household.

Manufacture.—Sodium hydroxide may be made from the black ash liquor of the Leblanc process (p. 314) by treating the diluted liquor with lime at a boiling temperature. Calcium carbonate settles out and the resulting lye is purified by evaporation and filtration until finally fused $NaOH$ is obtained. The last step in the purification consists in the addition of a very little niter, which decomposes sulphides and cyanides. Sodium hydroxide is made in exactly the same way from sodium carbonate prepared by the ammonia process, but it does not then require the treatment with niter. The spent causticizing mud, after being thoroughly separated from the liquor, is generally treated in rotary kilns to recover the lime.

Many pulp and paper mills make sodium hydroxide from lime and soda ash in their own plants, 80 to 92 per cent of the soda ash, however, being obtained from the evaporation of their own waste liquors and the incineration of the residues.

At the mill of the Kingsport Pulp Corporation, Kingsport, Tenn., a continuous process of causticizing soda ash with lime has been tried successfully over a period of several months. It is stated that the total cost of producing caustic soda, exclusive of the cost of raw materials is approximately 47 cents a short ton of 100 per cent sodium hydroxide, with labor at 30 cents an hour and power at 2 cents a kilowatt hour.

Much caustic soda is now made by the electrolysis of sodium chloride in solution, and many types of cells have been used or proposed to keep the anodic and cathodic products separated. Chlorine is produced at the anode and either sodium hydroxide, or an alloy, or an amalgam of sodium at the cathode. For some purposes the anodic and cathodic products of electrolysis are allowed to mix and the resulting solution is used directly in bleaching. The anodes are generally of graphite. The chlorine produced at the anode is either liquefied or converted into bleaching powder, carbon tetrachloride, or "intermediates" used in making dyes and explosives.

In the Castner-Kellner process the cathode is mercury, and the cell consists of three compartments so arranged that a weak sodium amalgam is no sooner formed in the middle compartment containing a solution of salt than it passes into one of the outer compartments containing water, which reacts with the amalgam under the influence of the electric current to form a dilute solution of sodium hydroxide.

The Townsend cell relies on the separation of caustic soda solution by gravity through a heavy oil, into which drops of the caustic solution are carried from the cathode by means of a slight flow of the brine through the diaphragm adjacent to the cathode. This cell is a variation of those relying on gravity to keep the caustic liquor from mixing with the anodic constituents.

The Allen-Moore cell relies on a circulation of the brine. The framework of these cells is of concrete and the construction permits a change of diaphragms without dismantling the whole cell. The voltage drop per cell varies from 3.2 to 3.5 volts and a current density of about 42 amperes per square foot is employed.

Before the European war the manufacture of electrolytic alkali was limited by the quantity of by-product chlorine that could be utilized, and the present great demand for chlorine for war materials should permit an increased production of caustic soda.

An electrolytic process may be used to produce caustic soda and hydrochloric acid from salt as follows: Electrolytic decomposition of sodium sulphate yields sodium hydroxide and sodium bisulphate. On evaporating and heating sodium bisulphate with salt hydrochloric acid is produced and sodium sulphate is recovered.

Patents.—Patents relating to caustic soda and issued in 1917 are as follows:

U. S. patent No. 1222239, dated April 10, 1917, issued to K. Ochs, describes a cell for electrolyzing alkali metal halides, having as cathode a horizontal wire net which is surmounted by a thin diaphragm of asbestos.

U. S. patent No. 1238916, dated September 4, 1917, issued to C. P. Hoover. Sodium hydroxide is formed by passing calcium hydroxide solution through a sodium zeolite. The zeolite is later regenerated by the action of sodium chloride.

U. S. patent No. 1222453, dated May 22, 1917, issued to H. B. Kipper. Solutions containing sodium hydroxide are purified by electrolysis, hot, using a nickel anode.

U. S. patent No. 1249314, dated December 11, 1917, issued to C. S. Bradley. Sodium hydroxide is formed from barium hydroxide and sodium carbonate, and some barium hydroxide is made from a part of the sodium hydroxide thus produced and barium chloride, which is obtained in the reaction of barium carbonate, ammonium chloride, and sodium chloride.

Producers.—The following list gives the producers of caustic soda in 1917, exclusive of soap makers:

Brown & Co., 404 Commercial Street, Portland, Me.
Champion Fibre Co., Canton, N. C.
Columbia Chemical Co., Pittsburgh, Pa.
Diamond Alkali Co., Pittsburgh, Pa.
Dill & Collins Co., Sixth and Cherry Streets, Philadelphia, Pa.
Dow Chemical Co., Midland, Mich.
Eastern Electro-Chemical Co., Bangor, Maine.
Federal Dyestuffs & Chemical Co., 2 Rector Street, New York, N. Y.
Great Western Electro-Chemical Co., Holbrook Building, San Francisco, Cal.
Gulf Refining Co., Port Arthur, Tex.
Hammerschlag Manufacturing Co., Garfield, N. J.
Hooker Electro-Chemical Co., E. H. Hooker, pres., Buffalo Avenue and Union Streets, Niagara Falls, N. Y.
Huron Milling Co., Harbor Beach, Mich.
Isco Chemical Co., Niagara Falls, N. Y.
Jessup & Moore Paper Co., Philadelphia, Pa.
Kimberly-Clark Co., Kimberly, Wis.
Mathieson Alkali Works, Saltville, Va.
Miami Paper Co., West Carrollton, Ohio.
Michigan Alkali Co., Detroit, Mich.
Michigan Electrochemical Co., Menominee, Mich.
New York-Pennsylvania Co., 200 Fifth Avenue, New York, N. Y.
Niagara Alkali Co., Niagara Falls, N. Y.
Niagara Smelting Corporation, Niagara Falls, N. Y.
Oxford Paper Co., 200 Fifth Street, New York, N. Y.
Penobscot Fibre Co., 49 Federal Street, Boston, Mass.
Pennsylvania Salt Manufacturing Co., Philadelphia, Pa.
Republic Chemical Co., Pittsburgh, Pa.
Rub No More Co., Dorenger Avenue, Fort Wayne, Ind.
Solvay Process Co., Syracuse, N. Y.
Warner Chemical Co., 52 Vanderbilt Avenue, New York, N. Y.
Warner-Klipstein Chemical Co., 52 Vanderbilt Avenue, New York, N. Y.
S. D. Warren Co., Cumberland Mills, Me.

SODIUM IODIDE.

Sodium iodide (NaI) may be prepared in several ways, as, for example, from caustic soda and iodine. It is used in analytical chemistry and in medicine, especially for making solutions of iodine.

The production of sodium iodide in the United States in 1917 amounted to 7 tons, value not reported, but estimated at about $490,000. It is manufactured by the Mallinkrodt Chemical Works, St. Louis, Mo.; McKesson & Robbins (Inc.), 91 Fulton Street, New York, N. Y.; E. R. Squibb & Sons, New York, N. Y.

SODIUM NITRATE.

Data on the occurrence and production of sodium nitrate ($NaNO_3$) are given in a previous volume of Mineral Resources.[1] As is well known, most of the sodium nitrate used in the United States is imported from South America, principally from Chile. The imports for consumption in 1916 were 1,255,962 short tons, valued at $38,131,364, and in 1917 they were 1,728,390 short tons, valued at $60,727,100, according to records of the Department of Commerce.

Refined sodium nitrate was produced in 1917 by E. R. Squibb & Sons, New York, N. Y., and the Stauffer Chemical Co., San Francisco.

Many samples of nitrate-bearing material have been examined by the United States Geological Survey from time to time, but, although the percentages of nitrate have at times been very promising, the

[1] Phalen: W. C., Potash salts: U. S. Geol. Survey Mineral Resources, 1914, pt. 2, p. 18, 1916.

material has so far either not been found in quantity in any given locality or it has been found to be so widely disseminated in lavas or tuffs as to make its successful commercial treatment doubtful.

Patents.—The following patents, issued in 1917, refer to the separation of sodium nitrate from sodium chloride:

U. S. patent No. 1230162, dated June 19, 1917, and issued to J. B. Hobsbawn and J. L. Grigioni. Apparatus for separating sodium chloride at about 124° C. from a solution containing sodium nitrate.

U. S. patent No. 1230163, dated June 19, 1917, and issued to J. B. Hobsbawn and J. L. Grigioni. Apparatus for separating sodium nitrate and sodium chloride alternately from the same solution.

SODIUM NITRITE.

Sodium nitrite ($NaNO_2$) is generally made by heating sodium nitrate with lead. The product is extracted with water and the solution is allowed to crystallize, when anhydrous sodium nitrite separates. It is used in making coal-tar dyes and as a chemical reagent. The production reported for 1917 was 861 short tons, valued at $480,145.

The imports for consumption in 1916 were 3,630,074 pounds, valued at $255, 755, and in 1917 they were 8,767,415 pounds, valued at $349,111.

Sodium nitrite was manufactured in 1917 by the following firms:

Merrimac Chemical Co., 148 State Street, Boston, Mass.
E. I. du Pont de Nemours & Co., Harrison Works, Philadelphia, Pa.
Semet-Solvay Co., Syracuse, N. Y.
American Nitrogen Products Co., Seattle, Wash.
Harshaw, Fuller & Goodwin Co., 720 Electric Building, Cleveland, Ohio.

SODIUM PERBORATE.

Sodium perborate, which is made by suspending borax in a solution of sodium carbonate that is being electrolyzed, is used in laundry work and for hygienic purposes. It is an oxidizing agent. According to the mode of preparation, sodium perborate has the formula $Na_2B_4O_8.10H_2O$ or $NaBO_3.4H_2O$.

Figures for the production of this salt have been combined with those for the production of metallic sodium. The total amounts to 4,594 short tons, valued at $2,119,100. Sodium perborate was manufactured in 1917 by The Roessler & Hasslacher Chemical Co., 100 William Street, New York, N. Y.

U. S. patent No. 1222640, dated April 17, 1917, and issued to O. Liebknecht, claims a method of forming stable double salts containing sodium perborate in the presence of borax, magnesium chloride, and carbon dioxide. The same inventor in U. S. patent No. 1235904, dated August 7, 1917, claims the preparation of sodium perborate by electrolyzing a solution of sodium carbonate and borax.

SODIUM PEROXIDE.

Sodium peroxide is manufactured by the Niagara Electro Chemical Co., Niagara Falls, N. Y. It is made by burning metallic sodium in an excess of air or oxygen. It is used in chemical analysis, especially in decomposing pyrite and chromite, and in bleaching, also for generating oxygen in hospitals, submarines, and mine-rescue apparatus, and in making hydrogen peroxide. When pressed into blocks with a little nickel sulphate, copper sulphate, or potassium permanganate, sodium peroxide may be used to generate oxygen merely through the action of water.

In order not to reveal the output of single producers the production of sodium peroxide in 1917 has been added to that of sodium chlorate. The total production of these two salts in 1917 amounted to 4,522 short tons, with an estimated value of $2,119,626.

SODIUM PHOSPHATE.

Sodium phosphate ($Na_2HPO_4.12H_2O$), is one of several different phosphates, all of which are derived originally from acid calcium phosphate by treatment with sodium carbonate. Sodium phosphate is used in the textile industries, especially the silk industry, and in the pharmaceutical trade.

Sodium phosphate was manufactured in 1917 by the following firms:

Armour Fertilizer Works, Chicago, Ill.
Bowker Chemical Co., New York, N. Y.
Grasselli Chemical Co., Cleveland, Ohio.
Victor Chemical Works, Fisher Building, Chicago, Ill.

Trisodium phosphate was manufactured by the Bowker Chemical Co., New York, N. Y., and the Grasselli Chemical Co., Cleveland, Ohio.

The total production of all varieties of sodium phosphate, including monosodium phosphate, disodium phosphate, and trisodium phosphate, in the United States in 1917 amounted to 13,305 short tons, valued at $711,283. The following table contains such figures as are available for the annual production of sodium phosphate to date:

Sodium phosphate produced in the United States, 1899–1917.[a]

	Quantity (short tons).	Value.		Quantity (short tons).	Value.
1899	2,340	$155,989	1914	15,397	$853,528
1904	4,830	244,373	1917	13,305	711,283
1909	12,290	540,282			

[a] The figures for the years 1899, 1904, 1909, and 1914 are from Chemicals and allied industries: Census of manufactures, p. 18, U. S. Dept. Commerce Bur. Census, 1918.

SODIUM SILICATE.

Sodium silicate, or water glass, as manufactured commercially, is not a definite chemical compound. The bulk of the commercial product is of 40° B. strength, but it ranges from 37° to 69° B. The ratio of silica to sodium in these different grades varies from 1.6 to 3.8, being lowest in the most concentrated solutions.

The production of sodium silicate for the calendar year 1917 amounted to 254,011 short tons, valued at $3,317,547. The last previously reported production was that given by the Bureau of the Census for 1914, which amounted to 169,049 short tons, valued at $1,648,854, a great advance over all previous years. The price of the 40° B. strength f. o. b. tank cars rose from $12 a ton during the first quarter of 1917 to $17 in the last quarter, and had advanced to $19 by March, 1918.

Exports of sodium silicate during the last six months of 1917, according to figures furnished by the Department of Commerce, amounted to 14,549,574 pounds, valued at $216,828. Canada received more than half of this material, followed, in order of quantity exported, by Cuba, Mexico, Uruguay, Japan, and Venezuela.

Sodium silicate is used in making acid-proof cements, adhesives, and fiber board, in sealing boxes containing foods, in fire-proofing materials, in preserving eggs, and by manufacturers of soap, asbestos goods, and emery wheels. Its use as a binder in building roads was proposed in U. S. patent No. 1206056, dated November 28, 1916, and issued to J. G. Vail. Some sodium silicate is also used in weighting silk, in sizing paper, and in making veneers.

Sodium silicate was manufactured by the following firms in 1917:

L. Feuchtwanger, Little Ferry, N. J.
Frohman Chemical Co., Sandusky, Ohio.
General Chemical Co., New York, N. Y.
Grasselli Chemical Co., Cleveland, Ohio.
John Horstmann Co., 685 Bryant Street, San Francisco, Cal.
Mechling Bros. Manufacturing Co., Line Street and Coopers Creek, Camden, N. J.
Philadelphia Quartz Co., 121 Third Street south, Philadelphia, Pa.

SODIUM SULPHATE.

SALT CAKE.

Sodium sulphate (Na_2SO_4) is obtained in large quantities in the manufacture of hydrochloric acid from sodium chloride, either with the aid of niter cake, of sulphuric acid, or by Hargreave's process from sulphur dioxide, air and steam. The product is generally termed "salt cake."

The salt cake marketed in the United States in 1917 amounted to 183,909 short tons, valued at $2,987,641. The Bureau of the Census reported an output of 90,442 tons of salt cake, valued at $841,887 for the year 1914. The output of salt cake in 1917, together with that of Glauber's salt, indicates the production of at least 121,000 short tons of 35 per cent hydrochloric acid, if niter cake was used, or of 301,000 short tons of hydrochloric acid, if sulphuric acid was used to form the hydrochloric acid from the sodium chloride.

Uses.—Sodium sulphate as salt cake is used in making plate glass, window glass, and bottles. Glassmaker's salt cake should be very low in iron, sulphuric acid, sodium chloride, and calcium sulphate. Hargreave's process for making salt cake is said to produce a practically iron-free product, but this process is not generally used in the United States. The same result is obtained by making salt cake in lead pans, which requires considerable skill, or by preparing Glauber's salt from crude salt cake. Sodium sulphate as salt cake is also used in making sodium sulphide and a small quantity is used by aniline manufacturers and in making ultramarine.

It is claimed that sodium sulphate can be used instead of sodium carbonate in the soda wood pulp industry. In this process of making pulp the waste liquors containing sodium carbonate and carbonaceous matter are evaporated and the residue is finally calcined to recover sodium carbonate. If sodium sulphate is added to the waste liquors it is converted by calcination into sodium sulphide, which is said to have the same action on pulp as caustic soda. But if the proper quantity of limestone is added before calcining it appears that sodium carbonate would be the principal product obtained by extraction. This could then be causticized as usual.

Manufacturers.—The following firms produced sodium sulphate as salt cake in 1917:

American Steel & Wire Co., 502 Western Reserve Building, Cleveland, Ohio.
Armour Fertilizer Works, Chicago, Ill.
Ault & Wiborg Co., Cincinnati, Ohio.
Butterworth-Judson Corp., 61 Broadway, New York, N. Y.
Charles Lennig & Co., Inc., Philadelphia, Pa.
Consolidated Chemical Co., McKittrick, Cal.
Commercial Acid Co., 3943 Duncan Avenue, St. Louis ,Mo.
Contact Process Co., 351 Abbott Road, Buffalo, N. Y.
E. I. duPont de Nemours & Co., Harrison Works, Philadelphia, Pa.
Gill Soda Co., Cheyenne, Wyo.
General Chemical Co., New York, N. Y.
Grasselli Chemical Co., Cleveland, Ohio.
Kalbfleisch Corporation, 31 Union Square, west, New York, N. Y.
Merrimac Chemical Co., 148 State Street, Boston, Mass.
Monsanto Chemical Works, St. Louis, Mo.
Mutual Chemical Co. of America, New York, N. Y.
National Zinc Co., Kansas City, Kans.
Naugatuck Chemical Co., Elm Street, Naugatuck, Conn.
Pennsylvania Salt Manufacturing Co., Philadelphia, Pa.
Powers-Weightman-Rosengarten Co., Box 1625, Philadelphia, Pa.
Robinson Bros., Seneca and Montrose Avenues, Brooklyn, N. Y.
E. R. Squibb & Sons, New York, N. Y.
Stauffer Chemical Co., 624 California Street, San Francisco, Cal.
Western Chemical Manufacturing Co., West Bryant Avenue and South Pecos Street, Denver, Colo.

GLAUBER'S SALT.

The hydrated salt obtained by recrystallization below 32.4°C. ($Na_2SO_4.10H_2O$), Glauber's salt, is in demand where purity is an essential. It is used in dyeing, in tanning, in the textile industry as a mordant assistant, and in medicine. It is, however, an expensive form in which to transport sodium sulphate. Much Glauber's salt is made from impure salt cake which after heating to remove the excess water is sold as "glassmaker's salt cake."

The Glauber's salt marketed in 1917 amounted to 47,757 short tons, valued at $732,403. This output of Glauber's salt, if all made from salt cake, represents a production of at least 21,100 tons of salt cake in addition to the salt cake reported as marketed in 1917.

Manufacturers.—The following list gives the manufacturers of Glauber's salt in 1917:

Atlantic Carbonic Co., 258 Third Street, Chelsea, Mass.
Central Chemical Co., foot of Chapel Street, Newark, N. J.
Charles Lennig & Co. (Inc.), Philadelphia, Pa.
Columbus Crystal Co., 15 Arch Street, Newark, N. J.
General Chemical Co., New York, N. Y.
Grasselli Chemical Co., Cleveland, Ohio.
John Horstmann Co., 685 Bryant Street, San Francisco, Cal.
Iowa Soda Products Co., Detroit Mich.
Kalbfleisch Corp., 31 Union Square west, New York, N. Y.
Merrimac Chemical Co., 148 State Street, Boston, Mass.
National Zinc Co., Kansas City, Kans.
Pennsylvania Salt Manufacturing Co., Philadelphia, Pa.
Powers-Weightman-Rosengarten Co., Box 1625, Philadelphia, Pa.
Roessler & Hasslacher Chemical Co., 100 William Street, New York, N. Y.
Stauffer Chemical Co., 624 California Street, San Francisco, Cal.

NITER CAKE.

Niter cake, the residual product in the manufacture of nitric acid from sodium nitrate and sulphuric acid, differs from salt cake in containing acid sodium sulphate ($NaHSO_4$) in varying quantity. Manufacturers report either the percentage of bisulphate or the percentage of sulphuric acid in the product. Pure sodium bisulphate carries 40.8 per cent of sulphuric acid and commercial grades carry from 25 to 35 per cent of sulphuric acid, which corresponds to 61 to 86 per cent of sodium bisulphate.

The quantity of niter cake made in the United States in 1917 was very large, owing to the demand for nitric acid for making explosives, and much of the niter cake was not marketed.

The marketed production amounted to 387,821 short tons, valued at $780,278, or about $2 a ton.

This quantity of niter cake accounts for only about 316,000 tons of sodium nitrate, whereas the Department of Commerce reports the importation of 1,728,390 short tons of sodium nitrate from Chile in 1917. The difference in these figures may be partly accounted for by the consumption of niter cake in making hydrochloric acid and sodium sulphide—which could not, however, account for more than 136,000 tons of sodium nitrate—leaving a large amount to represent either niter cake not utilized or sodium nitrate that went into fertilizers or was stored for future use.

Uses.—Many uses have been proposed for niter cake which could probably be obtained in quantity for about $2 a ton. Its use in making fertilizers hinges on the question whether sodium sulphate in moderate quantity is a harmful constituent of a mixed fertilizer, as it is not thought that it would pay to attempt to remove the sodium sulphate after the preparation of the acid phosphate. Proposed uses for niter cake have been summarized by John Johnston.[1]

Patents.—The following patents issued in 1917 also indicate possible uses of niter cake:

U. S. patent No. 1203357, dated October 31, 1916, issued to W. C. Kerr. Niter cake and magnesium chloride are heated to produce hydrochloric acid and the resulting sodium sulphate and magnesium sulphate are afterward separated.

U. S. patent No. 1206796, dated December 5, 1916, issued to L. E. Barton. Ilmenite is treated with niter cake first at about 200° C., and then with charcoal at 650–825° C. to form compounds yielding titanium dioxide with dilute acid.

U. S. patent No. 1250471, dated December 18, 1917, issued to H. B. Kipper. Sodium sulphate and ferric sulphate are formed by heating ferric acid with niter cake to 400° C.

Manufacturers.—The following firms manufactured niter cake in 1917:

Aetna Explosives Co., New York, N. Y.
American Steel Wire Co., 502 Western Reserve Building, Cleveland, Ohio.
American Zinc & Chemical Co., Oliver Building, Pittsburgh, Pa.
Armour Fertilizer Works, Chicago, Ill.
Ault & Wiborg Co., Cincinnati, Ohio.
Butterworth-Judson Corporation, 61 Broadway, New York, N. Y.
Commercial Acid Co., 3943 Duncan Avenue, St. Louis, Mo.
Contact Process Co., 351 Abbott Road, Buffalo, N. Y.
Charles Cooper & Co. (Inc.), Newark, N. J.
E. J. du Pont de Nemours Co., Wilmington, Del.

[1] Jour. Ind. and Eng. Chemistry, June, 1918; see also Soc. Chem. Industry Jour., vol. 34, p. 1121, 1915.

Federal Dyestuffs & Chemical Corporation, 2 Rector Street, New York, N. Y.
General Chemical Co., New York, N. Y.
Grasselli Chemical Co., Cleveland, Ohio.
Kalbfleisch Corporation, 31 Union Square west, New York, N. Y.
Charles Lennig & Co. (Inc.), Philadelphia, Pa.
Merrimac Chemical Co., 148 State Street, Boston, Mass.
Monsanto Chemical Works, St. Louis, Mo.
National Zinc Co., Kansas City, Kans.
Naugatuck Chemical Co., Naugatuck, Conn.
Powers-Weightman-Rosengarten Co., Box 1625, Philadelphia, Pa.
Robinson Bros., Seneca and Montrose Avenues, Brooklyn, N. Y.
Semet-Solvay Co., Syracuse, N. Y.
Southern Acid & Sulphur Co., 1303 Boatman's Bank Building, St. Louis, Mo.
Tennessee Copper Co., 61 Broadway, New York, N. Y.
Virginia-Carolina Chemical Co., Richmond, Va.
Western Chemical Manufacturing Co., West Bryant Avenue and South Pecos Street, Denver, Colo.

NATURAL SODIUM SULPHATE.

Some of the analyses on pages 317–319 indicate that sodium sulphate is a prominent constituent of surface salts in several localities, especially in Wyoming, Utah, and Nevada. Sodium sulphate is found in many soils in regions of deficient rainfall, being known as white alkali, in contrast to sodium carbonate, which is known as black alkali on account of its corrosive action on vegetation. The exact proportion of white alkali that may exist in a soil without being positively deleterious is a matter of disagreement among soil experts, but small quantities are certainly not fatal to many crops.

Hydrated sodium sulphate ($Na_2SO_4 10.H_2O_3$) decreases markedly in solubility with falling temperature, so that it deposits from many lakes containing strong brine in cold weather. Gilbert [1] says that this salt is deposited from the Great Salt Lake in cold weather and thrown up in heaps on the shore. Experiments by the writer have shown that the separation begins at 1° C. In Sevier Lake, Utah, which is at times entirely dry, the salts have been alternately dissolved and redeposited, with the result, as noted by Gilbert, that the sodium sulphate is chiefly found near the center and sodium chloride near the margin of the lake.

Natural sodium sulphate has been utilized at various times in small quantity. It seems as if greater use could be made of it. In this connection it may be noted that when it occurs mixed with sodium carbonate the mixture may be regarded as having been carried nearly through the Leblanc process, so that instead of attempting to separate the two salts it might be possible to transform the sulphate into carbonate by calcination with limestone and coal producing soda ash, a large proportion of soda ash being already present in the natural salts. Moreover, the natural mixture might be used directly in making glass.

The Gill Soda Co., Cheyenne, Wyo., reported the production of natural sodium sulphate in 1917. Natural sodium sulphate has also been produced commercially at Green River, Sweetwater County, Wyo., and McKittrick, Cal.

In Mineral Resources for 1885 Weeks [2] describes natural sodium carbonate and sulphate near Laramie, Wyo., and the manufacture of caustic soda from these materials.

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[1] Gilbert, G. K., U. S. Geol. Survey Mon. 1, p. 253, 1890.
[2] Weeks, J. D., Glass materials: U. S. Geol. Survey Mineral Resources, 1885, pp. 551–552, 1886.

SODIUM SULPHIDE.

The production of sodium sulphide in the United States in 1917 amounted to 49,494 short tons, valued at $1,905,473. This includes 36,078 tons of single strength material (30 to 32 per cent of Na_2S), valued at $1,073,181, and 13,416 tons of double strength material (60 to 62 per cent of Na_2S), valued at $832,292. In all, this is equivalent to 19,120 short tons of anhydrous sodium sulphide.

The last previously reported production of sodium sulphide is that given by the Bureau of the Census, which reported 20,263 tons, valued at $516,644, for 1914 and only 7,673 tons, valued at $206,450, for 1909.

In 1917 there was imported for consumption 288,292 pounds of sodium sulphide, valued at $5,104, according to the figures of the Department of Commerce.

Sodium sulphide (Na_2S), may be formed by heating salt cake with coal, but it is more economical to make it from niter cake, sodium chloride, and coal, with the incidental production of hydrochloric acid. After lixiviation the product is obtained as crystals ($Na_2S.9H_2O$), running about 32 per cent sodium sulphide. A more concentrated salt may be prepared by evaporation until the temperature reaches about 160° C. and allowing the liquor to cool. The product thus obtained carries about 62 per cent of sodium sulphide. For preservation and transportation a more nearly anhydrous salt is desirable. The General Chemical Co. sells a product known as "chipped" sodium sulphide.

Sodium sulphide is used in dyeing, in cleaning fabrics, in making the sulphur dyes and other dyes, in tanning, for removing hair from skins, in sulphurizing oxidized lead and copper ores preparatory to flotation, and in precipitating silver from cyanide solutions.

Manufacturers.—The following list gives the manufacturers of sodium sulphide in 1917:

Ault & Wiborg Co., Cincinnati, Ohio.
Clinchfield Products Corp., 120 Broadway, New York, N. Y.
Contact Process Co., 351 Abbott Road, Buffalo, N. Y.
Chemical Products Co., 616 Majestic Building, Denver, Colo.
Grasselli Chemical Co., Cleveland, Ohio.
E. I. duPont de Nemours & Co., Harrison Works, Philadelphia, Pa.
Merrimac Chemical Co., 148 State Street, Boston, Mass.
Rollin Chemical Co., South Charleston, W. Va.
Charles Lennig & Co. (Inc.), Philadelphia, Pa.

Patent.—U. S. patent No. 1212702, dated January 16, 1917, and issued to H. Specketer and W. Hofman. It is proposed to make sodium sulphide by heating sodium sulphate and coal in a shaft furnace with a regulated supply of air.

SODIUM SULPHITE AND SODIUM BISULPHITE.

Sodium sulphite (Na_2SO_3), sodium bisulphite ($NaHSO_3$), and sodium metabisulphite (NaS_2O_5), are all made from sodium carbonate and sulphur dioxide and are used as a source of sulphur dioxide in making wood pulp, sterilizing brewer's casks, as reducing agents in photography, dyeing, and bleaching, and for removing traces of chlorine where a chlorine bleach has been used.

The total production of these salts in the United States in 1917 amounted to 13,707 short tons, valued at $300,668.

Patent.—U. S. patent No. 1216452, dated February 20, 1917, issued to T. W. S. Hutchins, L. Hargreaves, and A. C. Dunningham.

It is proposed to make sodium bisulphite by passing sulphur dioxide over sodium carbonate, etc., in such a way as to drive off carbon dioxide.

Manufacturers.—The following list shows the manufacturers of sodium sulphite, sodium bisulphite, and sodium polysulphite in 1917:

Sodium sulphite: Semet-Solvay Co., Syracuse, N. Y.

Sodium bisulphite: Atlantic Carbonic Co., 268 Third Street, Chelsea, Mass.; Merrimac Chemical Co., 148 State Street, Boston, Mass.; Avery Chemical Co., 88 Broad Street, Boston, Mass.

Sodium polysulphite: Roessler & Hasslacher Chemical Co., 100 William Street, New York, N. Y.

SODIUM TETRABORATE (BORAX).

Composition.—Sodium tetraborate ($Na_2B_4O_7.10H_2O$), commonly called borax and by some sodium biborate, is both a mineral and a manufactured product. Crude natural borax is known as tincal. It is found in San Bernardino County, Cal., associated with gypsum, anhydrite, thenardite, glauberite, hanksite, halite, and trona; also in several other counties in California; in saline lakes and playas in Nevada and Oregon; and in the hot springs of the Yellowstone Park. The present source of refined borax in the United States, however, is the mineral colemanite ($Ca_2B_6O_{11}.5H_2O$), from which borax is manufactured by treatment with sodium carbonate.

The formula of borax given above represents the hydrate formed at ordinary temperature. The crystals effloresce, however, when exposed to the air and lose in all $5H_2O$ below 100° C., the sixth molecule at 100°, the seventh and eighth at 130°, the ninth at 150°, and the tenth at 160° and above, the last molecule being held so tenaciously that 300° is desirable to insure complete desiccation, according to J. Hoffman.[1] The very careful experiments of Smith and Van Haagen[2] show that even borax glass still retains about 0.2 per cent of moisture under ordinary conditions.

Production and prices.—The quantity of borax sold in the United States in 1917 was 32,089 short tons, valued at $4,717,532. This salt was produced in 1917 by the Pacific Coast Borax Co., 100 William Street, New York; Charles Pfizer & Co., 81 Maiden Lane, New York; and the Thorkildsen-Mather Co., Forty-fifth and Elizabeth streets, Chicago, Ill.

According to quotations in the trade journals, the price of borax was steady throughout 1917, ranging from 6½ to 8¾ cents a pound but most of the time holding close to 8 cents.

Uses.—Borax on fusion dissolves the oxides of the metals, forming characteristically colored glasses that are useful in blowpipe tests. Fully a third of the borax consumed annually in this country, however, is used in the manufacture of enamels or porcelain-like coatings for such objects as bathtubs, kitchen sinks, and cooking utensils. Borax is also used as a flux in the melting and purification of the precious metals, in decomposing chromite, in making glass, as a preservative, and for household purposes.

Sources of domestic borax.—Domestic borax was derived entirely in 1917 from the mineral colemanite, which is produced from a few mines in southern and southeastern California, although the American Trona Corporation is reported to be in a position to produce refined

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[1] Chem. Industry, vol. 39, p. 411, 1916.

[2] Smith, E. F., and Van Haagen, W. K., The atomic weights of boron and fluorine: Carnegie Inst. Washington Pub. 267, 1918.

borax from the water of Searles Lake if the demand warrants it. A map showing the location of boron deposits in the western United States will be found in Mineral Resources for 1916, Part II, page 389. So far as the Survey is informed no new deposits were opened in 1917. The Pacific Coast Borax Co. did some drilling for colemanite near Kramer, in San Bernardino County, but no statement has been issued as to the results obtained. The Stauffer Chemical Co. also did some prospecting on the north side of Frazier Mountain, Ventura County, but without favorable results.

Most of the boron ore mined in California is concentrated before being shipped to the refinery. At the Lang property of the Sterling Borax Co., this treatment includes heating, which drives off most of the water, disintegrates the colemanite, and causes the admixed clay to gather into balls that are easily separated. The concentrated ore runs from 30 to 45 per cent of boric oxide. In 1917 the Pacific Coast Borax Co. put in Wilfley concentrators to work over old tailings and was reported to be making a very good recovery.

According to C. G. Yale and H. S. Gale,[1] the production of crude boron ore in the United States in 1917 was 108,875 short tons, valued at \$3,609,632, compared with 103,525 short tons, valued at \$2,409,459, in 1916. The value of the product given is the value of the ore at the point of shipment estimated on the basis of \$1 per unit (per cent) of boron trioxide (B_2O_3) in the raw material.

A statement of the production of borate materials in the United States, compiled from the most authentic sources available, is given below:

Borate materials produced in the United States, 1864–1917.

Year.	Crude (short tons).	Refined (short tons).	Value.	Year.	Crude (short tons).	Refined (short tons).	Value.
1864		12	\$9,478	1892		6,750	\$900,000
1865		125	94,099	1893		4,350	652,425
1866		201	132,538	1894		7,340	974,445
1867		220	156,137	1895		5,959	595,900
1868		32	22,384	1896		6,754	675,400
1869		0	0	1897		8,000	1,080,000
1870		0	0	1898		8,000	1,120,000
1871		0	0	1899		20,357	1,139,882
1872		140	89,000	1900	24,235	1,602	1,018,251
1873		1,000	496,000	1901	17,887	5,344	1,012,118
1874		2,000	567,000	1902	2,600	17,404	2,538,614
1875		2,717	672,000	1903	34,430		661,400
1876		2,590	563,000	1904	45,647		698,810
1877		1,864	364,000	1905	46,334		1,019,154
1878		1,401	249,000	1906	58,173		1,182,410
1879		792	143,000	1907	52,850		1,121,520
1880		1,846	277,233	1908	25,000		975,000
1881		2,023	304,461	1909	41,434		1,534,365
1882		2,118	338,903	1910	42,357		1,201,842
1883		3,250	585,000	1911	53,330		1,569,151
1884		3,500	490,000	1912	42,315		1,127,813
1885		4,000	480,000	1913	58,051		1,491,530
1886		4,889	488,915	1914	62,400		1,464,400
1887		5,500	550,000	1915	67,003		1,677,099
1888		3,795	455,340	1916	103,525		2,409,459
1889		4,000	500,000	1917	108,875		3,609,632
1890		4,750	617,500				
1891		6,690	869,700		885,446	151,315	42,965,308

NOTE.—Prior to production from Nevada, prices ranged from 28 to 35 cents a pound for the refined borax extracted from the California lake waters. After 1872 the price dropped during the next two years to $6\frac{1}{2}$ cents a pound; it then advanced slowly to 11 to 13 cents, but again fell off. In 1885 borax sold in San Francisco for 6 to 8 cents a pound; a further decline followed. From 1882 to 1903, inclusive, the refined product was used as a basis for estimating the value; but since 1904 the value has been estimated on a basis of unit values assigned to the boric acid in the crude product.

[1] Personal communication.

Imports.—No borax was imported into the United States in 1917, and only a very small quantity of crude calcium borate. The quantity of boric acid imported was slightly less than in 1916, but the value was slightly greater. The imports of boron compounds are shown in the following table compiled from records of the Department of Commerce:

Borax and borates imported for consumption in the United States, 1902–1917.

Year.	Borax.		Borates, calcium and sodium (crude) and refined sodium borate.		Boric acid.	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1902	684,537	$20,795	186,807	$12,002	822,907	$30,439
1903	68,978	5,727	146,654	13,280	693,619	28,011
1904	153,952	10,569	89,447	6,630	708,815	27,658
1905	166,960	8,802	20,395	1,626	676,105	22,372
1906	791,425	27,343	57,711	2,436	986,021	33,200
1907	2,268,065	77,258	2,959	175	534,524	23,547
1908	641,632	22,058	40	4	385,064	14,702
1909	7,124	1,023	20,284	1,956	265,985	8,708
1910	6,860	1,170	563	66	336,466	11,164
1911	9,582	732	28,815	5,230	458,900	17,666
1912	9,280	636	16,091	1,861	232,545	8,752
1913	4,215	477	7,900	1,125	423,215	16,932
1914	220	29	3,862	546	425,241	18,837
1915	....	....	2,748	393	442,073	20,888
1916	83	3	703	135	354,710	19,905
1917	....	....	110	7	341,622	21,199

Bibliography.—An excellent bibliography of the borax industry will be found in Mineral Resources for 1913, Part II, page 523.

SODIUM THIOSULPHATE.

Sodium thiosulphate is very generally known in the trade as sodium hyposulphite or "hypo."

The production of this salt in the United States in 1917 was 26,598 short tons, valued at $717,924. This quantity of crystals is equivalent to 16,920 tons of the anhydrous salt.

Sodium thiosulphate is used in the textile industry for removing the last traces of chlorine from bleached fabrics, and in bleaching wool, straw, oils, ivory, and bones (as a source of sulphur dioxide). It is also used in chrome tanning, in dyeing, in sterilizing drinking water, in analytical chemistry, in the manufacture of dyes, paper, and mordants, and as a solder for sealing glass tubes containing explosives to be used under water. Its use in photography as a fixing agent depends on its solvent action on silver salts which have not been affected by light.

The salt may be made by treating sodium sulphite with sulphur or from milk of lime, sulphur and soda ash, or from waste materials containing sulphur, such as Leblanc tank waste.

Sodium thiosulphate was manufactured in 1917 by the Charles Lennig Co. (Inc.), Philadelphia, Pa., the Grasselli Chemical Co., Cleveland, Ohio, the Mallinkrodt Chemical Works, St. Louis, Mo., and Mechling Bros. Manufacturing Co., Camden, N. J.

Patents.—In U. S. patent No. 1207782, dated December 12, 1917, and issued to E. Marburg and G. Munch, it is proposed to make anhydrous sodium thiosulphate by adding aniline to an aqueous solution of the salt and finally evaporating in a vacuum.

U. S. patent No. 1219819, dated March 20, 1917, and issued to T. W. S. Hutchins, L. Hargreaves, and A. C. Dunningham, describes the manufacture of sodium thiosulphate by passing a hot solution of sodium sulphite continuously over a mixture of sodium sulphite and sulphur.

MISCELLANEOUS SODIUM COMPOUNDS.

A scattered production of various sodium salts, chiefly organic chemicals used in analytical chemistry, photography, and medicine, was reported in 1917, which can not be given in detail without revealing figures of individual producers. The list includes sodium citrate, sodium phenolsulphonate, sodium salicylate, sodium oxalate, sodium arsenate, sodium arsenite, sodium bitartrate, sodium bromide, sodium tartrate, sodium hypochlorite or chlorinated soda solution, sodium benzoate, sodium formate, sodium succinate, sodium permanganate, sodium fluosilicate, and sodium sulpho-carbolate.

The total production of these salts reported, which is admittedly short of the true production, amounts to 49 tons. Few values have been reported for these salts, as the market for them is narrow and prices vary widely according to the quantities involved.

The producers reporting include the Mallinkrodt Chemical Works, St. Louis, Mo.; E. R. Squibb & Sons, New York, N. Y.; and the Semet-Solvay Co., Syracuse, N. Y.

Patents.—The following patents refer to miscellaneous sodium salts:

U. S. patent No. 1212359, dated January 16, 1917, issued to S. H. Katz and F. K. Ovitz. Sodium formate is made by passing finely divided 32 per cent sodium hydroxide solution downward against a stream of carbon dioxide and ammonia under a pressure of 10 to 20 atmospheres and at 150° to 220° C.

U. S. patent No. 1232249, dated July 3, 1917, and issued to F. A. Dugan. Sodium oxalate is made from molten sodium and carbon dioxide at about 360° C.

U. S. patent No. 1247165, dated November 20, 1917, and issued to K. F. Stahl. Sodium fluosilicate is made from phosphate rock containing fluoride.

CEMENT.

By Ernest F. Burchard.[1]

INTRODUCTION.

The cement industry, in common with most other manufacturing industries, faced unusual conditions in 1917. The demand for cement was generally very good during the first five to eight months, but showed a decided falling off during the remainder of the year. The strong demand in the early part of the year so stimulated production that the quantity of finished cement of all kinds manufactured reached a total of more than 93,000,000 barrels—the largest production ever recorded. The total shipments, on the other hand, decreased, and the stocks increased accordingly. The prices for cement reached higher levels than at any time since 1899, and although the net profits appear not to have been great, the effect of prices high enough to minimize the chances of loss and of the absence of price cutting seems to have stimulated production as well as to have encouraged the completion of three new mills and the resumption of operations at one mill that was idle in 1916.

The adverse effects on the cement industry of the entrance of the United States into the European war began to be generally felt after the middle of the year and consisted mainly in shortage of fuel, railroad cars, and labor and the lessened demand for cement in some districts due to the curtailment of building operations not essential to the war. The necessary railroad embargoes were far reaching; they affected supplies of fuel and other raw materials and of machinery and mill supplies and also shipments of cement to such an extent that some mills had to be closed temporarily on account of lack of storage capacity.

At the beginning of the year the rate of shipment of Portland cement was about 4,000,000 barrels a month, and it rose steadily until May to about 11,000,000 barrels. During the next two months there was a sharp decrease to about 8,500,000 barrels in July, followed by an increase to about 9,500,000 barrels in August and to more than 11,000,000 barrels in September. Later the decrease was almost uniform to the end of the year, December showing shipments of about 4,000,000 barrels and a production of less than 6,000,000 barrels. The average monthly shipments and production in 1917 were, respectively, about 7,559,000 barrels and 7,735,000 barrels. The stocks

[1] The statistics in this chapter were prepared by Mrs. H. L. Bennit, except those showing imports and exports, which were compiled by J. A. Dorsey.

of finished cement were highest about the end of March, when they exceeded 13,000,000 barrels, and lowest at the beginning of the year, when they were about 8,360,000 barrels, whereas at the end of the year they were nearly 10,500,000 barrels.

Statistics of the cement industry in 1917 were issued by the United States Geological Survey in press bulletins giving estimates of shipments, production, and stocks (January 20, 1918), and an advance statement of final figures of shipments, prices, production, and stocks (August 15, 1918). The estimates of shipments and production were within 0.08 per cent and 0.8 per cent, respectively, of the final figures.

This chapter includes a section on "Concrete ships," by Robert W. Lesley, associate, American Society of Civil Engineers, one of the pioneer manufacturers of Portland cement and a member of the committee on concrete ships of the American Concrete Institute. The subject which Mr. Lesley has so ably treated is of great interest and importance at present.

PRODUCTION OF PRINCIPAL HYDRAULIC CEMENTS.

The total quantity of Portland, natural, and puzzolan cements marketed or shipped from the mills in the United States in 1917 was 91,342,930 barrels, valued at $123,210,458, as compared with 95,394,433 barrels, valued at $104,689,090, in 1916, a decrease in quantity of 4,051,503 barrels, or 4.2 per cent, but an increase in value of $18,521,-368, or about 17.7 per cent. The distribution of the three main classes of cement marketed in 1915–17 is shown in the following table:

Principal hydraulic cements shipped from factories in the United States in 1915, 1916, and 1917.

Class.	1915		1916		1917	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.
Portland	86,891,681	$74,756,674	94,552,296	$104,258,216	90,703,474	$122,775,088
Natural	750,863	358,627	842,137	430,874	639,456	435,370
Puzzolan	42,678	39,801				
	87,685,222	75,155,102	95,394,433	104,689,090	91,342,930	123,210,458

The historical table that follows gives the production and value of natural, Portland, and puzzolan cements so far as recorded by the Survey. The curves in figure 11 show graphically some of these data from 1890 to 1917. The figures in the table represent actual production of Portland cement for all years and of natural and puzzolan cements until 1911, inclusive, after which the figures for these cements represent shipments. In 1916 and 1917 there was but one manufacturer of puzzolan cement; hence the shipments of puzzolan are included with those of natural cement. No figures for production or stocks are collected for natural and puzzolan cements because production and shipments are generally nearly the same and stocks are relatively small.

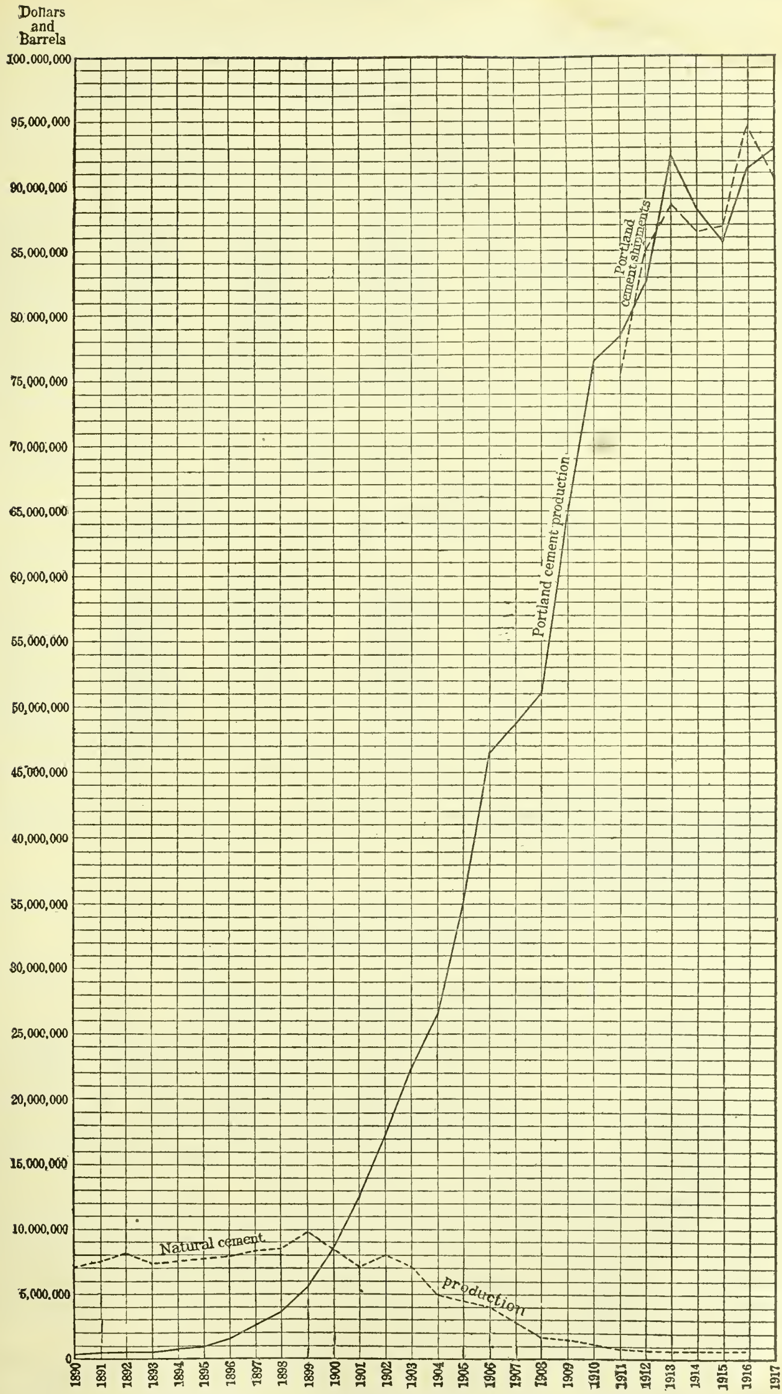

FIGURE 11.—Production of Portland and natural cements, 1890–1917, and shipments of Portland cement, 1911–1917. Natural cement includes puzzolan cement in 1916 and 1917.

Principal hydraulic cements produced in the United States, 1818–1917.[a]

Year.	Natural cement.		Portland cement.	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.
1818–1907	225,965,550	$145,407,732	[b] 236,610,203	[b] $264,364,571
1908	1,686,862	834,509	51,072,612	43,547,679
1909	1,537,638	652,756	64,991,431	52,858,354
1910	1,139,239	483,006	76,549,951	68,205,800
1911	926,091	378,533	78,528,637	66,248,817
1912	821,231	367,222	82,438,096	67,016,928
1913	744,658	345,889	92,097,131	92,557,617
1914	751,285	351,370	88,230,170	81,789,368
1915	750,863	358,627	85,914,907	73,886,820
1916	[c] 842,137	[c] 430,874	91,521,198	100,947,881
1917	[c] 639,456	[c] 435,370	92,814,202	125,670,430
	235,805,010	150,045,888	1,040,768,538	1,037,094,265

Year.	Puzzolan cement.		Total.	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.
1818–1907	[d] 3,995,313	[d] $3,323,517	466,571,066	$413,095,820
1908	151,451	95,468	52,910,925	44,477,656
1909	160,646	99,453	66,689,715	53,610,563
1910	95,951	63,286	77,785,141	68,752,092
1911	93,230	77,786	79,547,958	66,705,136
1912	91,864	77,363	83,351,191	67,461,513
1913	107,313	97,663	92,949,102	93,001,169
1914	68,311	63,358	89,049,766	82,204,096
1915	42,678	39,801	86,708,448	74,285,248
1916	([e])	([e])	92,363,335	101,378,755
1917	([e])	([e])	93,453,658	126,105,800
	4,806,757	3,937,695	1,281,380,305	1,191,077,848

[a] Statistics by years or decades between 1818 and 1907 have been published in the chapters on cement in Mineral Resources for 1914, 1915, and 1916.
[b] First recorded output in 1870.
[c] Includes puzzolan cement.
[d] First recorded output in 1896.
[e] Included with natural cement.

PORTLAND CEMENT.

PRODUCTION AND SHIPMENTS.

The total production of Portland cement in the United States in 1917, as reported to the United States Geological Survey, was 92,814,202 barrels, valued at $125,670,430. This represents an increase in quantity of 1.4 per cent and in value of about 25 per cent. The value assigned is computed at a price of $1.354 a barrel, the average price of the Portland cement shipped in 1917.

The shipments of Portland cement from the mills in the United States in 1917 were, according to reports received by the Survey, 90,703,474 barrels, valued in bulk at the mills at $122,775,088, compared with 94,552,296 barrels, valued at $104,258,216, in 1916, a decrease in quantity of 3,848,822 barrels, or 4.1 per cent, but an increase in value of $18,516,872, or about 17.8 per cent.

The average price per barrel for the whole country in 1917, according to these figures, was $1.354, compared with $1.103 in 1916, an increase of 25.1 cents a barrel, or 22.8 per cent. This represents the selling price of cement in bulk at the mills, including cost of labor and packing but not the value of the sacks or barrels. The average price per barrel for the country was 13.4 cents higher than the average price received for Portland cement in the Lehigh district, where it was lowest, and was near the average price received in California, Illinois, Indiana, Kansas, New York, and the following districts: Illinois-northwestern Indiana, Kentucky-southern Indiana, Ohio-western Pennsylvania, and Pacific coast. It was 33.3 cents below the average received in Washington, where Portland cement brought the highest price ($1.687) of the year. The quantity of Portland cement made in 1917 (92,814,202 barrels of 376 pounds) was approximately equivalent to 15,579,527 gross tons, and the price per ton was about $8.07.

The average price of Portland cement in the United States has been increased slightly over the average for ordinary gray cement by the inclusion in the total shipments of a small quantity of white Portland cement. This white cement was produced in the Lehigh district, so that the value for that district has been increased in greater proportion than that of the other districts. Two mills, both in Pennsylvania, reported the production of white Portland cement in 1917.

PRODUCTION AND SHIPMENTS, BY STATES.

In the following table the production and shipments and the corresponding values of Portland cement for 1916 and 1917, are arranged by States in alphabetic order, provided there are three or more producers or shippers in a single State or permission is given to publish figures where there are less than three. By the term "producer" is meant a Portland-cement manufacturing company, whether the company operates one or more plants. In the table the term "producing plant" is applied to a mill or group of mills located at one place and operated by one company, but each establishment at a different place is counted as a plant. There were producing plants in 26 States in 1916 and 27 States in 1917, but as only 15 of these States contained three or more plants it has been necessary to group together in this table a number of States that are not closely related geographically. This disadvantage is, however, compensated for in the table "Portland cement produced and shipped by districts," in which statistics are given for groups of States—generally not more than three—that are geographically related.

Of the 27 States in which Portland cement was manufactured in 1917, 14 showed increase in shipments and 13 showed decrease, as compared with 1916. The increase in shipments was chiefly in the Central and Western States, Maryland alone of the Atlantic Seaboard States having shown an increase. East of Mississippi River the other States that showed increase were Illinois, Kentucky, and Tennessee, and west of that river all States increased their shipments except Iowa, Kansas, and Washington. The net change for the whole country was a decrease in shipments of 3,848,822 barrels, or 4.1 per cent, and an increase in production of 1,293,004 barrels, or 1.4 per cent. In 1917 production exceeded shipments by 2,110,728 barrels.

Portland cement shipped and produced in 1916 and 1917, by States.

[Figures opposite S relate to shipments; those opposite P to production.]

State.		Active plants.		1916		1917		Percentage of change in quantity, 1917.	Average factory price per barrel.	
		1916	1917	Quantity (barrels).	Value.	Quantity (barrels).	Value.		1916	1917
California	S	9	9	5,216,324	$7,407,290	5,659,547	$7,426,097	+ 8.5	$1.420	$1.312
	P	9	9	5,332,860		5,653,362		+ 6.0		
Illinois	S	4	4	3,562,659	3,386,431	4,378,233	6,090,158	+22.9	.951	1.391
	P	4	4	3,642,563		4,659,990		+27.9		
Indiana	S	5	5	10,350,105	11,487,893	8,148,678	11,084,930	−21.3	1.110	1.360
	P	5	5	10,050,433		8,705,831		−13.4		
Iowa	S	3	4	4,853,789	6,165,547	4,428,765	6,870,863	− 8.8	1.270	1.551
	P	3	4	4,703,213		4,626,141		− 1.6		
Kansas	S	8	8	4,298,097	4,613,609	3,772,884	5,271,721	−12.2	1.073	1.397
	P	8	8	4,212,010		4,015,169		− 4.7		
Michigan	S	11	11	5,151,818	6,017,911	4,313,771	6,122,887	−16.3	1.168	1.419
	P	11	11	4,919,023		4,688,899		− 4.7		
Missouri	S	5	5	5,732,001	6,333,567	5,800,988	8,248,007	+ 1.2	1.105	1.422
	P	5	5	5,178,021		5,882,240		+13.6		
New Jersey	S	3	3	2,592,302	2,534,623	2,397,069	2,962,592	− 7.5	.978	1.236
	P	3	2	2,609,617		2,449,876		− 6.1		
New York	S	9	9	5,603,477	5,752,809	5,408,726	7,050,656	− 3.5	1.027	1.304
	P	9	9	5,643,677		5,417,530		− 4.0		
Ohio	S	5	5	2,142,931	2,517,949	1,565,394	2,328,432	−27.0	1.175	1.487
	P	5	5	2,109,348		1,566,209		−25.7		
Oklahoma	S	3	3	1,712,116	2,188,325	1,736,761	2,633,479	+ 1.4	1.278	1.516
	P	3	3	1,629,899		1,772,466		+ 8.7		
Pennsylvania	S	20	21	28,748,546	27,915,298	27,709,442	34,512,388	− 3.6	.971	1.246
	P	20	21	27,323,147		27,752,838		+ 1.6		
Texas	S	5	5	2,327,659	3,177,104	2,358,944	3,661,328	+ 1.3	1.365	1.552
	P	5	5	2,212,821		2,436,398		+10.1		
Utah	S	3	3	892,596	1,467,564	899,599	1,461,689	+ 0.8	1.644	1.625
	P	3	3	893,533		929,730		+ 4.1		
Washington	S	5	5	1,575,919	2,447,779	1,403,191	2,367,045	−11.0	1.553	1.687
	P	5	5	1,369,485		1,513,792		+10.5		
Other States [a]	S	15	18	9,791,957	10,844,517	10,721,482	14,682,816	+ 9.5	1.108	1.369
	P	15	18	9,691,548		10,743,731		+10.9		
	S	113	118	94,552,296	104,258,216	90,703,474	122,775,088	− 4.1	1.103	1.354
	P	113	117	91,521,198		92,814,202		+ 1.4		

[a] Alabama, Colorado, Georgia, Kentucky, Maryland, Minnesota, Montana, Oregon, Tennessee, Virginia, and West Virginia in 1916, and Nebraska in addition in 1917.

SHIPMENTS AND PRODUCTION, BY COMMERCIAL DISTRICTS.

The division of the cement-producing territory into 12 geographic units termed "commercial districts" is based to some extent on the relations of the Portland cement plants to their trade territory. These relations are, of course, governed largely by transportation facilities and rates, and in forming the districts it has been found advisable to divide Pennsylvania, Indiana, and Texas in order to group the plants commercially.

According to the accompanying table there was in 1917, compared with 1916, an increase in both shipments and production in the Tennessee-Alabama-Georgia, the Iowa-Missouri-Minnesota, the Rocky Mountain, and the Pacific Coast districts, and an increase in production alone in the Lehigh, Illinois-northwestern Indiana, and Nebraska-Kansas-Oklahoma-central Texas districts. The following districts showed decrease in both shipments and production: New York, Ohio-western Pennsylvania, Michigan-northeastern Indiana, Kentucky-southern Indiana, and Maryland-Virginia-West Virginia. If increase in shipments is taken as the best index to the demand for cement it would appear that, except for the Tennessee-Alabama-Georgia district, the increased demand was wholly west of Mississippi River, and even in this western area there was decrease in shipments in the Nebraska-Kansas-Oklahoma-central Texas district. Increases in shipments were nowhere large, 5.2 per cent in the Pacific Coast States having been largest. The largest increase in production of finished cement was 11.2 per cent, in the Iowa-Missouri-Minnesota district. On the other hand there were noteworthy decreases in both shipments and production in several districts: Ohio-western Pennsylvania showed a reduction of 10.8 per cent in shipments; Michigan-northeastern Indiana a reduction of 15.9 per cent in shipments; and Kentucky-southern Indiana a reduction of 26.9 per cent in shipments and of 22.3 per cent in production.

Portland cement shipped and produced in 1916 and 1917, by districts.

[Figures opposite S relate to shipments; those opposite P to production.]

Commercial district.		Active plants.		Shipments and production (barrels).			Average factory price per barrel.		
		1916	1917	1916	1917	Percentage of change, 1917.	1916	1917	Percentage of change, 1917.
Lehigh district (eastern Pennsylvania and western New Jersey	S.	20	21	25,360,287	24,423,641	− 3.7	$0.944	$1.220	+29.2
	P.	20	20	24,105,381	24,423,507	+ 1.3			
New York	S.	9	9	5,603,477	5,408,726	− 3.5	1.027	1.304	+27.0
	P.	9	9	5,643,677	5,417,530	− 4.0			
Ohio and western Pennsylvania	S.	8	8	8,123,492	7,248,264	−10.8	1.113	1.382	+24.2
	P.	8	8	7,936,731	7,345,416	− 7.5			
Michigan and northeastern Indiana	S.	13	13	5,747,113	4,835,304	−15.9	1.168	1.427	+22.2
	P.	13	13	5,521,876	5,263,810	− 4.7			
Kentucky and southern Indiana	S.	3	3	3,266,215	2,386,347	−26.9	1.106	1.352	+22.2
	P.	3	3	3,238,942	2,517,257	−22.3			
Illinois and northwestern Indiana	S.	5	5	10,637,659	10,233,233	− 3.8	1.056	1.367	+29.5
	P.	5	5	10,360,563	10,927,990	+ 5.5			
Maryland, Virginia, and West Virginia	S.	4	5	3,315,323	3,109,098	− 6.2	1.009	1.265	+25.4
	P.	4	5	3,189,585	3,122,936	− 2.1			
Tennessee, Alabama, and Georgia	S.	5	5	3,541,572	3,686,359	+ 4.1	.980	1.233	+25.8
	P.	5	5	3,502,259	3,676,354	+ 5.0			
Iowa, Minnesota, and Missouri	S.	9	10	11,178,790	11,510,753	+ 3.0	1.187	1.485	+25.1
	P.	9	10	10,592,234	11,774,381	+11.2			
Nebraska,[a] Kansas, Oklahoma, and central Texas	S.	15	16	7,735,418	7,405,415	− 4.3	1.168	1.453	+24.4
	P.	15	16	7,502,111	7,710,365	+ 2.8			
Rocky Mountain States (Colorado, Utah, Montana, and western Texas)	S.	7	7	3,141,855	3,197,284	+ 1.8	1.572	1.664	+ 9.0
	P.	7	7	3,097,385	3,261,675	+ 5.3			
Pacific Coast States (California, Oregon, and Washington	S.	15	16	6,901,095	7,259,050	+ 5.2	1.458	1.399	− 4.0
	P.	15	16	6,830,454	7,372,981	+ 7.9			
	S.	113	118	94,552,296	90,703,474	− 4.1	1.103	1.354	+22.8
	P.	113	117	91,521,198	92,814,202	+ 1.4			

[a] No output in 1916.

The United States Geological Survey has collected the statistics of shipments of Portland cement during the last seven years, and these data are summarized as follows:

Portland cement shipped from mills in the United States, 1911–1917.

Year.	Quantity (barrels).	Value.
1911	75,547,829	$63,762,368
1912	85,012,556	69,109,800
1913	88,689,377	89,106,975
1914	86,437,956	80,118,475
1915	86,891,681	74,756,674
1916	94,552,296	104,258,216
1917	90,703,474	122,775,088

LEHIGH DISTRICT.

The production of Portland cement in the Lehigh district, in eastern Pennsylvania and western New Jersey, in 1917, was 24,423,507 barrels, compared with 24,105,381 barrels in 1916, an increase of 318,126 barrels, or 1.3 per cent. The shipments from mills in this district in 1917 amounted to 24,423,641 barrels, compared with 25,360,287 barrels in 1916, a decrease of 936,646 barrels, or 3.7 per cent. The shipments and production of this district in 1917 were thus practically the same. The total value of the Portland cement shipped from this district in 1917 was reported as $29,787,313, at an average price of $1.22 a barrel in bulk at the mills, as compared with $23,929,361, or 94.4 cents a barrel, in 1916. The production of white Portland cement from two plants in this district is included in the figures for 1917. As the average price reported for the white cement was considerably higher than that reported for ordinary gray cement, the average price for the district is slightly higher than if it represented gray Portland cement alone.

Twenty plants produced and 21 plants shipped Portland cement from the Lehigh district in 1917, as compared with 20 producers and 20 shippers in 1916.

The Lehigh district produced practically 26.3 per cent of the total output of Portland cement in the United States in 1916 and 1917. In 1897 this district produced 74.8 per cent of the total for the United States. The production of the Lehigh district by years since 1890 and its relation to the total for the United States for these years is shown in the following table. (See also fig. 12.)

Portland cement produced in the Lehigh district and in the United States, 1890–1917.

Year.	Lehigh district (barrels).	United States (barrels).	Percentage made in Lehigh district.	Year.	Lehigh district (barrels).	United States (barrels).	Percentage made in Lehigh district.
1890	201,000	335,500	60.0	1904	14,211,039	26,505,881	53.7
1891	248,500	454,813	54.7	1905	17,368,687	35,246,812	49.3
1892	280,840	547,440	51.3	1906	22,784,613	46,463,424	49.0
1893	265,317	590,652	44.9	1907	24,417,686	48,785,390	50.0
1894	485,329	798,757	60.8	1908	20,200,387	51,072,612	39.6
1895	634,276	990,324	64.0	1909	24,246,706	64,991,431	37.3
1896	1,048,154	1,543,023	68.1	1910	26,315,359	76,549,951	34.4
1897	2,002,059	2,677,775	74.8	1911	25,972,108	78,528,637	33.1
1898	2,674,304	3,692,284	72.4	1912	24,762,083	82,438,096	30.0
1899	4,110,132	5,652,266	72.7	1913	27,139,601	92,097,131	29.5
1900	6,153,629	8,482,020	72.6	1914	24,614,933	88,230,170	27.9
1901	8,595,340	12,711,225	67.7	1915	24,876,442	85,914,907	29.0
1902	10,829,922	17,230,644	62.8	1916	24,105,381	91,521,198	26.3
1903	12,324,922	22,342,973	55.2	1917	24,423,507	92,814,202	26.3

STOCKS AT MILLS.

The stock of Portland cement reported on hand at the various factories at the end of 1917 amounted to 10,462,882 barrels, compared with 8,360,552 barrels on hand at the close of 1916, an increase in stock of 2,102,330 barrels, or 25.1 per cent, during 1917. The stocks at a few factories in 1916 were revised by the producers, at the request of the Survey, and the stock reported for 1917 checks with the revised total for 1916 within 0.08 per cent of the stock calculated by balancing the shipments for 1917 against the production of 1917, plus the stock at the close of 1916. This agreement is remarkably

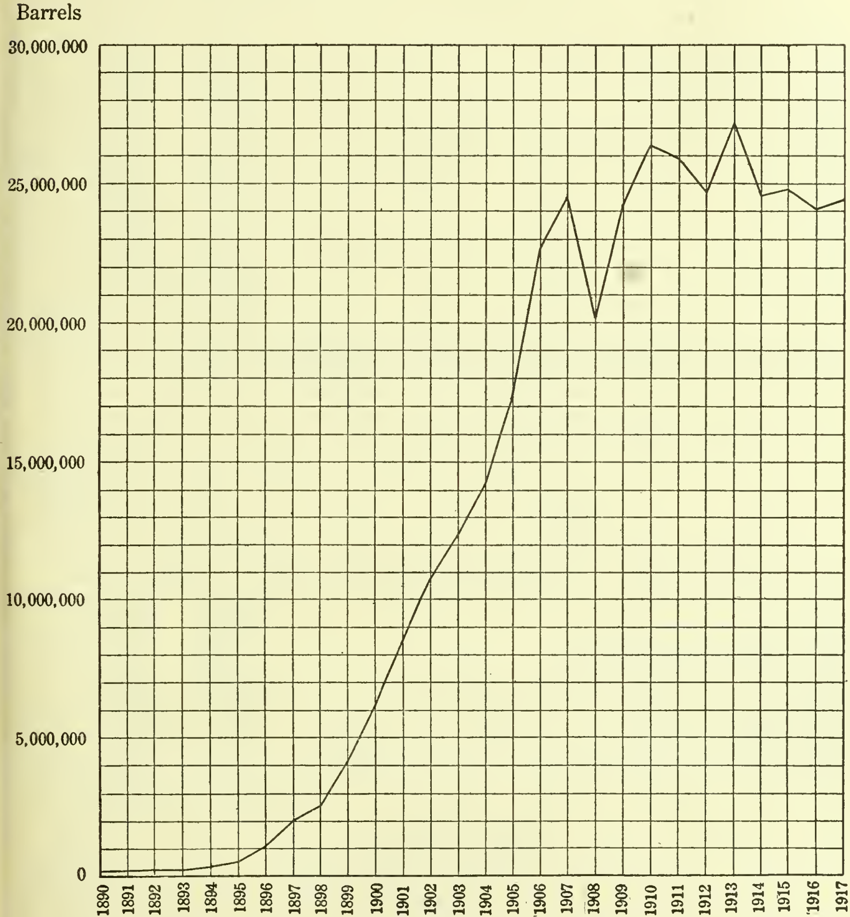

FIGURE 12.—Production of Portland cement in the Lehigh district, 1890–1917.

close considering that the volume of stocks can not be measured with great accuracy.

State and district stocks at the close of 1916 and 1917 and the United States totals at the close of each of the last seven years are given in the next three tables.

Portland cement in stock Dec. 31, 1916, and Dec. 31, 1917, by States.

State.	Quantity (barrels).		Percentage of change in 1917.
	1916 (revised).	1917	
California	494,893	480,073	− 3.0
Illinois	526,341	805,763	+ 53.1
Indiana	1,195,891	1,760,101	+ 47.2
Iowa	428,011	618,811	+ 44.6
Kansas	210,905	452,835	+114.7
Michigan	338,035	713,796	+111.2
Missouri	314,990	403,424	+ 28.1
New Jersey	182,661	237,554	+ 30.1
New York	798,207	808,328	+ 1.3
Ohio	159,834	129,838	− 18.8
Oklahoma	45,485	70,708	+ 55.5
Pennsylvania	2,366,082	2,412,247	+ 2.0
Texas	144,846	222,537	+ 53.6
Utah	88,105	106,590	+ 21.0
Washington	272,913	385,707	+ 41.3
Other States [a]	793,353	854,570	+ 7.7
	8,360,552	10,462,882	+ 25.1

[a] Includes Alabama, Colorado, Georgia, Kentucky, Maryland, Minnesota, Montana, Oregon, Tennessee, Virginia, and West Virginia in 1916, and Nebraska in addition in 1917.

Portland cement in stock Dec. 31, 1916, and Dec. 31, 1917, by districts.

District.	Quantity (barrels).		Percentage of change in 1917.
	1916 (revised).	1917	
Lehigh district (New Jersey and eastern Pennsylvania)	2,155,674	2,163,395	+ 0.4
New York	798,207	808,328	+ 1.3
Ohio and western Pennsylvania	552,903	616,244	+11.5
Michigan and northeastern Indiana	453,282	882,421	+94.7
Kentucky and southern Indiana	477,232	611,199	+28.1
Illinois and northwestern Indiana	1,193,341	1,889,763	+58.4
Maryland, Virginia, and West Virginia	256,093	305,948	+19.5
Tennessee, Alabama, and Georgia	237,395	220,582	− 7.1
Iowa, Minnesota, and Missouri	860,001	1,123,654	+30.7
Kansas, Nebraska,[a] Oklahoma, and central Texas	392,277	686,390	+75.0
Rocky Mountain States (Colorado, Utah, Montana, and western Texas)	197,084	263,063	+33.5
Pacific Coast States (California, Oregon, and Washington)	787,063	891,895	+13.3
	8,360,552	10,462,882	+25.1

[a] No stock, 1916.

Portland cement in stock in the United States at the end of the years 1911 to 1917.

	Barrels.		Barrels.
1911	10,385,789	1915	11,462,523
1912	7,811,329	1916	8,360,552
1913	11,220,328	1917	10,462,882
1914	12,773,463		

PORTLAND CEMENT CONSUMED PER CAPITA.

In estimating the consumption of Portland cement in the States and the dependencies of the United States, the consumption by political divisions is, of course, not absolute, as it is represented only by the records of shipments by manufacturers into the several States. Also, the shipments of cement into a State do not equal the consumption in that State during the same period, but if taken for a long period they should afford a very fair index to that consumption. The consumption in the outlying possessions of the United States is represented simply by the official statistics of exports to those countries from the United States and do not include small imports that may have come from foreign countries. The table of export to other countries on pages 364–365 shows the shipments of cement from the United States to the Philippines, but there are no data available as to the imports of cement to the islands from foreign countries, which, of course, should figure in their per capita consumption. The simplest available common index appears to be the estimated consumption per capita in barrels, which has been obtained by comparing the shipments into States and possessions with the population for the States and possessions in 1916 and 1917 as estimated by the Bureau of the Census.

The discrepancy between the official figures of the Bureau of Foreign and Domestic Commerce for exports of cement, given on page 365, and the exports reported by manufacturers, as given in the following table, is due to the following facts: Cement shipped from mills destined for foreign countries is reported by the shipper as exported. He does not know whether or not it leaves the country during that calendar year, but the Bureau of Foreign and Domestic Commerce bases its export figures on the cement that actually leaves the country, according to its records. The exports given by that bureau include all natural or puzzolan cement which may have been exported, whereas the table of per capita consumption given below relates only to Portland cement. Another source of apparent disagreement is the fact that the lump figure for unspecified exports reported by manufacturers does not include the exports to Alaska, Hawaii, and Porto Rico, statistics for which are given separately in the same table.

The per capita consumption shown by the table necessarily falls short of the total apparent consumption by the quantity of the imports. These, however, are small—only 1,836 barrels in 1916 and 2,323 barrels in 1917, but there are no data to show just which States consumed the imported cement.

The highest per capita consumption in 1917 was that of Montana, 1.69 barrels. The next nine divisions, in order, were Iowa (1.57), California (1.52), Wyoming (1.50), Hawaii (1.49), Arizona (1.46), Michigan (1.43), District of Columbia (1.38), Ohio (1.33), and Indiana (1.21). In 1916 Iowa showed the highest per capita consumption, 1.77 barrels, and this State led also in 1915 with a per capita consumption of 1.54 barrels. In 1917 the per capita consumption was more than 1 barrel in 19 States or divisions; but in 1916 only 17 States exceeded this quantity and only 14 in 1915. Of the 19 States that consumed more than 1 barrel of Portland cement per capita in 1917, 10 were west of Mississippi River compared with 8 in 1916. Comparison of the figures by States shows that all but 3 of the 52 divisions showed some change in per capita consumption, although there were not many marked changes. Thirty-one States showed decrease and 18 showed increase in per capita consumption. The most noteworthy increase in 1917 was in Hawaii, which increased from 0.95 to 1.49 barrels; Montana, from 1.44 to 1.69; and Wyoming, from 0.95 to 1.50. The general average per capita consumption was 0.84 barrel in 1917, compared with 0.89 barrel in 1916.

Estimated per capita consumption of Portland cement in the United States and outlying possessions in 1916 and 1917.

State.	1916			1917			
	Population (estimated).	Consumption (shipments to States).	Estimated consumption per capita.	Population (estimated).	Consumption (shipments to States).	Estimated consumption per capita.	Increase or decrease.
		Barrels.	*Barrels.*		*Barrels.*	*Barrels.*	
Alabama	2,332,608	474,797	0.20	2,363,939	467,823	0.20	0
Alaska	64,834	36,739	.57	64,912	14,953	.23	−
Arizona	255,544	359,001	1.40	263,788	385,520	1.46	+
Arkansas	1,739,723	297,215	.17	1,766,343	344,240	.19	+
California	2,938,654	4,434,425	1.51	3,029,032	4,608,011	1.52	+
Colorado	962,060	659,554	.69	988,320	766,926	.78	+
Connecticut	1,244,479	1,618,711	1.30	1,265,373	1,451,454	1.15	−
Delaware	213,380	182,499	.86	215,160	213,281	.99	+
District of Columbia	363,980	434,841	1.19	369,282	510,296	1.38	+
Florida	893,493	474,478	.53	916,185	523,997	.57	+
Georgia	2,856,065	804,882	.28	2,895,841	799,207	.28	0
Hawaii	215,741	205,681	.95	219,580	327,971	1.49	+
Idaho	428,586	434,529	1.01	445,176	367,776	.83	−
Illinois	6,152,257	7,749,121	1.26	6,234,995	7,189,662	1.15	−
Indiana	2,816,817	3,749,207	1.33	2,835,492	3,425,053	1.21	−
Iowa	2,220,321	3,930,325	1.77	2,224,771	3,501,871	1.57	−
Kansas	1,829,545	2,049,797	1.12	1,851,870	1,977,798	1.07	−
Kentucky	2,379,639	879,203	.37	2,394,093	963,314	.40	+
Louisiana	1,829,130	617,375	.34	1,856,954	612,710	.33	−
Maine	772,489	395,684	.51	777,340	376,236	.48	−
Maryland	1,362,807	1,250,389	.92	1,373,673	1,552,833	1.13	+
Massachusetts	3,719,156	2,922,834	.79	3,775,973	2,800,769	.74	−
Michigan	3,054,854	4,820,946	1.58	3,094,266	4,425,533	1.43	−
Minnesota	2,279,603	3,338,560	1.46	2,312,445	2,793,371	1.21	−
Mississippi	1,951,674	247,559	.13	1,976,570	251,523	.13	0
Missouri	3,410,692	2,801,674	.82	3,429,595	2,548,152	.74	−
Montana	459,494	662,150	1.44	472,935	800,997	1.69	+
Nebraska	1,271,375	1,471,443	1.16	1,284,126	1,469,201	1.14	−
Nevada	106,734	52,433	.49	110,738	79,774	.72	+
New Hampshire	442,506	245,933	.56	444,429	313,154	.70	+
New Jersey	2,948,017	3,424,009	1.16	3,014,194	3,120,589	1.04	−
New Mexico	410,283	189,834	.46	423,649	161,742	.38	−
New York	10,273,375	10,081,041	.98	10,460,182	8,920,808	.85	−
North Carolina	2,402,738	1,146,329	.48	2,434,381	1,030,295	.42	−
North Dakota	739,201	415,125	.56	765,319	410,687	.54	−
Ohio	5,150,356	7,646,792	1.48	5,212,085	6,950,672	1.33	−
Oklahoma	2,202,081	1,090,643	.50	2,289,855	1,443,928	.63	−
Oregon	835,741	522,764	.63	861,992	410,701	.48	−
Pennsylvania	8,522,017	7,554,715	.89	8,660,042	7,787,055	.90	+
Porto Rico	1,216,083	257,019	.21	1,231,880	242,703	.20	−
Rhode Island	614,315	368,686	.60	625,865	332,272	.53	−
South Carolina	1,625,475	463,347	.29	1,643,205	501,405	.31	+
South Dakota	698,509	581,492	.83	716,972	537,983	.75	−
Tennessee	2,288,004	949,502	.41	2,304,629	889,456	.39	−
Texas	4,429,566	2,193,460	.50	4,515,423	2,034,548	.45	−
Utah	434,083	539,721	1.24	443,866	526,086	1.19	−
Vermont	363,699	202,065	.56	364,946	179,973	.49	−
Virginia	2,192,019	1,103,787	.50	2,213,025	1,347,254	.61	+
Washington	1,534,221	1,298,559	.85	1,597,400	1,189,880	.74	−
West Virginia	1,386,038	994,047	.72	1,412,602	1,187,499	.84	+
Wisconsin	2,500,350	3,290,721	1.32	2,527,167	2,964,196	1.17	−
Wyoming	179,559	170,677	.95	184,970	276,815	1.50	+
Unspecified	....	92,922	....	....	41,239	....	
	103,513,970	92,179,242	.89	105,156,845	88,351,192	.84	−
Exports reported by manufacturers, but not included above	....	2,373,054	....	....	2,352,282	....	
Total shipped from cement plants	....	94,552,296	....	....	90,703,474	....	

In connection with the study of consumption of cement it is of interest to compare the shipments from the mills within a State or group of States with the estimated cement consumption of that area and thus to ascertain the extent of the surplus or deficiency in the supply of cement locally available. The following table has therefore been arranged with that in view. The second table shows how much of the surplus product was consumed by each of the non cement-producing States and dependencies.

Estimated surplus or deficiency in local supply of Portland cement in cement-producing States, 1916–17, in barrels.

State or division.	1916			1917		
	Shipments from mills.	Estimated consumption.	Surplus or deficiency.	Shipments from mills.	Estimated consumption.	Surplus or deficiency.
California	5,216,324	4,434,425	+ 781,899	5,659,547	4,608,011	+ 1,051,536
Illinois	3,562,659	7,749,121	− 4,186,462	4,378,233	7,189,662	− 2,811,429
Indiana	10,350,105	3,749,207	+ 6,600,898	8,148,678	3,425,053	+ 4,723,625
Kansas	4,298,097	2,049,797	+ 2,248,300	3,772,884	1,977,798	+ 1,795,086
Michigan	5,151,818	4,820,946	+ 330,872	4,313,771	4,425,533	− 111,762
Missouri	5,732,001	2,801,674	+ 2,930,327	5,800,988	2,548,152	+ 3,252,836
New Jersey	2,592,302	3,424,009	− 831,707	2,397,069	3,120,589	− 723,520
New York	5,603,477	10,081,041	− 4,477,564	5,408,726	8,920,808	− 3,512,082
Ohio	2,142,931	7,646,792	− 5,503,861	1,565,394	6,950,672	− 5,385,278
Oklahoma	1,712,116	1,090,643	+ 621,473	1,736,761	1,443,928	+ 292,833
Pennsylvania	28,748,546	7,554,715	+21,193,831	27,709,442	7,787,055	+19,922,387
Texas	2,327,659	2,193,460	+ 134,199	2,358,944	2,034,548	+ 324,396
Utah	892,596	539,721	+ 352,875	899,599	526,086	+ 373,513
Washington	1,575,919	1,298,559	+ 277,360	1,403,191	1,189,880	+ 213,311
Maryland, Virginia, and West Virginia	3,315,323	3,348,223	− 32,900	3,109,098	4,087,586	− 978,488
Tennessee and Kentucky	2,303,795	1,828,705	+ 475,090	2,628,388	1,852,770	+ 775,618
Alabama and Georgia	1,824,182	1,279,679	+ 544,503	1,672,173	1,267,030	+ 405,143
Iowa, Minnesota, and Nebraska [a]	5,446,789	8,740,328	− 3,293,539	5,731,652	7,764,443	− 2,032,791
Colorado, Montana, and Oregon	1,755,657	1,844,468	− 88,811	2,008,936	1,978,624	+ 30,312
	94,552,296	76,475,513	+18,076,783	90,703,474	73,098,228	+17,605,246

[a] Nebraska had no output in 1916.

Estimated consumption of Portland cement in non cement-producing States, 1916–17, in barrels.

State.	1916	1917	State.	1916	1917
Alaska	36,739	14,953	Rhode Island	368,686	332,272
Arizona	359,001	385,520	South Carolina	463,347	501,405
Arkansas	297,215	344,240	South Dakota	581,492	537,983
Connecticut	1,618,711	1,451,454	Vermont	202,065	179,973
Delaware	182,499	213,281	Wisconsin	3,290,721	2,964,196
District of Columbia	434,841	510,296	Wyoming	170,677	276,815
Florida	474,478	523,997	Unspecified	92,922	41,239
Hawaii	205,681	327,971			
Idaho	434,529	367,776		15,703,729	15,252,964
Louisiana	617,375	612,710			
Maine	395,684	376,236	Exports to foreign countries	2,373,054	2,352,282
Massachusetts	2,922,834	2,800,769			
Mississippi	247,559	251,523			
Nevada	52,433	79,774	Surplus from cement-producing States	18,076,783	17,605,246
New Hampshire	245,933	313,154			
New Mexico	189,834	161,742	Consumption in cement-producing States	76,475,513	73,098,228
North Carolina	1,146,329	1,030,295			
North Dakota	415,125	410,687	Total shipments	94,552,296	90,703,474
Porto Rico	257,019	242,703			

Among the cement-producing States or groups of States there are, of course, fewer deficiencies than surpluses, and certain of the conditions indicated are more apparent than real. For instance, in 1917 Illinois showed a deficiency of more than 2,800,000 barrels, while Indiana showed a surplus of more than 4,700,000 barrels.

This was due in large part to the flow of cement from northeastern Indiana into the adjacent populous Chicago district in Illinois. Ohio showed a deficiency of about 5,385,000 barrels, which was largely supplied from Pennsylvania's surplus of more than 19,900,000 barrels. The Iowa-Minnesota-Nebraska group showed a deficiency of more than 2,000,000 barrels in 1917, considerably less than the deficiency of nearly 3,300,000 barrels in 1916. The quantities consumed in the nonproducing States and dependencies are of interest in comparison with the other data. More than half a million barrels were consumed in the District of Columbia and in each of the following States: Connecticut, Florida, Louisiana, Massachusetts, North Carolina, South Carolina, South Dakota, and Wisconsin, but the per capita consumption in these States is a better index to the relative consumption than the total figures. The quantity consumed in the nonproducing States plus the unspecified quantities and the exports amounted in 1917 to 17,605,246 barrels, compared with 18,076,783 barrels in 1916, and in 1917 this total represented 19.4 per cent of the total shipments from mills in the United States.

DOMESTIC CONSUMPTION OF PORTLAND CEMENT.

An estimate of the total consumption of Portland cement in the United States may be made by adding the imports to the shipments and subtracting the exports from the sum. Of course, a variable but considerable stock of cement is at all times in transit, in warehouses at distributing points, and awaiting use on the ground at large jobs, so that the estimate thus made is at best approximate. Still another uncertain element in this estimate is the fact that as imports and exports are classed as hydraulic cement the records do not discriminate between Portland and other cements. Portland cement, however, constitutes by far the greater part of the exports, and, as the tables show, the imports are small. The apparent domestic consumption in 1917 amounted to 88,119,582 barrels, compared with 91,990,156 barrels in 1916, a decrease of 3,870,574 barrels, or about 4 per cent, as compared with an increase of 9 per cent in 1916.

The following table gives the figures necessary for estimates of consumption so far as available, as prior to 1911 no records are at hand for stocks:

Apparent domestic consumption of Portland cement, 1911–1917, in barrels.

Year.	Shipments.	Imports.	Exports.	Apparent consumption.
1911	75,547,829	164,670	3,135,409	72,577,090
1912	85,012,556	68,503	4,215,532	80,865,527
1913	88,689,377	85,470	2,964,358	85,810,489
1914	86,437,956	120,906	2,140,197	84,418,665
1915	86,891,681	42,218	2,565,031	84,368,868
1916	94,552,296	1,836	2,563,976	91,990,156
1917	90,703,474	2,323	2,586,215	88,119,582

PRICES.

Average prices of Portland cement sold in bulk at the factories as reported to the Geological Survey are shown in the tables of shipments by States and districts during 1916 and 1917, pages 348 and 349.

According to these figures the average prices in 1917 ranged between $1.22 a barrel in the Lehigh district and $1.69 a barrel in the State of Washington, as compared with 94.4 cents in the Lehigh district and $1.644 in Utah in 1916. The general average price for the whole country was $1.354 in 1917, compared with $1.103 in 1916, an increase of 25.1 cents per barrel, or 22.8 per cent. This is the highest average price that has been realized since 1899. The States whose increases were more than 25.1 cents per barrel were Illinois, 44 cents; Iowa, 28.1 cents; Kansas, 32.4 cents; Missouri, 31.7 cents; New Jersey, 25.8 cents; New York, 27.7 cents; Ohio, 31.2 cents; and Pennsylvania, 27.5 cents. California showed a decrease in average price of 10.8 cents a barrel and Utah a decrease of nearly 2 cents. All the districts showed an increase in average price except the Pacific Coast district, which showed a decrease of 5.9 cents a barrel. The district average prices are, of course, much nearer the general average than the State average prices, and only one district, Illinois-northwestern Indiana, showed an average increase in excess of 30 cents a barrel.

The following prices on Portland cement at certain shipping points were quoted to the United States Government by the cement industry in 1917 and for the first four months of 1918. These prices were based on the understanding that the Government requirements would be small—less than 5 per cent of the total output—and that the price to the Government should not control the price to the trade. It was deemed possible to make these prices to the Government because of the fact that the burden, admittedly small, would also be evenly distributed, so that when the quota of the mills in a locality had been supplied any additional cement would have to be shipped from the nearest localty whose quota had not been exhausted, and the price would then be the base price of the shipping locality plus the freight to the point of delivery.

The following prices per barrel exclusive of packages were accepted by the War Industries Board:

Prices of Portland cement to the United States Government at different shipping points for the year 1917 and the first four months of 1918.

Hudson, N. Y.	$1.40	El Paso, Tex.	$1.90
Lehigh Valley, Pa.	1.30	New Orleans, La.	1.78
Pittsburgh, Pa.	1.50	Portland, Colo.	1.70
Fordwick, Va.	1.40	Trident, Mont.	1.70
Bellevue, Mich.	1.50	Irvin, Wash.	1.70
Mitchell, Ind.	1.50	Seattle, Wash.	1.90
Hannibal, Mo.	1.50	Tacoma, Wash.	1.70
Buffington, Ind.	1.40	Portland, Oreg.	1.70
Mason City, Iowa	1.55	Stockton, Cal.	1.70
Iola, Kans.	1.50	Oakland, Cal.	1.70
Steelton, Minn.	1.55	San Francisco, Cal.	1.70
Kingsport, Tenn.	1.40	Santa Cruz, Cal.	1.70
Richard City, Tenn.	1.40	Santa Barbara, Cal.	1.70
Harrys, Tex.	1.30	Los Angeles, Cal.	1.70
Houston, Tex.	1.40		

Figure 13 illustrates graphically the rapid early decline and the recent fluctuations in the general average factory prices of Portland cement, and the following table summarizes the same data.

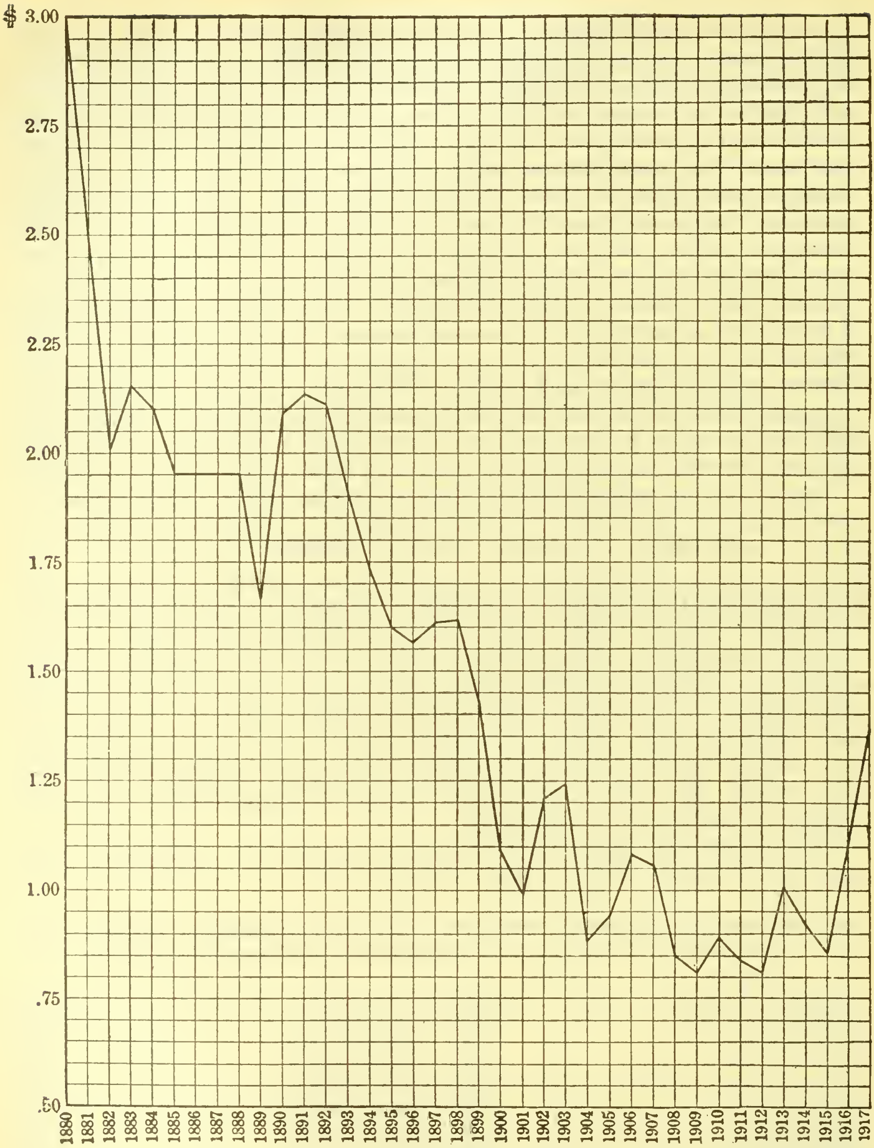

FIGURE 13.—Range in average factory price per barrel of Portland cement, 1880–1917.

Average factory price per barrel in bulk of Portland cement, 1870–1917.

1870–1880	$3.00	1895	$1.60	1907	$1.11
1881	2.50	1896	1.57	1908	.85
1882	2.01	1897	1.61	1909	.813
1883	2.15	1898	1.62	1910	.891
1884	2.10	1899	1.43	1911	.844
1885–1888	1.95	1900	1.09	1912	.813
1889	1.67	1901	.99	1913	1.005
1890	2.09	1902	1.21	1914	.927
1891	2.13	1903	1.24	1915	.860
1892	2.11	1904	.88	1916	1.103
1893	1.91	1905	.94	1917	1.354
1894	1.73	1906	1.13		

Lengths of rotary cement kilns in active plants in the United States, 1914–1917.

Length (feet).	Number of kilns.				Length (feet).	Number of kilns.			
	1914	1915	1916	1917		1914	1915	1916	1917
40 to 60	170	99	128	108	125	157	148	150	194
60 to 90	133	124	119	94	125 to 140	63	63	62	65
100	94	86	81	84	150 or more	46	47	69	73
110	76	88	89	83					
120	100	99	109	88		839	754	807	789

MANUFACTURING CONDITIONS.

PLANTS.

Portland cement was manufactured at 117 plants in 1917, compared with 113 plants in 1916. Three new plants reported production in 1917, one each in Iowa, Oregon, and Pennsylvania, and, in addition, one plant in Nebraska and one plant in Virginia, idle in 1916, reported production in 1917. One plant in New Jersey which operated in 1916 did not manufacture cement in 1917, so that there was a net increase of four producing plants.

Shipments were reported from 118 plants in 1917, compared with 113 plants in 1916, the three new plants and the one not manufacturing all having made shipments.

The new plants that began operations in 1917 are as follows:

Iowa.—Fort Dodge Portland Cement Corporation, Gilmore, Pocahontas County. Dry process; limestone and clay; clinker burned with coal; two 8 by 125 foot kilns; daily capacity, 1,500 barrels.

Oregon.—Beaver Portland Cement Co., Gold Hill, Jackson County. Wet process; limestone and shale; clinker burned with oil; one 10 by 200 foot kiln; daily capacity, 1,000 barrels.

Pennsylvania.—Hercules Portland Cement Corporation, Hercules, Northampton County (Lehigh district). Dry process; cement rock; clinker burned with coal; four 7½ by 125 foot kilns; daily capacity, 2,500 barrels.

KILNS.

The total number of rotary kilns reported in plants that operated in 1917 was 789, compared with 807 in 1916, a net decrease of 18 kilns. The number of active small kilns, 40 to 60 feet long, was decreased by 20; kilns between 60 and 90 feet long decreased by 25; 100-foot kilns increased by 3; 110-foot kilns decreased by 6; kilns 120 feet long decreased by 21; kilns 125 feet long increased by 44; kilns 125 to 140 feet long increased by 3; and kilns 150 feet or more in length increased by 4. The increases were, therefore, practically all in the larger-sized kilns, which is the natural trend in a period in which prevailed high manufacturing costs, together with a normal demand. The kilns were distributed by lengths as follows:

KILN FUELS.

A summary of kiln fuels reported in 1917 shows that 93 plants, employing 636 kilns, burned powdered coal; that 18 plants, employing 103 kilns, burned crude oil; that 1 plant, employing 6 kilns, burned natural gas; and that 1 kiln was operated on producer gas. At certain plants more than one fuel is used. For instance, 1 plant reported coal and oil; 2 plants, coal and gas; and 1 plant, oil, coal, and gas. The percentages of cement burned by coal and by crude oil increased slightly.

The following table summarizes the data on kiln fuels for 1916 and 1917, together with the quantities and percentages of Portland cement burned with coal, crude, oil, natural gas, producer gas, and with two or more of these fuels:

Summary of Portland cement kiln fuels in 1916 and 1917.

Fuel.	1916				1917			
	Number of plants.	Number of kilns.	Barrels of cement.	Percentage of total.	Number of plants.	Number of kilns.	Barrels of cement.	Percentage of total.
Coal	87	643	74,844,603	81.8	93	636	76,410,379	82.2
Coal and crude oil	2	32	5,646,327	6.2	1	24	6,492,713	7.0
Coal and gas	1	7			2	14		
Crude oil	17	96	8,041,026	8.8	18	103	8,680,313	9.4
Crude oil, coal, and gas	1	5	2,989,242	3.2	1	5	1,230,797	1.4
Crude oil and gas	2	13			......	......		
Producer gas	1	1			1	1		
Natural gas	2	10			1	6		
	113	807	91,521,198	100.0	117	789	92,814,202	100.0

CAPACITY.

The total daily kiln capacity in the United States in 1917 of all the plants either active or only temporarily closed, according to manufacturers' reports, was 424,835 barrels, compared with 416,375 barrels in 1916, an increase of 2 per cent. If due allowance be made for the customary loss of time from breakdowns and from necessary shutdowns for repairs and other ordinary causes, the apparent total kiln capacity for the country in 1917 was about 136,750,000 barrels of Portland cement, compared with nearly 134,000,000 barrels in 1916. According to these figures the total production of cement in 1917 (92,814,202 barrels) was nearly 68 per cent of the total capacity, whereas the production in 1916 represented about 68.5 per cent of the apparent total capacity in that year. It is possible, however, that the actual capacity was higher than the figures estimated indicate, in which event a smaller proportion of the capacity was utilized.

Based on the reported kiln capacities, the following table of estimated capacities by districts has been prepared, and these figures, compared with the respective figures of production, give the apparent percentage of capacity utilized in 1916 and 1917.

Annual Portland cement manufacturing capacity of the United States by commercial districts, 1916–17.

District.	Estimated capacity (barrels).		Per cent of capacity utilized.	
	1916	1917	1916	1917
Lehigh district (eastern Pennsylvania and western New Jersey)	37,840.010	37,016,132	63.7	66.0
New York	8,648,840	8,552,480	65.3	63.3
Ohio and western Pennsylvania	8,833,000	9,379,040	89.9	78.3
Michigan and northeastern Indiana	7,917,580	8,672,400	69.7	60.7
Southern Indiana and Kentucky	4,400,440	4,336,200	73.6	58.1
Illinois and northwestern Indiana	15,000,040	13,859.780	69.1	78.8
Maryland, Virginia, and West Virginia	4,031,060	4,384,380	79.1	71.2
Tennessee, Alabama, and Georgia	5,171,320	4,657,400	67.7	78.9
Iowa, Missouri, and Minnesota	12,945,420	13,764,480	81.8	85.5
Nebraska,[a] Kansas, Oklahoma, and central Texas	11,001,100	12,197,570	68.2	63.2
Rocky Mountain States (Colorado, Utah, Montana, and western Texas	3,709,860	4,336,200	83.5	75.2
Pacific Coast States (California, Washington, and Oregon)	14,180.980	15,594,260	48.2	47.3
	133,679,650	136,750,322	68.5	67.9

[a] No output in 1916.

RECOVERY OF POTASH.

The production of potash salts as a by-product of the manufacture of Portland cement continued to be a subject of interest to the cement industry in view of the shortage in potash and the military needs for it. At the end of 1917 the production of potash salts was reported by 7 plants, 4 of them in California, 1 in Maryland, 1 in New York, and 1 in Pennsylvania, and flue dust carrying soluble potash was gathered from below the kiln stacks at 1 plant in Pennsylvania and at 1 plant in Missouri. At the same time 4 plants reported the construction of apparatus for the recovery of potash under way, and 16 plants reported that this recovery was under consideration.[1] The content of potash in raw materials and the loss through volatilization in cement manufacture is discussed in a recent bulletin of the Department of Agriculture.[2]

The following table summarizes the plants that at the end of 1917 were producing potash, constructing apparatus for that purpose, or were seriously considering the undertaking:

Recovery of potash at Portland cement plants in the United States in 1917.

Plant and location.	In operation.	Under construction.	Under consideration.	Type of process.
California Portland Cement Co., Colton, Cal.	Yes			Leaching and evaporation.
Riverside Portland Cement Co., Crestmore, Cal.	Yes			Cottrell.
Santa Cruz Portland Cement Co., Davenport, Cal.	Yes			Wet precipitation.
Southwestern Portland Cement Co., Victorville, Cal.	Yes			Leaching and evaporation.
Sandusky Portland Cement Co., Dixon, Ill.			Experimenting.	Wet.

[1] See also the chapter on potash in Mineral Resources for 1917.
[2] Ross, W. H., Merz, A. R., and Wagner, C. R., The recovery of potash as a by-product in the cement industry: U. S. Dept. Agr. Bull. 572, 22 pp., 1917.

Recovery of potash at Portland cement plants in the United States in 1917—Continued.

Plant and location.	In operation.	Under construction.	Under consideration.	Type of process.
Louisville Cement Co., Speeds, Ind.			Yes	
Western States Portland Cement Co., Independence, Kans.			Yes	
Kosmos Portland Cement Co., Kosmosdale, Ky.			Yes	Cottrell.
Security Cement & Lime Co., Security, Md.	Yes			Cottrell.
Michigan Portland Cement Co., Chelsea, Mich.			Yes	
Newaygo Portland Cement Co., Newaygo, Mich.		In operation June 1, 1918.		Cottrell.
New Egyptian Portland Cement Co., Fenton, Mich.			Yes	Wet.
Missouri Portland Cement Co., Sugar Creek, Mo.			Yes	
Missouri Portland Cement Co., Prospect Hill, Mo.			Yes	
Alpha Portland Cement Co., Cementon, N. Y.	Yes			Cottrell.
Alpha Portland Cement Co., Jamesville, N. Y.			Yes	
Castalia Portland Cement Co., Castalia, Ohio.			Yes	
Ironton Portland Cement Co., Ironton, Ohio.			Yes	Cottrell.
Coplay Cement Manufacturing Co., Coplay, Pa.	Yes			Cottrell.
Dexter Portland Cement Co., Nazareth, Pa.		Almost completed.		Cottrell.
Lawrence Portland Cement Co., Siegfried, Pa.			Yes	
Nazareth Cement Co., Nazareth, Pa.			Yes	
Pennsylvania Cement Co., Bath, Pa.			Yes	
Clinchfield Portland Cement Corporation, Kingsport, Tenn.		Yes		Cottrell.
Trinity Portland Cement Co., Eagle Ford, Tex.			Yes	
Ogden Portland Cement Co., Bakers, Utah.		Yes		Wet.
Portland Cement Co. of Utah, Salt Lake City, Utah.			Yes	Dry and wet precipitation.

This table indicates that an increasing interest is being taken by manufacturers of Portland cement in the by-product potash problem and offers encouragement for the belief that more and more potash may be expected from this source in the future. Ross, Merz, and Wagner[1] have pointed out that the available recoverable potash escaping from kilns of Portland cement plants in the United States that lose 1 pound or more of potash per barrel of cement should amount to 71,000 tons a year and that it should be practicable to increase the percentage of potash volatilized so that more than 100,000 tons of potash annually might be recovered. Gale[2] states that 1,621 short tons of potash (K_2O) was recovered from Portland cement kilns in the United States in 1917. A good beginning has thus been made, but as the normal potash requirements of this country are more than twice the quantity possibly available from cement plants, it is hoped that the good work may be continued, and that the cement industry may do its utmost to free the United States forever from dependence on an outside source of potash, even though the prospects of pecuniary reward after the war may not be great.

[1] Op. cit., p. 22.

[2] Gale, H. S., Potash in 1917: U. S. Geol. Survey Mineral Resources, 1917, pt. 2, p. 434, 1919.

FOREIGN TRADE IN CEMENT.

EXPORTS.

In 1917 the total quantity of hydraulic cement exported to foreign countries, including the Philippines and the Panama Canal Zone, was 2,586,215 barrels, most of it Portland cement, valued at $5,328,536 at the United States ports of shipment, or an average of approximately $2.06 a barrel, as compared with 2,563,976 barrels, valued at $3,828,231, or about $1.49 a barrel, in 1916. The quantity exported in 1916 and 1917 was not quite 2.8 per cent of the total production of hydraulic cements in those years.

The exports have never been great, the largest quantity, that in 1912, having been only 4,215,532 barrels. Examination of the tables for 1915, 1916, and 1917 shows that in 1916 there were relatively large increases in exports to Bolivia, Colombia, Cuba, Dutch Guiana, Dutch West Indies, Ecuador, French West Indies, Haiti, Salvador, and Trinidad, but that exports to Argentina, Brazil, Honduras, Mexico, Panama, and Uruguay decreased notably. Exports to Canada and England decreased, whereas those to Newfoundland showed a large percentage of increase. In 1917 there were important increases in exports to Argentina, Brazil, Cuba, the Dominican Republic, the Dutch East Indies, Mexico, and Salvador, whereas the exports to Bolivia, Ecuador, Newfoundland and Labrador, Panama, Peru, and Venezuela decreased, notably those to Bolivia and Panama. As the Panama trade was largely in connection with canal construction, and therefore domestic, and as the decrease in exports to that zone amounted to more than 250,000 barrels, it is evident that the foreign trade has increased more than enough to offset this loss and is gaining slowly, but that it can not be expected to make rapid headway until the shortage of ships is relieved.

It should also be noted here that the manufacture of Portland cement in Cuba, Central America, and South America is increasing, largely through the construction of new factories financed with capital from the United States. This growth of local industries will restrict the trade of the United States.

In Cuba the new and modern mill of the Cuban Portland Cement Co., on Mariel Bay, about 28 miles west of Havana, began producing Portland cement in February, 1918. This mill is utilizing two varieties of limestone, possibly of Tertiary age, one hard, the other soft and chalky, quarried above the plant, and a soft clay from a pit on the bay shore. The hard limestone carries about 96 per cent of calcium carbonate, and the chalky rock not more than 94 per cent. The wet process is employed. Two 150-foot rotary kilns are in operation, with a combined capacity of about 1,800 barrels a day. The kiln fuel is Mexican petroleum, but the plant is also equipped for storing coal.

According to the Bureau of Foreign and Domestic Commerce,[1] there is very little activity in the cement industry in Mexico at present. In Guatemala a factory capable of producing 50,000 to 100,000 barrels a year was reported to be about ready for operation, April 1, 1917. In Argentina there were reported to be 15 cement factories

[1] Communicated by correspondence and Consular Repts. in 1917 and 1918.

as long ago as 1910, and recently a modern plant equipped to produce about 3,000 barrels of Portland cement a day is reported to have been established. Brazil produces little cement, but plans were being formulated in 1917 for the construction of a plant at Bello-Horzonte, Minas Geraes. Cement is made at Valparaiso, Chile, and it is planned to enlarge the plant as soon as machinery and materials of construction can be obtained. For further and later information concerning the foreign cement field it is suggested that inquiries be addressed to the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C.

The following table affords a comparison of the details of exports to the various countries for the last two years:

Hydraulic cement exported from the United States in 1916 and 1917.[a]

Destination.	1916		1917	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.
Argentina	37,690	$56,720	185,265	$362,501
Australia	455	878	305	619
Azores and Madeira Islands				
Bermuda	6,642	9,972	8,964	17,283
Bolivia	109,986	142,215	2,397	4,989
Brazil	184,053	263,298	350,572	750,115
British East Africa	60	90		
British Guiana	18,175	29,147	22,739	43,020
British Honduras	1,055	1,804	1,036	2,015
British India	487	696	212	545
British Oceania	438	1,013	664	1,758
British South Africa	825	1,619	8	25
British West Africa	12,658	18,304	5,756	12,978
British West Indies:				
Barbados	2,154	3,215	1,886	4,223
Jamaica	42,861	65,093	35,447	66,829
Trinidad and Tobago Islands	41,932	60,463	45,146	83,555
Other British West Indies	12,921	19,866	19,784	41,285
Canada	20,001	31,337	9,844	24,122
Canary Islands				
Chile	65,248	98,030	60,966	119,628
China	253	592	110	357
Chosen (Korea)			364	899
Colombia	74,354	107,953	64,579	137,545
Costa Rica	16,225	29,126	12,091	26,851
Cuba	802,682	1,206,174	836,739	1,740,974
Dominican Republic	63,036	96,733	95,775	199,224
Dutch East Indies	5,295	12,208	65,551	153,411
Dutch Guiana	8,181	12,747	5,144	10,742
Dutch West Indies	16,256	28,794	14,837	35,366
Ecuador	36,338	57,087	15,721	34,931
England	1,955	4,174	70	247
Egypt	3	5		
France			510	1,096
French Guiana	1,350	2,053	2,000	3,604
French Oceania	539	1,068	319	813
French West Indies	12,208	19,393	22,966	50,382
German Oceania	280	622	161	310
Guatemala	18,196	30,323	12,259	25,448
Haiti	44,898	67,068	43,808	77,492
Honduras	9,736	16,588	9,592	23,972
Hongkong	40	100		
Italy	4	7	1,100	2,100
Japan	20	60	4	15
Japanese China				
Liberia			565	1,199
Mexico	92,925	179,950	118,993	301,090
Miquelon, Langley, etc	100	211	191	492
Netherlands	5	7		
Newfoundland and Labrador[b]	25,571	35,354	9,736	19,515
New Zealand	62	83		
Nicaragua	9,154	17,738	13,031	27,513
Norway	275	394		

[a] Statistics compiled from records of Bureau of Foreign and Domestic Commerce, Department of Commerce.
[b] No exports to Labrador in 1916.

Hydraulic cement exported from the United States in 1916 and 1917—Contd.

Destination.	1916		1917	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.
Panama	609,278	$842,847	345,581	$619,689
Paraguay			2,714	5,959
Peru	84,615	132,085	55,641	112,985
Philippine Islands	130	232	2,848	6,121
Portugal	2,000	3,200	10	40
Portuguese Africa	1,358	2,462	1,349	3,178
Russia in Asia	30	60		
Salvador	27,322	53,023	41,808	90,460
Scotland				
Spain	20	37	545	1,177
Straits Settlements	2	3		
Turkey in Asia				
Uruguay	1,985	3,072	6,072	12,537
Venezuela	38,234	57,770	27,807	54,385
Virgin Islands	1,420	3,068	4,633	10,927
	2,563,976	3,828,231	2,586,215	5,328,536

The following table gives the quantity and value of all classes of hydraulic cement exported during the years 1900–1917, inclusive, and the proportion of exports to the total quantity of hydraulic cement manufactured in the United States. The exports at present consist almost wholly of Portland cement.

Hydraulic cement exported from the United States, 1900–1917.[a]

Year.	Quantity (barrels).	Value.	Percentage of total quantity.	Year.	Quantity (barrels).	Value.	Percentage of total quantity.
1900	100,400	$225,306	0.6	1909	1,056,922	$1,417,534	1.6
1901	373,934	679,296	1.9	1910	2,475,957	3,477,981	3.2
1902	340,821	526,471	1.3	1911	3,135,409	4,632,215	3.9
1903	285,463	433,984	.95	1912	4,215,532	6,160,341	5.1
1904	774,940	1,104,086	2.4	1913	2,964,358	4,270,666	3.2
1905	897,686	1,387,906	2.2	1914	2,140,197	3,088,809	2.4
1906	583,299	944,886	1.1	1915	2,565,031	3,361,451	3.0
1907	900,550	1,450,841	1.7	1916	2,563,976	3,828,231	2.8
1908	846,528	1,249,229	1.6	1917	2,586,215	5,328,536	2.8

[a] Statistics compiled from records of Bureau of Foreign and Domestic Commerce, Department of Commerce.

IMPORTS.

The following table shows the quantities of foreign cement imported for consumption into the United States during the years 1878 to 1917, inclusive. Owing to the manner in which statistics of imports are grouped, the quantities given include not only Portland cement but all other hydraulic cements. In recent years, however, most of the total has been Portland cement.

The imports in 1917 were approximately 2,323 barrels, of 380 pounds, valued at $6,076, or about $2.62 a barrel, as compared with 1,836 barrels, valued at $4,942, or about $2.69 a barrel, in 1916. The number of barrels given in the following table is slightly in excess of the true quantity. The imports of cement as reported by the Bureau of Foreign and Domestic Commerce are given in pounds and include the weights of barrels, sacks, and other packages. No data are at hand to show what proportion of the imports are received in barrels or in sacks, though it is understood that the greater part of the material is imported in sacks, which, of course, weigh very little—between 0.5 and 0.6 per cent of the weight of the cement.

The table shows a decline in the imports of foreign cement for the six years ending with 1912, slight increases in 1913 and 1914, and large decreases since 1914, due probably to the cessation of imports from Belgium and Germany.

Foreign cement imported for consumption, 1878–1917, in barrels of 380 pounds.[1]

1878	92,000	1892	2,440,654	1906	2,273,493
1879	106,000	1893	2,674,149	1907	2,033,438
1880	187,000	1894	2,638,107	1908	842,121
1881	221,000	1895	2,997,395	1909	443,888
1882	370,406	1896	2,989,597	1910	306,863
1883	456,418	1897	2,090,924	1911	164,670
1884	585,768	1898	1,152,861	1912	68,503
1885	554,396	1899	2,108,388	1913	85,470
1886	915,255	1900	2,386,683	1914	120,906
1887	1,514,095	1901	939,330	1915	42,218
1888	1,835,504	1902	1,963,023	1916	1,836
1889	1,740,356	1903	2,251,969	1917	2,323
1890	1,940,186	1904	968,409		
1891	2,988,313	1905	896,845		

PORTLAND CEMENT IN CANADA.

The following statement is quoted from the preliminary report on the mineral production of Canada in 1917, issued by the Canada Department of Mines, Mines Branch, February, 1918:

> The total quantity of Portland cement sold or used in 1917 was 4,768,488 barrels of 350 pounds each, valued at $7,699,521, or an average of $1.61 per barrel, as compared with 5,369,560 barrels sold or used in 1916, valued at $6,547,728, or an average of $1.22 per barrel, showing a decrease in quantity of 601,072 barrels, or 11.2 per cent, but an increase in total value of $1,151,793, or 17.6 per cent.
>
> The total quantity of cement made in 1917 was 4,987,255 barrels, as compared with 4,753,033 barrels, an increase of 234,222 barrels, or 4.9 per cent. Cement mills were slightly more active in 1917. The output was sufficient to increase stocks during the year by about 220,000 barrels, whereas in 1916 the output was less than sales, and stocks were drawn upon to the extent of about 620,000 barrels.
>
> The total imports of cement in 1917 were 30,031 hundredweight, equivalent to 8,580 barrels of 350 pounds each, valued at $19,646, or an average of $2.29 per barrel, as compared with imports of 20,596 barrels, valued at $31,621, or an average of $1.54 per barrel, in 1916.
>
> The total consumption of cement, therefore, neglecting a small export, was 4,777,068 barrels, as compared with a consumption of 5,390,156 barrels, showing a decrease of 613,088 barrels, or about 11.4 per cent.

NATURAL AND PUZZOLAN CEMENTS.

In 1916 and 1917 only one manufacturer reported an output of puzzolan or slag-lime cement, and in order that this quantity may be comprised in the cement totals for the United States it is included with the statistics of natural cement.

The marketed production of natural cement and puzzolan cement in the United States during 1917 amounted to 639,456 barrels, valued

[1] Statistics compiled from records of Bureau of Foreign and Domestic Commerce, Department of Commerce.

at $435,370, as compared with an output of 842,137 barrels, valued at $430,874, in 1916, a decrease in 1917 of 202,681 barrels, or 24 per cent, in quantity, and an increase of $4,496, or 1 per cent, in value. The average price of these cements per barrel at the mills in 1917 was 68.1 cents, as compared with 51.2 cents in 1916. It is of interest to compare these prices with those of Portland cement in 1916 and 1917, which were respectively $1.103 and $1.354.

Natural cement was produced in 1916 in 12 plants, distributed in seven States, the plants being located at Binnewater (near Rosendale), Jamesville (1), and Fayetteville (2), N. Y.; Siegfried, Pa.; Lisbon, Ohio (2); Speeds, Ind.; Utica, Ill.; Fort Scott, Kans.; and Austin and Mankato, Minn. The plant at Mankato produces what is called "bricklayer's cement," which is reported to contain more lime than most other kinds of natural cement. In 1917 one plant at Fayetteville, N. Y., and the two plants at Lisbon, Ohio, discontinued operations. The puzzolan cement was made at North Birmingham, Ala. In the following table the combined marketed production of natural and puzzolan cements in 1916 and 1917 is outlined by groups of States:

Natural and puzzolan cement shipped, 1916 and 1917.

State.	1916			1917		
	Producing plants.	Quantity (barrels).	Value.	Producing plants.	Quantity (barrels).	Value.
New York	4	104,415	$51,635	3	57,629	$41,395
Alabama [a]	1			1		
Illinois	1	298,598	161,829	1	217,761	166,159
Indiana	1			1		
Kansas	1	315,300	156,400	1		
Minnesota	2			2	364,066	227,816
Ohio [b]	2	123,824	61,010	....		
Pennsylvania	1			1		
	13	842,137	430,874	10	639,456	435,370

[a] Puzzolan only. [b] Ohio had no production in 1917.

CONCRETE SHIPS.

By R. W. Lesley.[1]

HISTORICAL SUMMARY.

From a production of 42,000 barrels of Portland cement in 1880, valued at $126,000, the annual output in the United States has risen to nearly 93,000,000 barrels in 1917, valued at more than $125,000,000. According to the latest available statistics Germany produces about 30,000,000 barrels of Portland cement a year; England, 17,000,000 barrels; France, 8,000,000 barrels; Denmark, 7,000,000 barrels; and the other European nations, 10,000,000 barrels. It will thus be seen that the output of the United States, though this country was one of the last to begin the production of Portland cement, has far outstripped that of Europe. For this there is a reason in the re-

[1] Associate Am. Soc. Civ. Eng.

markable success of American engineers and inventors in developing the rotary kiln, a labor-saving device that enabled the industry of this country to excel that of Europe, which up to the period of the advent of the rotary kiln had been using intermittent kilns of the English type or the German continuous vertical kilns.

This great development of the Portland cement industry in our country was not due, however, merely to economical manufacture but also to the progress of concrete construction on a very large scale. It was in Europe, and especially in France, that concrete for building purposes had its earliest beginnings. Monier's celebrated flower pot made in 1849 or thereabouts was the first type of concrete construction ever known. Hennebique, Coignet, and Bordunave, were pioneers in concrete construction for dwellings, factories, and other buildings many years before the art took foothold in this country, and yet when building operations in France, where the material is carried from one floor to the other upon exterior or interior scaffolding, are compared to American reinforced concrete construction with its high towers, concrete mixers, and gravity placing, it can readily be seen why the concrete "skyscraper" is an American institution and why America takes front rank in the art of concrete construction.

The same parallelism prevails in the development of the concrete ship, as it was in France in 1849 that reinforced concrete was first used in shipbuilding, the original vessel having been a concrete rowboat built by Lambot near the Mediterranean Sea. This boat was subsequently exhibited at the World's Fair in Paris in 1855, and it was still in existence at the beginning of the European war.

It is this development of skyscraper construction, this handling mechanically of large masses of concrete, this development of special machinery and apparatus, typical of American engineering practice, that has produced the 5,000-ton ship *Faith* in 1918, to follow in the wake of Lambot's boat of 1849, the original concrete "ship."

It was in answer to the cry "Why not concrete ships to meet the great emergency created by the lack of American shipbuilding facilities?" that the concrete ship came into being, through the concentration of American engineering and cement-manufacturing talent upon the new national need.

Historically, the art of concrete shipbuilding may be said to have languished from 1849 until 1887 when a small concrete boat named the *Zeemeeuve* or *Seagull* was built in Holland. It was used at first for duck shooters on account of its high stability, and in 1918 it was still in use by a cement-products company in Amsterdam. Holland followed this in 1909 with the *Juliana*, used for canal work, in 1910 with concrete lighters 65 by 15 feet, in 1911 with the concrete barge *Antoon* of 50 tons capacity, and later with a number of small 15-ton lighters; and to-day Holland is still constructing concrete vessels for her navigable canals and rivers.

In 1897 Gabellini, of Rome, Italy, began the construction of concrete barges, bridge pontoons, scows, and rowboats. Several of these were built under patents granted Gabellini for his inventions, and one of them was successfully subjected to severe Government tests by being sent into forced collisions against stone pillars, and an old ship especially loaded for the purpose. At the present time many concrete vessels of great stability are being constructed in Italy and are used at the war front along the Adriatic and on the River Piave to support heavy guns. A number of pontoons made from ferro-concrete in Italy in 1900 were used in a bridge across the River Po. These pontoons have so far not cost one cent for maintenance and they are still in the best of condition. They have to withstand shocks from both ships and ice. Wooden pontoons, on the other hand, which are also widely used for similar purposes in bridges across the River Po, have to be completely renewed after about 5 years, and after 9 to 10 years it is no longer worth while to calk them.

Germany was not far behind the other nations in concrete-ship construction, as at Frankfort on the Main a concrete freighter of 220 tons was built in 1909. At Mannheim shortly thereafter a bathhouse supported on pontoons of concrete collided with a large grain vessel and suffered no damage, except the demolition of the wooden superstructure. At Dresden a concrete sailboat was built in 1912.

In England since 1912 there have been a large number of concrete barges in use on various English canals, one 100 feet by 28 feet being used successfully on the Manchester Canal, and a reinforced concrete rowboat was successfully built at Montrose, Scotland. At the present time it is stated that there are 140 concrete barges of 1,400 tons each and 24 concrete tug boats of various sizes in advanced stages of completion at various places in England.

The Sydney Harbor Trust Co., Sydney, New South Wales, after investigating various available methods of construction decided in 1914 to use concrete for building a pontoon needed in the harbor. This pontoon is 110 feet long, ranges in width from 53 to 67 feet, has a draft of 7 feet 9 inches, and a total displacement of 783 tons. It has been subjected to severe treatment from the ferries using it as a landing stage.

At Montreal, Canada, a small concrete ship of 300 tons capacity has been launched and is now being equipped by her builders, the Atlas Construction Co.

It was a long interval between the first concrete boat in France in 1849 and the revival of boat construction in that country in 1916. At present France is building concrete barges 150 feet long by 26 feet wide of 700 tons weight, is constructing numerous concrete lighters of large tonnage, and at one of her shipbuilding yards is producing barges, tugs, and lighters in large quantity for all her interior canal and river navigation. The French Government is also having constructed at Tonkin, China, at the works of the French Compagnie de Ciment de l'Indo-Chine, a whole fleet of concrete passenger and freight boats of about 2500-tons capacity each for the Chinese and East Indian trade.

A 65-foot concrete vessel was launched at Shanghai on May 24, 1918, and the builders (Yangtszepoo Dock) state that a second vessel of the same size can be completed in three weeks. This statement is based on data furnished by the reinforced concrete department of a Shanghai British firm (Arnhold Bros. & Co.). For the present concrete vessels of the kind just launched will be used for carrying steel and other heavy freight in the Shanghai harbor and for towing. This concrete vessel is provided with kerosene motors and has a speed of about 8 knots.

Spain is also building some large concrete vessels at Barcelona, some of them having a capacity of 6,000 tons.

It was but natural that with the destruction of her ships by submarines Norway would lose no time after the outbreak of the war in building concrete ships and at two works in that country, one at Porsgrund and the other at Fougner's works at Moss, very successful construction of concrete ships has been going on. At the Fougner plant the 200-ton concrete cargo vessel, the *Nannsiffiord*, was built, and, after a successful trial trip, has been engaged in traffic between Norway and England and along the Norwegian coast. This was practically the pioneer seagoing, self-propelled, concrete ship. At the same yard concrete dry docks have been built and also a number of 100-ton lighters for use by the navy of Norway. At the Porsgrund works a 200-ton motor lighter has been successfully constructed and others are on the ways.

The first mention of concrete boats in the United States is in the magazine Concrete, February, 1909, in which it is stated: "A Baltimore man built a reinforced-concrete yacht 11 years ago. Craft in 1909 one of the fleet of the Baltimore Yacht Club. Dimensions: Length, 65 feet; beam, 18 feet. Man who built it convinced that if steel boats were seaworthy a stone boat would be." Upon this assumption we have been building concrete boats ever since. The real beginning of concrete shipbuilding in this country, however, was about 1912, when the Furst Concrete Scow Construction Co. built a 500-ton concrete scow for the Arundel Sand & Gravel Co., of Baltimore, Md. Vessels of this type have been in use ever since that time by this company and have rendered excellent service. In the same year a Gabellini type of concrete barge—length 90 feet, beam 26 feet, and depth 9 feet—was finished at Mobile, Ala., and is still in service. Concrete pontoons built on the Panama Canal in 1914 are still used for landing stages for small steamers. Concrete motor boats, yachts, tug boats, and rowboats have also been built in this country. At the present time a fleet of concrete barges 130 feet by 30 feet and of 550-tons capacity each is under construction at New Orleans and similar vessels are building at Seattle, Wash.

From the history of the art, therefore, it will be seen that the querry "Why not concrete ships?" has been answered by practical experience in construction of vessels of moderate size all over the world and by the completion of the ship *Faith* at San Francisco. The history of her trial trip and of her cruise from San Francisco to Vancouver and the report of those on board as to her behavior answer conclusively the query above propounded. The concrete ship is here and is doing her legitimate work.

THE SHIP FAITH.

The *Faith* is a concrete self-propelled merchant vessel of 5,000 tons dead weight capacity, 320 feet long, 46 feet beam, and 24 feet deep. She is equipped with turbine engines having a capacity of 3,500 horsepower, and on her trial trip she developed more than the designed speed of 10 knots, which was estimated at the time of construction. The firm of Comyn, Mackall & Co., San Francisco, financed the construction and Leroy Caverly was the marine engineer. The reports of the first and second trial trips of the ship on still water and in choppy seas were both most favorable, absence of vibration being particularly noticeable. Her first voyage was most successful, according to a report by a surveyor to the Lloyds Register, who, in company with Allan McDonald, the designer, Mr. Nicolsen, the builder, Prof. E. R. McMillan and his assistant, Mr. H. S. Loeffler, representing the Shipping Board, and Mr. Charles C. Brush, assistant engineer, Bureau of Lighthouses, made the trip from San Francisco to Seattle, Tacoma, and Vancouver with a cargo of salt and copper ore. On the trip a gale estimated by the captain to have a velocity of 60 miles an hour was met. The report says:

During the day the vessel was taking seas over forecastle and all fore and aft, but responded well to these head seas much in the manner of a steel vessel. On Saturday the wind had fallen considerably and on the afternoon of that day the gale had subsided, which gave the opportunity of removing a hatch cover from Nos. 1, 2, and 3 holds and examining the vessel as far as the cargo permitted.

It was then observed that the deck slab was cracked in several places in way of Nos. 1, 2, and 3 hatchways under the winch seatings, those cracks being more extensive in way of No. 2 hatchway. The cracks extended right through the slab, and evidences of slight leakage could be seen on underside, and were confined in extent to the area between the hatchways and under the winches. Small hair-line cracks were also observed in the inside surface of the radius corners of all the hatchways, more particularly in No. 2. A certain amount of leakage also occurred through the fastening of the wooden deck houses and other deck fittings through the slab and also from the fender bolts along ship's side.

From Saturday afternoon until the arrival of vessel at Seattle on Tuesday, 28th of May, good weather prevailed. Draft on arrival, fore 21 feet 3 inches, aft 22 feet 8 inches. During the voyage the bilges were sounded every hour day and night and except for port side No. 1 hold, which had about 5 inches on arrival, all other bilges were dry, this leakage only amounted to about a barrel full, and in my opinion was due entirely to seepage from cargo. After unloading part cargo, left Seattle on Tuesday, 30th of May, arriving Tacoma same day. Left Tacoma Saturday, June 1, arriving the following day at Vancouver, where remainder of cargo was discharged. On Friday afternoon, June 7, the vessel being then empty, was subjected to a thorough examination as far as possible outside and inside. The outside inspection showed cracks on the paint running parallel to the outer layer of reinforcing rods, particularly over the midship portion of vessel and on the port bow, and were probably caused by a slight movement of the slab with the force of the seas. On the inside of vessel, in addition to the cracks in deck slab previously mentioned, hair cracks were observed in the walls between upper and second deck extending from about the middle of hold No. 1 to middle of hold No. 3. These are probably shrinkage cracks and had been under observation before ship left San Francisco. In the lower holds at about the center of No. 2 and No. 3 hatchways on both sides, hair-line cracks were observed in the shell slab and extending across one longitudinal. These cracks showed slight working and were the only ones seen below the second deck and were probably caused by straining when laboring in a cross sea.

Apart from these minor failures the ship, in my opinion, is a success, the failure of the deck slab is due to lack of sufficient reinforcement and owing to the winches being bolted through the cement slab without any seatings.

Professor McMillan had a number of strainograph instruments placed around the midships of vessel, the cargo being so arranged that these were accessible at all times during the voyage, access to them being obtained through a ventilator to No. 2 hold. Professor McMillan informed me that the greatest stress registered during Friday's gale was only 8,000 pounds (that is, between hogging and sagging) on the indicators placed on the underside of deck, and the indicators on flat of bottom registered about three-quarters of that amount.

The following is a copy of some of the observations made by Mr. Brush: "Established sight lines fore and aft reading 0 in still water, passing out through Golden Gate vessel showed slight hog of one-fourth inch port and three-eighths inch starboard, and the greatest deflection taken during the voyage between extreme hogging and sagging was seven-eighths inch in the length of 180 feet, which is about one-third of what a steel ship would show under similar conditions."

From 1849, the date of the first concrete boat, to 1918, the date of the sailing of the *Faith*, seems a long period, but, after all, the leap from the rowboat to the 5,000-ton freight carrier may well cover two generations, and it must be remembered that it is practically only since the outbreak of the European war that there has been any awakening in concrete ship construction. The enormous destruction of shipping by the submarines and the vast demand for new shipping to meet the requirements of the war have made concrete vessels almost essential.

ADVANTAGES OF CONCRETE SHIPS.

The main reasons that have led to the adoption of reinforced concrete as a shipbuilding material with a view to overcoming the shortage in tonnage without increasing the stress on the existing shipyards may be briefly stated as follows: (1) The materials required are easily obtained, and the necessary steel is employed in a form and quantity which does not stress the output of rolling mills. (2) The labor is less skilled and is recruited from a class totally different from the ordinary shipyard labor. (3) The cost of the finished article is equal or less than for the steel vessels, and no upkeep is required. (4) The time of construction is shorter.

When these elements of material fact are coupled with three important properties which render reinforced concrete most valuable for shipbuilding, there seems to be ample reason for the present progress in the art. These properties are: First, the concrete ship can be made practically waterproof; second, the reinforcement can be inclosed by the concrete so as to exclude rusting completely; third, the concrete and also the reinforced concrete are absolutely fireproof.

The construction of the concrete ship and its manifold advantages are discussed in papers by Robert Hall and J. E. Freeman of the Portland Cement Association read before the American Concrete Institute; in an article published in Norway by the Porsgrund Cement Fabrick; in a most interesting paper by T. J. Gueritte, of the Société des Ingénieurs Civils (France), Councilor of the French Board of Trade, which was published in the Scientific American Supplement of May 4, 1918; in the report of an interview with G. A. Tomlinson, general manager, New York Canal Section, U. S. Railroad Administration, published in the New York Times Magazine, April 28, 1918; in papers by Maj. Maurice Denny and Walter Pollock, and by T. G. Owens Thurston, presented before the Institute of Naval Architects of England and published in the Times Engineering Supplement of March 29, 1918; in a description of the construction of concrete ships and methods of building the same in Engineering (London) of October 5, 1917; and in an article by A. A. Boone, civil engineer, published in Beton und Eisen, May 4, 1917. All these papers are full of interesting material descriptive of the various methods of concrete shipbuilding, the materials to be used, the methods of handling and placing them, and the possibilities of the concrete ship as a competitor in the field of the world's commerce.

It is made clear in the articles above referred to that concrete ships can be made more nearly waterproof than wooden or steel vessels, that in a general way the reinforcing steel can be protected by the concrete so as to practically exclude injury, and, further, a fact known to every man skilled in the art, that concrete improves in its quality with increasing age, quite unlike both wood and steel, which are impaired in the course of time. Timber, especially, soon becomes subject to rotting and deterioration, particularly at such points as are exposed alternately to water and air. Although iron is more durable than wood, iron must at regular intervals be carefully cleansed and painted as otherwise it will rust unduly; but in spite of such precautions iron ships possess only a limited life. Concrete, on the other hand, is a construction material that improves in its properties with time, so that there is no definite knowledge to-day as to its real life limitations. Concrete is not known to be attacked by insects; mold, vermin, and bacteria find no soil for growth in it; and consequently ferroconcrete vessels can easily be kept clean. Iron ships, on the other hand, must every two years be laid on the ways, and the expense of this ever-recurring cleansing and repairing work must be included in the calculations for the purchase of an iron ship.

The ease of repairing a concrete ship is also brought forth very clearly in one of the articles, in which methods of repairing holes both above and below the water line by the simple application of new concrete is fully dwelt upon. In another of these articles the resiliency and powers of accommodation to new circumstances of ferroconcrete as a building material is dealt with, and special instances are mentioned as illustrations, one of the most remarkable being that of a reinforced-concrete water tower used by the Germans as an observation post in the war. The shells that struck this tank merely made circular holes through its sides and bottom, and, when the tank itself was later dynamited, its fall to the ground caused only local cracks.

All these statements bear in a measure upon the durability of the concrete ship, and in a summary of the papers by Wig and Hollister, before the American Concrete Institute, the following statement is made:[1]

> If durability is to be obtained, special attention must be given to many elements of the ship. The most serious problem is to provide means of adequately protecting the steel from corrosion. There is a large quantity of steel embedded in the concrete and much of it can not be covered by more than five-eighths inch of mortar. This of itself will not protect the [steel] particularly in the interior and in the upper portions of the hull. There are two means of allaying if not of wholly preventing the corrosion of the steel. The steel may be galvanized or painted with some protecting medium which will not appreciably affect the bond, or the concrete may be coated with some thoroughly impervious membrane which will prevent both air and water from reaching the steel. A large number of tests are being made, and it is quite possible that both methods of protection will be tried. The results are promising and a satisfactory protection should be developed.
>
> Another possibly disintegrating element which may have great inportance is the effect of constant reversal of stress, as the ship alternately is subjected to hogging and sagging stresses in a heavy sea. Our allowable steel stresses are such as to cause the concrete to crack. There are few analogous structures on land to which we can refer for guidance on this subject, and only experience can tell what may be expected. Reversal of stress tests are now under way.

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[1] Engineering News-Record, July 11, 1918, p. 93.

No trouble from chemical disintegration is anticipated except as the hull may be seriously abraded.

The concrete ship section of the Emergency Fleet Corporation estimates the life of the concrete ship without any special protection at several years, and known methods which can now be applied should extend the life several years longer. It believes adequate protection will be developed to insure reasonably permanent life to the concrete ship.

If proper coating can be developed to prevent deterioration, the concrete ship should be a competitor of the steel ship. With further experience it is believed the weight of the concrete can be very materially reduced, thus making the cargo capacity more nearly equal to that of the steel ship.

In connection with the two subjects mentioned in the last paragraph, namely, the development of proper coating and the lighter weight material for concrete ships, the concrete ship section of the Emergency Fleet Corporation is carrying on with a large force of experts experiments at the Lesley Cement Laboratory of the University of Pennsylvania, at Philadelphia, and it is expected that results of a most valuable character will be developed.

WORK OF AMERICAN CONCRETE INSTITUTE.

Within a short time after the declaration of war against the German Empire, a meeting of the American Society for Testing Materials was held at Atlantic City, N. J., in June, 1917. There were present many distinguished engineers and manufacturers having to do with concrete and the production of Portland cement. Many shipbuilding experts from Norway and elsewhere associated with the production of concrete ships were also present and, in view of the great demand for ship room to send troops and provisions to Europe, much interest was awakened in the problem of concrete vessels.

As a result of the many interviews there held a joint committee on concrete barges and ships was appointed by the American Concrete Institute and the Portland Cement Association. It included Messrs. L. C. Wason, C. R. Gow, R. W. Lesley, M. M. Ipson, and H. C. Turner (chairman), of the American Concrete Institute, and Messrs. Joseph Brobston, F. W. Kelley, W. S. Mallory, S. P. Crapo, and E. D. Boyer (chairman), of the Portland Cement Association. The committee began work promptly to meet the pressing emergency of the country's need for concrete ships. It engaged as its consulting engineer Robert W. Boyd, of New York, and as its ship engineers Messrs. Cox & Stevens, of the same city. In its report presented in January, 1918, much stress is laid upon the advantage of concrete ships in the matter of speed of construction and economy of cost. On the former ground, importance is given to the character of labor required and the minimum of yard construction necessary. A seagoing barge of 2,000 tons carrying capacity was designed as a sample vessel, and the various elements entering into its construction are dealt with in the report. So far as transverse strength is concerned, the report says this is not difficult to handle, the question of strength only being considered, but longitudinal strength must provide for the meeting of conditions unlike any to which land structures are subjected. In this connection the report says:

In determining the longitudinal strength of a ship it is customary to assume two conditions. Under the first condition the ship is assumed to be suspended between two wave crests, the length between crests being equal to the length of the ship between perpendiculars, the height of the wave being equal to one-twentieth of that length. In this case the ship as a whole is acting as a simple beam supported at the ends. This condition is termed "sagging." Under the second condition the ship is assumed to be supported amidships on one crest of the same wave. Under this condition the ship as a whole acts as a cantilever. This condition is termed "hogging." It is apparent, therefore, that when a ship is riding the waves both the deck and the bottom of the ship will be required to withstand tensile and compressive stresses alternately—the maximum tensile stress following the maximum compressive stress at very short intervals. In a steel ship the entire cross-sectional area of the midship section acts to resist these stresses, taking into account in determining the moment of inertia all the continuous members such as continuous scantlings and deck, side, and bottom plates. In the concrete ship, equivalent strength must be provided. In the case of the concrete ship, however, only the steel reinforcement can be relied upon to take tensile stresses. The concrete, assisted by the steel, will take the compressive stresses.

The effect of the change of the character of the stress in either the deck or the bottom is much more serious in the case of the concrete ship than in the steel ship.

So far as elasticity is concerned the report states that there is no reason to believe that reinforced concrete will not prove a suitable material for shipbuilding purposes, and as to the possibly deleterious effect of sea water on the concrete and reinforcing steel, it states that this may be guarded against by selected material and adequate workmanship assuring a good mix and a satisfactory surface skin, and further by properly protecting the steel reinforcing by galvanizing and embedding it in a proper surface of concrete.

The committee sums up its conclusions by suggesting that the specifications for a concrete vessel should embody the following elements:

(1) Both cement and aggregates should be selected with great care to insure a concrete of maximum efficiency.

(2) The concrete should be placed in one continuous operation to insure monolithic construction. The concrete mixture should be such as will develop a crushing strength in excess of 3,000 pounds per square inch when tested in standard cylinders at 28 days. A concrete consisting of 1 part Portland cement, 1 part sand, and 2 parts ½-inch aggregate may be expected to give such a concrete. The mixture and the workmanship in placing must be such as will assure impermeability.

(3) The reinforcing steel should be in the form of deformed bars and should be galvanized.

(4) In parts of the vessel where cracks in the concrete would tend to cause leaks, the stress in the steel should be kept low (preferably less than 12,000 pounds).

(5) Some form of elastic waterproofing coating should be applied to the hull below the deck.

GOVERNMENT CONSTRUCTION.

Concurrent with the preparation and presentation of the report of the American Society for Testing Materials the call for ships for Government purposes became more imperative, the delay in the construction of steel and wooden vessels almost causing an acute crisis in transportation facilities between this country and Europe. Out of this condition grew the creation of the Concrete Ship Section of the Division of Steel Ship Construction of the United States Shipping Board, Emergency Fleet Corporation. This organization was effected in Washington with a large force of well-known engineers, familiar with shipbuilding, with concrete construction, and with the various processes of manufacture and use of cement. Mr. R. J. Wig, formerly of the United States Geological Survey, and late of the Bureau of Standards, is chief engineer of the Concrete Ship Section. The first vessel designed was one of 3,500 tons, and later under an appropriation of $50,000,000 granted for the construction of concrete ships, the Emergency Fleet Corporation let contracts for the construction of 42 vessels. It has established five yards with four ways each and eight ships are to be built in each yard. These ships will be 7,500-ton tankers and 7,500-ton cargo ships. This is in addition to the two 3,500-ton vessels first contracted for. The tankers will each have a capacity of 50,000 barrels of oil. Each of the 7,500-ton ships will have 2,800-horsepower triple-expansion engines and a speed of 10½ knots per hour. The 42 concrete ships will have a total of 298,500 dead-weight tonnage. In addition to this it is stated that the Government is also contracting for 200 wooden barges, 50 concrete barges, 100 concrete oil-carrying barges, and 150 steel, wooden, and concrete tugs of 1,000 horsepower for ocean and harbor service, which aggregate a total dead-weight tonnage of 850,000.

In dealing with this important problem, almost new in many of its phases to engineers and shipbuilders as well, many interesting questions had to be studied. In the first place the relation of cost to carrying capacity of the concrete ship as compared with the wooden and the steel ship was most important and in the accompanying table the comparative weights of concrete, wooden, and steel vessels of nominal 3,500-ton dead-weight capacity are given:

Comparative weights of concrete, wooden, and steel vessels of 3,500-ton dead-weight capacity.

	Concrete.	Wooden.	Steel.
	Long tons.	*Long tons.*	*Long tons.*
Hull	2,500	2,300	1,160
Fittings, outfit, and equipment	191	191	180
Propelling machinery	206	206	200
Margin	75	80	60
Ship (light)	2,972	2,777	1,600
Reserve feed	80	80	80
Ordnance	23	23	23
Fuel	300	300	300
Stores	40	40	40
Cargo	2,760	2,680	3,057
Total dead-weight	3,203	3,123	3,500
Full-load displacement	6,175	5,900	5,100
Percentage dead-weight to full-load displacement	52	53	68.6

This table shows that the percentage of dead-weight to full-load displacement is 52 per cent for concrete, 53 per cent for wooden, and 68.6 per cent for steel ships. The estimates of costs by the Shipping Board are between $100 and $125 per ton for concrete ship dead-weight carrying capacity as against $165 for wooden ships and $180 to $220 for steel ships. Thus it will be seen that the diminished carrying capacity of the concrete vessel as compared to the capacity of the steel vessel would in times of peace make it a somewhat more expensive vessel to run, although the earning capacity of the two ships may be about the same on account of the lower construction cost of the concrete ship.

The weight of the standard concrete prescribed by the Government is calculated at 150 pounds per cubic foot. Many experiments are being made by the Concrete Ship Section to lessen this weight, and investigations seem to indicate that pumiceous rock found in New Mexico and at other points toward the Pacific coast, and also specially fused clay, may be employed to reduce this weight.

Investigations by G. F. Loughlin, of the United States Geological Survey, of concrete aggregates having a low specific gravity were made in the spring of 1918. Mr. Loughlin summarizes the results as follows:

Attention of the Concrete Ship Section was first called to the suitability of light volcanic rock for this cement by C. E. Barglebaugh, who, after spending considerable time and money in private exploration, found deposits of highly vesicular basalt and had samples of concrete made from it tested at the University of Texas. Mr. Barglebaugh was aided in his explorations by Frank Hayner and Prof. H. D. Pallister. Results of preliminary tests were so encouraging that Mr. Barglebaugh offered his results to the Concrete Ship Section, which at once called upon the State geological surveys and mining bureaus of Washington, Oregon, California, Arizona, and New Mexico, and the United States Geological Survey to cooperate in the location of deposits of adequate size. G. F. Loughlin, of the United States Geological Survey, was given general supervision of the work. In the meantime individuals reported promising occurrences of light-weight volcanic rocks. These were investigated and samples were submitted to tests to determine crushing strength, absorption, and weight per cubic foot. The most satisfactory rock, all things considered, proved to be vesicular basalt, whose texture resembled that of a sponge—the type collected by Mr. Barglebaugh at Cutter, N. Mex., and tested for him at the University of Texas.

Some large specimens of this rock, owing to their many air-tight vesicles, were light enough to float on water for several days, although the average weight (specific gravity 1.50) in the form of crushed stone was greater. Its weight per cubic foot solid was 93.4 pounds; weight per cubic foot loose, 39 pounds.[1] Its crushing strength ranged from 1,500 to 5,000 pounds per square inch. Concrete 28 days old, made from coarse and fine aggregates of this rock (1: 1: 2) weighed about 120 pounds per cubic foot and had an average crushing strength of 5,060 pounds per square inch, whereas parallel tests with limestone, sandstone, or gravel for coarse aggregate and sand for fine aggregate show strengths of 3,340 to 4,990 pounds per square inch. Similar unpublished tests on the same basalt made for the Concrete Ship Section at the Bureau of Standards, Washington, D. C., are said to have given equally satisfactory results.

Field examination of deposits yielding the more promising materials proved that adequate supplies of vesicular basalt close to main railroad lines existed in central and northeastern New Mexico, southern California, and Oregon. Those in New Mexico are the nearest deposits of this kind to Atlantic and Gulf coast ports, and unless an equally satisfactory material is found or produced nearer they can furnish stone to the Government or private shipyards along the South Atlantic and Gulf coasts. Those in southern California are between 200 and 300 miles of Los Angeles and may be drawn upon for stone to supply shipyards on the California coast.

The basalt deposits of suitable character are extinct volcanic cinder cones, Flows of basalt are very extensive in New Mexico and States west of the Rocky Mountains, but the rock in these flows, although in part vesicular, lacks the high degree of vesicularity required to give the necessary light weight. Volcanic cinder cones are numerous in several parts of this region, but many of them contain rock of considerably greater average weight per cubic foot than that from Cutter, N. Mex., and to judge from the search thus far conducted cones composed largely of the best quality of rock constitute a very small minority. Among the small number of cones thus far examined, how-

[1] Nash, J. P., Light-weight concrete for ships from special aggregate: Eng.-News Record, July 18, 1918, pp. 136–137.

ever, an adequate supply of suitable rock has been found to supply the present demand, and there is little doubt that as the demand continues other suitable deposits will be found.

Concrete of this type made of 1 part cement and 1 part of specially fused clay below $\frac{1}{4}$-inch to 2 parts of the same aggregate between $\frac{1}{4}$-inch and $\frac{1}{2}$-inch size had a compressive strength of 3,380 pounds to the square inch at 7 days and of 4,350 pounds to the square inch at 28 days. It weighed 106 pounds per cubic foot in a saturated condition. The requirement for shipbuilding concrete is that the concrete must have a compressive strength of at least 4,000 pounds per square inch at 28 days, and in order to insure strength and density the mixture of concrete specified is such Portland cement as will meet standard specifications of the United States Government, but shall be so fine that at least 90 per cent will pass a 200-mesh sieve, as against the present requirements of the standard specification of 78 per cent. By the use of this cement it is claimed a plastic mixture of great volume consistency is obtained.

In a paper read at the annual meeting of the American Concrete Institute at Atlantic City, N. J., in June, 1918, by R. J. Wig, chief engineer, and S. C. Hollister, engineer of design of the Concrete Ship Section, Emergency Fleet Corporation, it was stated that a ship of concrete of the special material above referred to, so far as percentage of carrying capacity is concerned, might be brought to a ratio of dead-weight to total displacement of 62 per cent as against 65 to 68 per cent for the steel ship and of 53 per cent for the wooden ship.

Reinforcing steel is the other material required for the construction of the concrete ship. This amounts to about 10 per cent of the carrying capacity of the ship and must be placed in a very small space in thin walls of $3\frac{1}{2}$ to 4 inches for 2 or 3 layers of steel, and the specifications require that the steel shall be of rods or bars rolled from new billets to conform to the specifications of the American Society for Testing Materials for structural grade, new billet steel. Plain round bars, says the paper, will be much easier to fabricate than deformed bars, but on account of the effect of reversal of stress deformed bars are used wherever the bond stress is high. As is already shown in the report of the joint committee on concrete ships, the stresses required to meet "hogging" and "sagging" are vital in the construction of the concrete ship, and on the 3,500-ton concrete ship first projected the following figures are given:

Stresses in Government 3,500-ton concrete ship.

Condition.	Maximum bending moment foot-tons.	Maximum tons per square inch fiber stress in—		Pounds per square inch fiber stress in concrete.
		Deck reinforcement.	Keel reinforcement.	
	Long tons.	*Long tons.*	*Long tons.*	
Ship without cargo, hogging	25,175	5.53	2.80	728
Ship fully loaded, hogging	37,000	5.63	2.95	766
Ship without cargo, sagging	14,400	1.28	2.63	270
Ship, light, with enough cargo in forward hold to trim, sagging	11,960	1.07	2.19	210
Ship fully loaded, sagging	9,400	.84	1.72	70

These figures indicate how important it is that all the reinforcing shall be absolutely of proper character and shall be accurately placed, and that where the material is to be welded the welding shall be by electrical method rather than any of the other methods now in use.

The construction of the forms is a vital essential to successful concrete shipbuilding, and they may be of wood or metal or of wood lined with metal, and they may be built in panels or as one unit to be later removed board by board. The inside forms may be constructed first and the outside forms placed after the steel is fabricated. A more common method is to place the outside forms first, then fabricate the steel, and then place the inside forms. The first method is being followed in the construction of one ship for the Emergency Fleet Corporation, but the second method will be used on subsequent ships.

After the forms have been placed and the steel has been fabricated, the mixing and placing of the concrete is a very delicate and serious operation. Rich mortar mixtures must be used and they must be carefully proportioned and mixed in order to insure the necessary high quality of the concrete. The machine mixers selected should be those that will give a uniform and thoroughly prepared mortar. The concrete should not be transported from the mixer and deposited directly in the forms in continuous operation or in large batches on account of the danger of not having it thoroughly worked into place about the reinforcing steel. For the present it is required that all concrete shall be shoveled into the forms in order to insure its deposit in small batches and its thorough working into place. It is preferable to place the concrete in one continuous operation in order to avoid construction joints. This will require approximately 3 days of 24 hours each for a 3,500-ton ship and six days for a 7,500-ton ship. The rich mortar mixture proposed is quite fluid and no difficulty is anticipated in working it thoroughly around and through the reinforcing. To avoid barnacles and sea vegetation adhering to the concrete it will be necessary to coat the bottom of the hull with some antifouling paint similar to that used on steel ships. The coating will probably be of the bituminous character.

Two of the vessels being built by the Emergency Fleet Corporation will be launched endwise and the others will be launched sidewise. In dealing with the design of the reinforced-concrete ship, many new problems have arisen and in the paper above referred to by Wig and Hollister full details are given as to the computations for the longitudinal strength, the shear values, and the transverse strengths of the ship to be built. The placing of the longitudinal steel is most important and in a general way it is stated that in the concrete ship the use of a greater metacentric height is permitted than is common in a steel vessel designed for the same service.

The vessels now under construction are in many cases designed to utilize the engines and fittings already partly manufactured for the Emergency Fleet Corporation's standard wooden ships, and this has had a great deal to do with the form of construction used in these first vessels. The location of the machinery is a most important element; its place is the center of the ship. The commonly so-called three-island type of vessel (elevated forecastle, bridge, and poop, carrying longitudinal stress) is stated to be less desirable for concrete construction than a vessel which has the greatest possible continuity in its deck line.

PATENTS FOR CONCRETE SHIPS.

Below is appended a brief summary of patents that have been taken out to cover various methods of using concrete in shipbuilding.

Patents for concrete ships.

Patent No.	Patentee.	Date of issue.	Description.
906846	Lorenzo D'Adda	Dec. 15, 1908	Reinforced concrete armor for battleships.
920046	Carlo Gabellini	Apr. 27, 1909	Float of reinforced concrete.
933314	O. F. Lackey	Sept. 7, 1909	Concrete scow having concrete hull and metal frame.
984285	W. E. McNeillie, jr	Feb. 14, 1911	Concrete boat reinforced with angle irons and wire mesh.
991780	A. Holin	May 9, 1911	Floating body with reinforced concrete frame and hull.
1008801	G. E. Elia	Nov. 14, 1911	Concrete protection for ships.
1018488	J. T. Gorsuch	Feb. 27, 1912	Reinforced concrete scow.
1090349	H. E. Smith	Mar. 17, 1914	Boat with reinforced concrete hull.
1209159	S. D. Hendricks	Dec. 19, 1916	Reinforced concrete unit construction for barge and ships.

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SAND AND GRAVEL.

By R. W. Stone.

INTRODUCTION.

To many people sand is used most commonly for mortar and plaster in building operations, and gravel for concrete and railroad ballast. Were these their only uses the sand and gravel industry would be large but not widely interesting. Sand and gravel are employed in many other ways, however. It is well known that sand and gravel are widely distributed, abundant, and much used in the United States, but their vital importance in the economy of the Nation was scarcely appreciated until war made unusual conditions and demands. The demand has been so great in recent months that in some places on the Atlantic coast sand and gravel have almost attained the status of war minerals. At certain shipbuilding and camp sites there is no gravel readily available and sand suitable for building is scarce. Sand dunes may be abundant, but the grains are too small. So great has been the demand for sand and gravel in large Government construction work that this common and cheap building material has been shipped considerable distances. It is understood that for some of the building recently done near Norfolk, Va., where the supply is inadequate, the sand and gravel were brought from New York, a distance of 300 miles, by sea in coal barges that otherwise would have returned empty; hence the cost of transportation was small.

Only four natural nonmetallic minerals produced in the United States—not including clay products and cement (manufactured products)—show a greater annual value than that of sand and gravel; these are petroleum, natural gas, coal, and stone. The production of sand and gravel in 1917 was valued at more than $35,000,000. This is an undervaluation, for the list of producers is notably incomplete and it has not been possible to get reports from numerous producers who dig small quantities intermittently for local use.

The statistics in the following tables more nearly represent the actual output of the industry than the reports of previous years, as the list of producers known to the Geological Survey is constantly increasing. It must be admitted, however, that the statistics are incomplete, as there are some States in which almost no producers are known and in all States sand and gravel are produced for local use in hundreds of villages, of which no information is obtained and the aggregate quantity of which must be large.

Most of the producers fill out reports in correct form, and this is especially true perhaps of the members of the National and State associations, for they keep accurate and detailed records of their business and appreciate the importance and use of these statistical data. There are other producers, however, who report sand sold for building in the space provided for glass sand and perhaps give no figures for value. In such cases, if the geologist knows that the material at the locality given is not suitable for making glass, he must write to the producer calling attention to the error and asking for what purposes the sand was actually used and the value of it. When no reply is received, as sometimes happens, it is impossible to give accurate classification. All too frequently producers fail to report value, and the writer is obliged to estimate. If all producers knew how great is the demand by various Government boards and other organizations for exact information as to producers and production of sand and gravel in different localities, this appeal for better reports, mailed promptly early in the year, would probably not be necessary. At the late date at which this report is being written (August 29), after many needless delays, a card reporting more than 8,000 tons of molding sand has been received, which necessitates changes in the tables. Such tardiness is one of the causes of delay in the publication of this report.

WAR USES.

The utility of sand and gravel has only to be mentioned to be appreciated, but to most people the great variety of their uses is unknown and their connection with war is unrecognized. Of course the largest quantity of sand produced in this country is that used by builders. Although the building operations in the large cities of the country were much less in 1917 than in 1916, in some localities there was an amazing increase in building. Among these large building operations may be mentioned cantonments, shipyards, and towns engaged in the manufacture of munitions and other war necessities. Sand and gravel are used in these structures, from the concrete piles and foundations placed in the ground to the mortar in the chimneys that rise above the gravel roofs. Other war-time uses of sand and gravel are mentioned in the following paragraphs.

Molding sand is used for casting molten metal and is of many kinds. There are three main classes—steel, iron, and brass molding sands. Each class includes several varieties of sand, the particular variety used depending on the size and weight of the casting and the position occupied in the mold. It is easily seen how important these sands are in war time, when a nation is making great quantities of machinery and munitions requiring castings in all these metals. Sand is used for molding such diverse things as shrapnel and the bodies of gasoline engines, cannon and car wheels, and for making many other things intimately connected with the prosecution of war.

Steel-molding sand is a white or yellowish clean quartz sand high in silica. It has no bond, and in order to make a mold with it a small quantity of fire clay, molasses water, or other material is added for binder. The size of the sand grain varies with the work to be done. Iron-molding sand or foundry sand is siliceous sandy material used in foundries for making molds and cores for casting molten iron. It is usually of some shade of brown, may be clayey, loamy, or sandy, fine or coarse grained, and has strong bond when moist. From

3,000,000 to 5,000,000 tons is used annually. Brass-molding sand includes sand used for molding brass, bronze, and aluminum. This is a very fine grained sand with strong bond which will take sharp detailed impressions and give a smooth surface to the casting. Articles for war use cast in these metals are numerous.

The manufacture of glass might at first thought be considered a nonessential industry with relation to war, but no sooner did this Nation enter the conflict than there was found to be a shortage of optical glass for range finders, field glasses, cameras, and surveying instruments. The making of optical glass was undertaken by the Government in cooperation with existing glassworks. The sand required for this work is small in quantity but important. How many people who are dependent on eyeglasses for clear vision are aware that sand is the principal component of the lenses? Sand composes 60 to 75 per cent of all glass, and more than 2,000,000 tons of glass sand was used in the United States in 1916. Glass is used in war for many purposes, ranging from plate glass for portholes and companionways on transport and battleships to cheap green-glass insulators for electric-transmission lines, from lenses in periscopes to electric-light bulbs and clinical thermometers. Fortunately for our large need, the supply of glass sand of all grades is abundant, and methods of making glass for optical use as well as for other purposes are now well understood.

Grinding, polishing, and blast sands have a part in the conduct of war in making smooth the rough places on metal, glass, stone, and other hard substances. Blast sand is clean tough sized sand, with either round or angular grains, which is driven by compressed air through a hose for such purposes as cleaning metal castings and dressing stone. In gun shops, locomotive and car shops, and most places where heavy metal castings are made the sand blast is used to clean off parts of the mold that adhere to the castings. The size of sand used is varied with the character of the duty to be performed.

Fire or furnace sand is highly refractory silica sand for lining furnaces and ladles used to contain molten metal and so has a place in all foundries. About 500,000 tons is used annually in the United States.

Military highways and railroads are built, ballasted, and repaired with sand and gravel. Many millions of tons of sand and gravel are used on the roads and railroads of this country, and readily available supplies of this material enable the roads to support the heavy traffic in war time. Sand is carried on all locomotives to increase the friction on slippery rails and so plays a not unimportant part in transportation. Engine or friction sand reported annually as used in the United States amounts to about 1,250,000 tons. It must be dry and for best service should be fairly even grained, tough, and sharp.

Filter sand and gravel are fairly pure quartz free from dirt, dust, organic matter, or other impurities, sized, and containing not more than a very small percentage of soluble minerals. They are used for beds in water-filtration plants and in filters for other liquids. As the used sand does not wear out or deteriorate, practically all the demand, which is not large, is for new filters rather than for renewal. Water for some of our military camps passes through sand filters.

There are many other uses of sand, some closely and others more remotely connected with the activities on the battle front. Sand in bags is used for protecting buildings and works of art in cities under gun fire and for balloon ballast. Fine, clean sand is employed in the care of pigeons and canaries used as messengers and gas detectors in the trenches, and sand bags form the parapets of many lines of defense.

TRADE CONDITIONS.

Many sand and gravel producers in all parts of the country report that trade was much better in the first half of 1917 than in the second half. The entry of the United States into the world war in April, 1917, and the consequent temporary unstable business conditions, followed by Government restrictions of shipping, resulted in a decreased production in sands for some uses, especially for buildings and roads, toward the end of the year. The scarcity and cost of labor and coal and the shortage of freight cars seriously impeded the production of sand. The larger producers in several of the Eastern States agree that the demand was the greatest ever experienced, but the sales were restricted by the above-mentioned conditions.

A tabulation of 736 reports from producers in six leading States shows that of this number 353, or 48 per cent, considered business conditions better in 1917 than in 1916, 24 per cent saw no change, and 28 per cent handled less material. In Ohio and Pennsylvania the trade was especially brisk.

PRODUCTION.

In 1917 the total quantity of sand and gravel produced was 76,419,325 short tons, valued at $35,296,932, as compared with 89,091,732 tons in 1916, valued at $29,809,995.

The tables for 1917 have been prepared by Mrs. L. M. Beach, statistical clerk, from reports received from about 2,500 producers throughout the United States.

Sand and gravel produced in the United States in 1916 and 1917.

1916.

State.	Glass sand.		Molding sand.		Building sand.		Grinding and polishing sand.		Fire or furnace sand.		Engine sand.	
	Quantity. (short tons).	Value.	Quantity. (short tons).	Value.	Quantity. (short tons).	Value.	Quantity. (short tons).	Value.	Quantity. (short tons).	Value.	Quantity. (short tons).	Value.
Alabama			131,312	$41,470	220,336	$66,989	(a)	(a)			6,199	$1,741
Arizona												
Arkansas			(a)	(a)	78,392	26,371					(a)	(a)
California	(a)	(a)	(a)	(a)	607,641	185,637	(a)	(a) j	(a)	(a)	(a)	(a)
Colorado			(a)	(a)	(a)	(a)			(a)	(a)	(a)	(a)
Connecticut			(a)	(a)	58,710	32,564	(a)	(a)				
Delaware			(a)	(a)	(a)	(a)			(a)	(a)		
Florida					71,776	37,777	(a)	(a)				
Georgia	(a)	(a)	3,545	1,756	319,467	77,081	10,091	$3,127			10,889	1,801
Hawaii					(a)	(a)						
Idaho					(a)	(a)						
Illinois	487,432	$318,235	632,529	313,219	2,059,259	597,771	168,088	152,432	(a)	(a)	67,979	12,143
Indiana	(a)	(a)	417,918	173,892	1,226,882	368,699	(a)	(a)			(a)	(a)
Iowa	(a)	(a)	(a)	(a)	1,181,505	388,080	(a)	(a)			19,177	5,296
Kansas					953,306	244,292					(a)	(a)
Kentucky	(a)	(a)	43,160	36,165	414,564	223,642	(a)	(a)	(a)	(a)	9,046	2,243
Louisiana	(a)	(a)			196,107	152,534					(a)	(a)
Maine					(a)	(a)						
Maryland	(a)	(a)	(a)	(a)	825,379	367,130	(a)	(a)			21,553	16,099
Massachusetts	(a)	(a)	28,482	21,812	575,222	248,591	(a)	(a)	(a)	(a)	(a)	(a)
Michigan	(a)	(a)	117,200	31,978	1,234,280	347,499	(a)	(a)	(a)	(a)	(a)	(a)
Minnesota			22,902	15,962	326,693	93,457	(a)	(a)	(a)	(a)	1,921	129
Mississippi			(a)	(a)	43,513	13,649	(a)	(a)			(a)	(a)
Missouri	(a)	(a)	161,788	61,972	766,534	224,863	138,141	66,438	(a)	(a)	35,865	11,836
Montana					(a)	(a)						
Nebraska			(a)	(a)	904,952	174,878					109,108	13,780
Nevada											(a)	(a)
New Hampshire					(a)	(a)						
New Jersey	139,934	115,204	644,611	479,426	1,950,858	417,954	71,708	86,599	62,240	$49,787	68,603	23,318
New Mexico					(a)	(a)					(a)	(a)
New York	(a)	(a)	661,673	570,898	4,331,603	941,884	169,737	46,900	38,144	16,430	66,497	30,144
North Carolina					144,467	30,003	(a)	(a)			(a)	(a)
North Dakota					(a)	(a)					(a)	(a)
Ohio	127,191	129,284	894,802	768,467	3,022,655	1,036,537	61,909	109,092	87,870	100,244	66,228	28,459
Oklahoma	(a)	(a)			222,576	80,287					(a)	(a)
Oregon					161,761	78,610					(a)	(a)

a Included in "Combined totals."

Sand and gravel produced in the United States in 1916 and 1917—Continued.

1916—Continued.

State.	Glass sand.		Molding sand.		Building sand.		Grinding and polishing sand.		Fire or furnace sand.		Engine sand.	
	Quantity. (short tons).	Value.	Quantity. (short tons).	Value.	Quantity. (short tons).	Value.	Quantity. (short tons).	Value.	Quantity. (short tons).	Value.	Quantity. (short tons).	Value.
Pennsylvania	534,511	$632,702	737,385	$590,704	2,706,240	$1,223,477	331,160	$308,472	152,319	$161,404	282,865	$194,839
Rhode Island			(a)	(a)								
South Carolina			(a)	(a)	(a)	(a)						
South Dakota					17,553	11,687					(a)	(a)
Tennessee			34,476	15,470	308,545	130,252	(a)	(a)	(a)	(a)	40,428	10,847
Texas	(a)	(a)	(a)	(a)	348,864	138,952	(a)	(a)	(a)	(a)	13,041	5,277
Utah					2,865	665					(a)	(a)
Vermont			(a)	(a)	(a)	(a)	(a)	(a)				
Virginia			10,176	8,609	204,383	51,453	(a)	(a)	(a)	(a)	55,522	8,904
Washington			(a)	(a)	448,943	101,444					(a)	(a)
West Virginia	358,624	427,339	(a)	(a)	203,744	109,081	37,932	21,144	(a)	(a)	130,742	60,980
Wisconsin			81,597	56,606	910,453	276,400					42,618	7,520
Wyoming					(a)	(a)					(a)	(a)
Combined totals	370,625	335,033	36,093	31,433	143,434	69,485	381,588	95,447	86,081	56,893	334,753	73,158
	2,018,317	1,957,797	4,662,649	3,219,839	27,193,462	8,569,675	1,370,354	889,651	426,654	384,738	1,383,034	508,514

a Included in "Combined totals."

Sand and gravel produced in the United States in 1916 and 1917—Continued.

1916—Continued.

State.	Paving sand.		Filter sand.		Railroad ballast sand and gravel.		Other sands.		Gravel.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama	(a)	(a)			259,957	$32,413	(a)	(a)	99,073	$36,264	726,650	$184,216
Arizona					(a)	(a)			(a)	(a)	(a)	(a)
Arkansas	(a)	(a)			(a)	(a)			42,142	22,109	543,902	170,068
California	295,609	$93,112			1,144,352	127,676	15,575	$7,638	2,385,738	594,843	4,489,498	1,036,085
Colorado	(a)	(a)	(a)	(a)	42,027	8,720	(a)	(a)	72,939	37,380	244,208	93,259
Connecticut									(a)	(a)	89,682	53,040
Delaware											9,487	9,721
Florida	(a)	(a)							(a)	(a)	86,452	42,352
Georgia	(a)	(a)	(a)	(a)			(a)	(a)	39,889	20,148	483,615	126,799
Hawaii											(a)	(a)
Idaho	(a)	(a)							(a)	(a)	(a)	(a)
Illinois	90,843	32,803	(a)	(a)	801,192	100,405	665,312	177,152	3,358,153	847,947	8,365,225	2,587,437
Indiana	468,434	142,575			2,555,368	190,829	399,395	101,549	2,753,865	845,197	8,165,989	1,879,073
Iowa	231,300	72,571	31,948	$9,250	924,191	164,800	68,880	23,218	853,277	309,299	3,321,691	980,272
Kansas	164,995	46,268					(a)	(a)	(a)	(a)	1,164,995	303,630
Kentucky	16,183	9,616			75,665	15,898	(a)	(a)	477,276	171,735	1,053,431	474,216
Louisiana					501,294	54,712	(a)	(a)	842,480	314,088	1,579,701	535,968
Maine					(a)	(a)			(a)	(a)	(a)	(a)
Maryland	(a)	(a)	(a)	(a)			40,394	32,370	864,663	439,955	1,872,159	900,061
Massachusetts	68,694	36,330	(a)	(a)	(a)	(a)	(a)	(a)	329,426	179,066	1,049,577	533,308
Michigan	154,413	38,068	(a)	(a)	392,457	34,239	54,244	11,439	2,226,878	739,311	4,407,475	1,306,256
Minnesota	108,037	33,628	(a)	(a)	(a)	(a)	16,705	3,638	724,240	280,904	1,468,530	491,270
Mississippi	34,532	15,999			781,734	96,631			557,554	190,991	1,435,460	321,509
Missouri	(a)	(a)			937,572	118,856	27,481	5,873	1,364,907	250,728	3,643,205	877,634
Montana							(a)	(a)	290,755	51,398	296,737	58,185
Nebraska	130,402	62,205			(a)	(a)	(a)	(a)	59,829	30,950	1,267,998	289,872
Nevada					(a)	(a)	(a)	(a)			(a)	(a)
New Hampshire					(a)	(a)			(a)	(a)	(a)	(a)
New Jersey	204,104	83,146	26,010	24,755	(b)	(b)	32,617	26,738	c 735,335	c 210,546	3,936,020	1,517,473
New Mexico					(a)	(a)			(a)	(a)	(a)	(a)
New York	83,671	29,282			(a)	(a)	16,512	4,325	2,580,694	980,979	8,098,097	2,644,829
North Carolina	6,850	2,550	(a)	(a)	341,824	75,036	(a)	(a)	(a)	(a)	554,381	150,209
North Dakota									(a)	(a)	(a)	(a)
Ohio	527,383	231,091	(a)	(a)	1,020,823	171,697	79,491	34,469	2,468,722	947,606	8,359,250	3,559,952
Oklahoma	(a)	(a)			(a)	(a)	(a)	(a)	128,290	42,145	574,844	196,206
Oregon	17,735	10,681			182,830	26,791	(a)	(a)	421,060	147,671	904,078	283,493

a Included in "Combined totals."   b A small output included in "Gravel."   c Includes a small output of "Railroad ballast sand."

Sand and gravel produced in the United States in 1916 and 1917—Continued.

1916—Continued.

State.	Paving sand.		Filter sand.		Railroad ballast sand and gravel.		Other sands.		Gravel.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Pennsylvania	332,368	$132,017	(a)	(a)	(a)	(a)	(a)	(a)	2,241,218	$734,881	7,442,452	$4,023,692
Rhode Island											(a)	(a)
South Carolina	(a)	(a)	(a)	(a)			(a)	(a)	(a)	(a)	54,018	21,211
South Dakota					(a)	(a)			85,207	33,772	1,095,594	133,755
Tennessee	35,076	18,372			(a)	(a)	(a)	(a)	513,687	193,807	1,092,270	414,225
Texas	305,266	101,453			276,362	$53,613	25,207	$8,862	1,643,209	643,092	2,617,409	957,794
Utah	(a)	(a)			(a)	(a)	(a)	(a)	48,634	9,728	185,569	24,048
Vermont	(a)	(a)			(a)	(a)			(a)	(a)	68,892	34,481
Virginia	5,108	1,665			(a)	(a)	(a)	(a)	293,387	141,803	641,595	226,373
Washington	(a)	(a)							816,811	234,618	1,401,237	387,337
West Virginia	67,867	31,169					(a)	(a)	231,561	108,342	1,054,878	777,952
Wisconsin	152,732	47,887			620,713	91,526	100,958	27,248	1,632,695	387,015	3,544,766	894,202
Wyoming					(a)	(a)	(a)	(a)	707,836	76,657	769,739	86,972
Combined totals	496,946	153,565	18,095	$34,335	2,791,466	415,447	292,136	100,723	586,497	185,882	930,976	221,560
	3,998,548	1,426,053	76,053	68,340	13,649,827	1,779,289	1,834,907	565,242	32,477,927	10,440,857	89,091,732	29,809,995

a Included in "Combined totals."

Sand and gravel produced in the United States in 1916 and 1917—Continued.

1917

State.	Glass sand.		Molding sand.		Building sand.		Grinding and polishing sand.		Fire or furnace sand.		Engine sand.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama			148,355	$54,742	157,107	$67,277	(a)	(a)			(a)	(a)
Arizona												
Arkansas	(a)	(a)	1,058	528	166,013	63,568					(a)	(a)
California	(a)	(a)	10,704	12,541	482,173	160,901	(a)	(a)	3,626	$2,686	(a)	(a)
Colorado			740	261	52,567	20,056			(a)	(a)	(a)	(a)
Connecticut			(a)	(a)	188,935	106,607	(a)	(a)				
Delaware			(a)	(a)	151,864	90,309			(a)	(a)		
Florida					48,148	19,448	(a)	(a)			7,034	$1,313
Georgia	(a)	(a)	31,793	8,950	257,880	78,409	6,600	$1,950			35,342	6,568
Hawaii					(a)	(a)						
Idaho												
Illinois	607,186	$679,618	703,208	412,626	2,592,774	932,455	129,605	167,414	85,051	54,834	133,715	33,586
Indiana	5,000	1,250	287,483	111,732	1,556,922	410,988	25,111	7,040	2,530	1,328	98,141	29,962
Iowa	(a)	(a)	72,844	26,028	1,194,878	372,756	(a)	(a)	(a)	(a)	21,093	6,146
Kansas					646,166	164,105					14,041	2,851
Kentucky	(a)	(a)	36,744	34,432	336,884	202,156			(a)	(a)	5,532	3,033
Louisiana	(a)	(a)			77,125	45,798					3,440	422
Maine					4,269	3,319						
Maryland	(a)	(a)	(a)	(a)	730,323	319,632	(a)	(a)	(a)	(a)	35,728	32,554
Massachusetts	(a)	(a)	26,701	18,643	666,487	355,498	(a)	(a)	6,221	9,263	(a)	(a)
Michigan			147,256	52,686	782,305	433,546	(a)	(a)	(a)	(a)	4,096	1,103
Minnesota			12,904	14,068	561,979	163,916	(a)	(a)	(a)	(a)	1,530	436
Mississippi			(a)	(a)	52,790	23,615					(a)	(a)
Missouri	153,970	162,838	90,811	58,608	1,018,719	449,596	(a)	(a)	(a)	(a)	21,170	9,289
Montana					2,200	1,699						
Nebraska			(a)	(a)	948,794	195,405					60,868	7,822
Nevada					17,733	1,756					405	150
New Hampshire					(a)	(a)						
New Jersey	100,448	93,194	611,916	651,279	1,818,275	545,437	95,741	127,244	118,682	121,295	58,552	30,319
New Mexico					(a)	(a)						
New York	(a)	(a)	650,427	808,550	3,836,257	975,512	65,669	32,322	(a)	(a)	19,057	9,655
North Carolina			(a)	(a)	151,209	68,093	(a)	(a)			(a)	(a)
North Dakota					(a)	(a)						
Ohio	161,408	276,619	999,974	1,218,217	2,318,904	1,090,689	57,449	122,673	149,776	292,231	91,629	76,189
Oklahoma	(a)	(a)	(a)	(a)	233,914	102,889					(a)	(a)
Oregon					59,234	29,003						

[a] Included in "Combined totals."

Sand and gravel produced in the United States in 1916 and 1917—Continued.

1917—Continued.

State.	Glass sand.		Molding sand.		Building sand.		Grinding and polishing sand.		Fire or furnace sand.		Engine sand.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons.)	Value.	Quantity (short tons).	Value.	Quantity short tons)	Value.
Pennsylvania	462,972	$742,815	640,450	$696,734	1,996,524	$1,319,624	480,955	$567,013	185,137	$175,022	414,315	$415,705
Rhode Island			(a)	(a)								
South Carolina			(a)	(a)	19,621	8,821					(a)	(a)
South Dakota					6,656	3,755						
Tennessee	(a)	(a)	33,971	18,833	323,731	183,695			3,885	2,176	27,132	8,843
Texas	6,894	6,484	2,678	3,813	326,370	162,880	(a)	(a)	(a)	(a)	22,936	5,960
Utah					65,398	25,365					2,300	272
Vermont			(a)	(a)	2,878	831	(a)	(a)				
Virginia	(a)	(a)	21,151	21,030	379,641	144,839	(a)	(a)	4,300	3,154	72,352	29,660
Washington			3,632	951	163,564	39,350					(a)	(a)
West Virginia	347,640	562,693	(a)	(a)	151,302	116,367	7,550	14,680	(a)	(a)	108,500	72,672
Wisconsin			97,674	53,846	787,480	295,952	(a)	(a)			(a)	(a)
Wyoming												
Combined totals	97,157	159,503	28,494	24,711	38,994	41,771	310,510	180,372	44,827	33,466	151,314	43,644
	1,942,675	2,685,014	4,660,968	4,303,809	25,374,987	9,837,688	1,179,190	1,220,708	604,035	695,455	1,410,222	832,834

a Included in "Combined totals."

Sand and gravel produced in the United States in 1916 and 1917—Continued.

1917—Continued.

State.	Paving sand.		Filter sand.		Other sands.		Railroad ballast sand and gravel.		Gravel.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama	(a)	(a)	(a)	(a)	(a)	(a)	12,690	$3,014	121,145	$82,336	476,678	$222,011
Arizona	(a)	(a)					(a)	(a)	(a)	(a)	17,268	5,799
Arkansas	(a)	(a)			(a)	(a)	361,824	94,176	17,646	11,677	582,053	176,923
California	605,131	$163,774			29,934	$10,491	1,029,062	125,391	1,605,649	637,015	3,781,388	1,138,128
Colorado	(a)	(a)			(a)	(a)			66,559	39,074	150,063	74,540
Connecticut									(a)	(a)	213,034	127,530
Delaware											166,413	101,252
Florida	(a)	(a)	(a)	(a)			(a)	(a)	23,966	8,131	262,971	145,579
Georgia	(a)	(a)							27,149	32,975	380,154	138,182
Hawaii					(a)	(a)			(a)	(a)	(a)	(a)
Idaho									(a)	(a)	(a)	(a)
Illinois	525,434	130,515			8,308	3,911	1,687,762	262,257	2,647,655	981,583	9,120,698	3,658,799
Indiana	424,575	130,482	(b)	(b)	c 47,992	c 11,853	1,663,277	216,994	1,795,165	669,529	5,906,196	1,591,158
Iowa	191,099	67,497	26,735	$8,616	48,052	12,798	471,822	119,223	878,918	444,522	2,909,441	1,060,586
Kansas	74,630	19,225					55,872	3,131	32,694	6,266	823,403	195,578
Kentucky	53,548	21,925			(a)	(a)	194,291	75,598	263,121	129,436	905,414	490,546
Louisiana	(a)	(a)			(a)	(a)	332,584	33,676	963,546	528,923	1,514,522	639,807
Maine									3,900	4,039	8,169	7,358
Maryland	148,721	63,515	(a)	(a)	(a)	(a)			782,614	470,751	1,727,440	923,463
Massachusetts	14,324	7,262	(a)	(a)	3,671	5,001	(a)	(a)	263,099	267,130	1,005,952	694,960
Michigan	136,214	49,669			94,227	41,267	207,827	21,829	2,292,374	1,011,182	3,814,445	1,641,748
Minnesota	78,211	24,761			90,355	32,758	23,969	3,164	433,382	246,966	1,209,455	488,069
Mississippi			(a)	(a)			764,792	116,299	577,696	216,409	1,414,048	360,664
Missouri	(a)	(a)			(a)	(a)	95,096	28,095	565,039	183,860	2,274,072	1,101,745
Montana	(a)	(a)					(a)	(a)	247,968	88,806	597,642	139,384
Nebraska	211,345	109,362	(a)	(a)	(a)	(a)	19,449	2,335	82,550	42,047	1,327,152	358,414
Nevada							38,810	2,906	18,518	4,001	75,466	8,813
New Hampshire							(a)	(a)	257,071	27,683	258,638	28,070
New Jersey	121,601	57,725	21,567	24,859	48,222	41,686			787,453	332,286	3,782,457	2,025,324
New Mexico									(a)	(a)	(a)	(a)
New York	65,423	34,271	2,325	1,356	52,853	21,032	(a)	(a)	2,353,100	1,141,947	7,119,013	3,046,447
North Carolina	16,829	7,834					(a)	(a)	111,149	69,714	543,364	231,813
North Dakota			(a)	(a)					4,090	3,125	5,750	4,425
Ohio	294,272	142,497	4,624	5,556	10,805	7,098	549,002	142,594	1,554,759	1,001,186	6,192,602	4,375,549

a Included in "Combined totals." b A small output included in "Other sands." c Includes a small output of "Filter sand."

Sand and gravel produced in the United States in 1916 and 1917—Continued.

1917—Continued.

State.	Paving sand.		Filter sand.		Other sands.		Railroad ballast sand and gravel.		Gravel.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Oklahoma	(a)	(a)			(a)	(a)			177,372	$74,698	463,233	$244,432
Oregon	64,760	$47,475					315,253	$38,081	259,104	127,970	698,351	242,529
Pennsylvania	432,849	356,575	(a)	(a)	18,567	$19,199			1,721,480	988,879	6,354,635	5,283,000
Rhode Island											(a)	(a)
South Carolina	(a)	(a)	(a)	(a)			(a)	(a)	9,869	4,112	98,068	42,162
South Dakota	6,458	2,216			(a)	(a)	131,523	17,245	47,383	24,963	194,520	49,654
Tennessee	40,493	24,776			(a)	(a)	93,579	26,127	357,800	220,277	885,957	489,577
Texas	50,527	28,128			(a)	(a)	78,863	18,790	1,090,894	489,427	1,580,939	716,457
Utah	(a)	(a)			(a)	(a)	112,174	5,895	124,890	50,901	307,596	82,707
Vermont							(a)	(a)	6,076	501	51,827	40,624
Virginia	(a)	(a)			(a)	(a)	(a)	(a)	554,591	292,193	1,126,527	532,310
Washington	174,143	37,879			(a)	(a)	(a)	(a)	446,145	113,874	895,120	199,565
West Virginia	56,298	29,827			(a)	(a)			197,446	163,748	877,679	966,763
Wisconsin	161,333	65,045			616,460	104,358	486,582	67,181	1,434,804	489,735	3,609,869	1,080,860
Wyoming							(a)	(a)	(a)	(a)	(a)	(a)
Combined totals	400,256	165,234	6,769	$6,904	193,489	65,023	1,534,896	319,376	106,991	40,935	709,643	123,628
	4,348,474	1,789,469	62,170	47,351	1,262,785	376,415	10,260,999	1,743,377	25,312,820	11,764,812	76,419,325	35,296,932

[a] Included in "Combined totals."

GLASS SAND.

GENERAL ASPECTS OF THE INDUSTRY.

Although the quantity of glass sand produced in the United States passed the 2,000,000-ton mark in 1916, it fell below that mark in 1917. The production was greater, however, than in any year previous to 1916. The value of the total output, on the other hand, increased largely, exceeding $2,500,000, although in no previous year had it reached $2,000,000. The average price per ton in the last seven years has ranged from $0.85 to $1.06, but in 1917 it rose to $1.38, owing to the increased cost of labor, machinery, and fuel.

The principal producers of glass sand in order of output are Illinois, Pennsylvania, West Virginia, Ohio, Missouri, and New Jersey.

Glass sand produced in the United States, 1910–1917.

Year.	Quantity (short tons).	Value.	Average price per ton.
1910	1,461,089	$1,516,711	$1.04
1911	1,538,666	1,543,733	1.01
1912	1,465,386	1,430,471	.97
1913	1,791,800	1,895,991	1.06
1914	1,619,649	1,568,030	.97
1915	1,884,044	1,606,640	.85
1916	2,018,317	1,957,797	.97
1917	1,942,675	2,685,014	1.38

GLASS-SAND LOCALITIES.

The resources of the United States in sand suitable for making the more common kinds of glass are very great. Twenty States produced glass sand in 1916, and it occurs in other States in numerous localities.

Localities where glass sand was reported as produced in 1917.

Arkansas: Ruddells.
California: Ione and Lake Majella.
Georgia: Lumber City.
Illinois: Millington, Oregon, and Ottawa.
Indiana: Michigan City.
Iowa: Clayton.
Kentucky: Olive Hill.
Louisiana: Opelousas.
Maryland: Robinson.
Massachusetts: Cheshire.
Missouri: Crystal City, Klondike, Pacific, and Silica.
New Jersey: Cedarville, Millville, Penbryn, South Vineland, and Williamstown Junction.
New York: Cleveland.
Ohio: Austintown, Barberton, Howard, Massillon, New Lexington, Silica, and Toboso.
Oklahoma: Hickory, Oklahoma City, and Roff.
Pennsylvania: Daguscahonda, Derry, Dunbar, Falls Creek, Kennerdell, Lewistown, Mapleton, Ridgway, St. Marys, Torpedo, and Vineyard.
Tennessee: Lagrange.
Texas: Santa Anna.
Virginia: Sandberg.
West Virginia: Berkeley Springs, Buckhannon, Independence, Sturgisson, Terra Alta (Holmes Station), and West Berkeley.

MOLDING SAND.

The molding-sand industry has reached such volume that the decrease of 1,681 tons from the production of 1916, as shown in the following table, is negligible. This small quantity may be covered by the failure of one producer to report, or it may be silica sand reported as foundry sand which might have been credited either to steel-molding sand or to furnace sand. The great increase in total value and in the average price per ton from 69 cents to 92 cents, or 33 per cent, is notable.

Molding sand produced in the United States, 1910–1917.

Year.	Quantity (short tons).	Value.	Average price per ton.
1910	3,636,167	$2,431,254	$0.67
1911	3,376,717	2,132,469	.63
1912	4,485,380	2,718,726	.61
1913	3,563,583	2,230,217	.63
1914	2,751,209	1,756,383	.64
1915	3,585,746	2,123,203	.59
1916	4,662,649	3,219,839	.69
1917	4,660,968	4,303,809	.92

Ohio was the leading State in the production of molding sand, as in 1916. Pennsylvania, however, dropped from second to fourth place, Illinois becoming second and New York third in order of production.

BUILDING SAND.

The recorded production of building sand in 1917 was 25,374,987 short tons, valued at $9,837,688, a decrease of 1,818,475 tons in quantity and an increase of $1,268,013 in value. It is presumed that there will be a greater decrease in production of building sand in 1918 because of the restrictions on building throughout the country. Although there is a very large increase in the production of sand and gravel for building in some localities, particularly at isolated places where large Government construction work is in progress, it is believed that this will not counterbalance the decrease through the country as a whole. It is freely predicted that after the war there will be a great deal of building and that the production of sand and gravel for this purpose will materially increase.

New York led in the production of building sand in 1917, with an output of more than 3,800,000 tons; Illinois was second, with 2,500,000 tons; and Ohio and Pennsylvania ranked third and fourth.

GRINDING AND POLISHING SAND.

The total production of grinding, polishing, and blast sand in 1917 was 1,179,190 tons, or only a little less than in 1916. There was, however, a very considerable increase in value, the total amount being $1,220,708, as compared with $889,651 in 1916. The average price per ton for all sands under this head was 65 cents in 1916 and $1.04 in 1917. Pennsylvania, Illinois, New Jersey, and New York were the leading producers in the order named.

FIRE OR FURNACE SAND.

The total production of fire or furnace sand in 1917 was 604,035 tons, valued at $695,455, as compared with 426,654 tons, valued at $384,738, in 1916. Pennsylvania, Ohio, New Jersey, and Illinois were the largest producers. The average price per ton was 34 cents in 1915, 90 cents in 1916, and $1.15 in 1917.

OTHER SANDS.

There was a slight increase in the quantity of engine sand reported, and a large increase in value, caused by an increase in average price from 37 cents in 1916 to 59 cents in 1917. Pennsylvania reported by far the largest production, or more than three times that of Illinois, which ranked second. Paving sand showed an increase in both quantity and value and would have been reported in larger quantity had not the use of freight cars for transporting sand and gravel been restricted in the later part of the year. Filter sand, reported separately for the first time in 1916, fell off in 1917, the production being 62,170 tons, valued at $47,351, as compared with 76,053 tons, valued at $68,340, in 1916. There was a small reduction in both quantity and value of railroad ballast reported to the Survey, and a reduction of about 7,000,000 tons in quantity of gravel produced for all purposes, but the total value of gravel produced was more than $1,300,000 greater than in 1916.

CHATS AND CHERTS.

The tables of production given above do not include a considerable quantity of chats or tailings from the Missouri zinc mines. This waste product, which is used on roads, has a nominal value equal to the cost of loading. The shipments of chats in 1917, as reported by the Missouri Bureau of Geology and Mines, amounted to 1,426,716 short tons, compared with 2,890,970 tons in 1916. Of these shipments in 1917, 1,055,972 tons were from mines in southwestern Missouri and 370,744 tons from mines in southeastern Missouri. More than 1,000,000 tons of this material is believed to have been used for railroad ballast, and the rest for other purposes, such as road metal and concrete.

Neither do the tables include between 15,000 and 20,000 tons of chert dug in Alabama and valued at more than $11,000.

IMPORTS.

Sand valued at $142,586 was imported into the United States in 1917, as compared with imports valued at $87,144 in 1916. This is largely building sand brought to the United States from Canada as a near source of supply or brought as ballast from overseas. The imports usually include a small quantity of French molding sand used for making fine bronze castings, refractory sand from England for lining certain iron furnaces, and sands adapted to special uses and brought in small quantity. This importation of sand from abroad is for the most part nonessential but is done because molders, foundrymen, or others of foreign birth learned their trade with a foreign sand and are averse to using other sands than those with which they are familiar.

EXPORTS.

In 1916 for the first time the value of the exports of sand and gravel were recorded separately by the Bureau of Foreign and Domestic Commerce. The table given herewith has been prepared by J. A. Dorsey, of the Survey, from the tables published by that bureau. No information is at hand as to the quantity of sand and gravel represented by these figures nor as to the character and use of the material. Building sand went to Canada from the Great Lakes and Canadian boundary rivers as a convenient source; the character of the material sent to other countries is not known to the writer.

Value of sand and gravel exported from the United States in 1916–17.

Destination.	1916	1917	Destination.	1916	1917
Denmark	$300	....	Argentina	$600	$6
Spain	420	....	Brazil	1,029	226
England	775	$7,136	China	428	217
Canada	196,001	415,699	Japan	2,554	5,951
Panama	8,190	33,941	Other countries	12,540	11,401
Mexico	7,011	16,892			
Newfoundland	1,943	1,039		233,310	494,251
Cuba	1,519	1,743			

POTASH.

By Hoyt S. Gale and W. B. Hicks.[1]

INTRODUCTION.

The potash industry of the United States began in 1914, when American Potash (Inc.), of Long Beach, Cal., made a small production from kelp. Stimulated by high prices, it has grown steadily since that date. The potash-bearing material reported to the United States Geological Survey as produced in the United States in 1917 amounted to 126,961 short tons, having an approximate average content of potash (K_2O) of 25.6 per cent. This was equivalent to a total content of 32,573 short tons of K_2O, valued at $13,980,577, or $429 a short ton, at point of shipment. The production in 1916 was 35,739 short tons of potash-bearing material having an average content of about 27 per cent of K_2O, or a total content of potash (K_2O) of 9,720 short tons, valued at $4,242,730. The production in 1917 was therefore nearly three and a half times the production in 1916, and it represented 13.6 per cent of normal consumption in the country. The experimental production in 1914 was not reported. The production in 1915 amounted to 1,090 short tons of K_2O, valued at $342,000.

PRODUCTION.

In the following summary the production in 1917 is classified with as much detail as is consistent with the Survey's obligation to hold individual reports of production as confidential.

Potash salts produced in the United States in 1917.

Source.	Number of producers.	Total production.	Available potash (K_2O). Quantity.	Available potash (K_2O). Percentage of total.	Value at point of shipment.
Mineral:		*Short tons.*	*Short tons.*		
Natural brines	10	79,876	20,652	63	$8,261,873
Alunite (refined salts and crude and roasted alunite)	3	7,153	2,402	7	892,763
Dust from cement mills	8	13,582	1,621	5	700,523
Dust from blast furnaces	3	2,133	185	1	68,841
Organic:					
Kelp	10	11,306	3,572	11	2,114,815
Molasses residues from distilleries	4	8,589	2,846	9	1,130,907
Wood ashes	49	1,035	621	2	549,150
Steffens water from sugar refineries	5	[a] 2,642	369	1	147,830
Wool washings and miscellaneous industrial wastes	3	645	305	1	113,875
	95	126,961	32,573	100	13,980,577

[a] Includes 1,333 tons of material produced but not sold in 1917.

[1] The writers gratefully acknowledge the assistance of Miss Margret R. Nourse, who collected and compiled a large part of the data on which this report is based. This report was prepared in the early part of 1918 but has been delayed in publication. The figures and other data given relate only to the year 1917.

This table does not include such potash-bearing materials as tobacco stems and corncob ashes, which are and have been for many years sold for fertilizer.

It is interesting to note that about 45 per cent of the output of the entire country came from the alkali-lake region of western Nebraska and that there was an increased production from each source. The largest gain, about five times the production of 1916, was in the potash recovered from natural brines, and the second largest increase was in that from cement mills. The production from kelp, molasses waste, and alunite was about double that in 1916.

So far as known, no potash was produced in 1917 from the utilization of silicate rocks, except where feldspars or shales were incorporated into the raw mix fed to some cement kilns for the purpose of increasing the quantity of potash salts eventually saved from flue dusts.

The nature and value (f. o. b. plant) of the product marketed are shown in the following table. The values, however, are not strictly comparable because of difference in freight rates:

Nature and value of potash produced in the United States.

Nature.	Percentage of the total production.	Approximate percentage of potash (K_2O).	Approximate value per short ton of potash (K_2O) at point of shipment.
Crude carbonate and sulphate	45	20–26	$400
Crude chloride	17	10–44	370
Charred residue from kelp and molasses	13	30–37	425
Refined sulphate	9	38–50	425
Refined chloride	7	50	730
Flue dust from cement kilns and iron furnaces	3	9	440
Crude carbonate and hydroxide from wood ashes	2	60	880
Unclassified	4		
	100		

The production was considerably above the quantity required even in normal times in manufacturing enterprises, and a large part of the potash produced was used for fertilizer. The crude carbonate and sulphate contains a small amount of chloride and consists essentially of salts of sodium and potassium. It is an excellent fertilizer, especially in the Eastern States, where soils commonly have a tendency to acidity. The crude chloride is of various grades. Some American potash, as now sold, contains borax, which may decrease its value somewhat as a fertilizer. Charred residue of organic matter and flue dust have proved very satisfactory fertilizers. The crude carbonate and the hydroxide from wood ashes serve well in the soap industry and are refined for glass manufacture. They are also used as a basis for conversion into other needed potassium compounds. The unclassified material listed in the foregoing table includes mainly ground kelp, roasted and raw alunite, and concentrated Steffens waste water.

IMPORTS.

In contrast to the large quantity and low cost of German potash used in the United States before the war, there was imported in 1917 only 8,100 short tons of potash (K_2O), valued at $7,788,406.

Approximately 17 per cent of the imports came from Russia, 15 per cent from England, 14 per cent from Japan, 12 per cent from Chile, 11 per cent from Spain, 10 per cent from Italy, 9 per cent from France, 5 per cent from Portugal, 4 per cent from Argentina, and the remaining 3 per cent from various other countries. About 35.5 per cent of the total importation came in the form of argol, cream of tartar, and rochelle salt, which have heretofore not been included in the potash statistics. Approximately 28 per cent of these commodities came from Italy, 26 per cent from France, 15 per cent from Spain, 12 per cent from Portugal, 10 per cent from Argentina, and the remaining 9 per cent from other countries.

Potash imported and entered for consumption in the United States, 1913–1917.[a]

Material.	Approximate potash (K_2O) content.	1913 Quantity (short tons). As imported.	1913 Quantity (short tons). Potash (K_2O) content.	1913 Value	1914 Quantity (short tons). As imported.	1914 Quantity (short tons). Potash (K_2O) content.	1914 Value.	1915 Quantity (short tons). As imported.	1915 Quantity (short tons). Potash (K_2O) content.	1915 Value.	1916 Quantity (short tons.) As imported.	1916 Quantity (short tons.) Potash (K_2O) content.	1916 Value.	1917 Quantity (short tons). As imported.	1917 Quantity (short tons). Potash (K_2O) content.	1917 Value.
	Per cent.															
Kainite	12.4	521,176	64,626	$2,201,730	351,566	43,594	$1,551,115	7,475	927	$95,440	40	5	$1,173	......	......	......
Manure salts	20.0	250,529	50,106	2,245,509	189,245	37,849	1,846,475	15,403	3,081	200,584	1,241	248	21,273	252	50	$9,047
Muriate	50.0	237,630	118,815	7,075,745	185,761	92,881	5,745,385	64,670	32,335	2,296,606	1,299	650	348,961	683	342	158,410
Sulphate	48.6	44,349	21,554	1,677,429	40,224	19,554	1,557,224	12,708	6,176	664,484	1,693	823	81,684	230	112	21,702
Bicarbonate	46.0	223	103	20,968	169	78	16,030	132	61	14,456	2	1	1,133	76	35	71,975
Bitartrate (argol)	20.0	14,499	2,900	2,779,180	13,664	2,733	3,016,073	8,339	1,668	2,132,276	14,943	2,989	5,021,291	14,277	2,855	4,740,912
Bitartrate (cream of tartar)	25.0	75	19	28,314	590	148	234,657	123	31	60,869	48	12	29,213	48	12	25,434
Carbonate, crude	61.0	4,858	2,963	272,973	4,663	2,844	265,158	2,693	1,643	191,621	341	208	113,413	2,967	1,810	1,042,639
Carbonate, crude black salts	50.0	344	172	17,852	1,284	642	44,086	2,074	1,037	98,409	1,081	541	109,121	903	452	220,403
Carbonate, refined	67.0	6,145	4,117	393,284	3,371	2,259	224,384	622	417	60,491	76	51	40,496	222	149	121,111
Caustic	80.0	4,324	3,459	342,056	3,642	2,914	285,739	1,016	813	100,035	24	19	16,694	35	28	29,308
Chlorate	38.0	596	226	64,468	13	5	2,235	8	3	3,666	5	2	7,167	503	191	404,783
Chromate and bichromate	40.0	9	4	1,819	15	6	2,375	16	6	2,902	459 lbs.	184 lbs.	75	1	800 lbs.	962
Cyanide	70.0	735	514	216,844	209	146	59,278	436	305	134,123	1	1	803	35	25	49,608
Ferrocyanide (yellow prussiate)	44.0	1,706	751	388,379	1,522	670	334,592	558	246	124,382	25	11	45,497	39	17	57,897
Ferricyanide (red prussiate)	42.0	34	14	12,035	40	17	14,446	26	11	9,044	2	1	6,952	5	2	18,262
Iodide	28.0	......	......	......	270 lbs.	76 lbs.	491	4 lbs.	1 lb.	13	5	1	26,578	15	4	66,823
Nitrate (saltpeter), crude	40.0	4,826	193	261,078	1,115	446	74,869	3	1	400	5,769	2,308	1,519,375	4,606	1,842	669,044
Nitrate (saltpeter), refined	46.0	203	93	22,602	135	62	15,062	......	......	......	2	1	771	368	169	50,606
Permanganate	29.0	273	79	38,188	746	216	102,619	315	91	64,592	45	13	33,728	5	1	21,462
Rochelle salts	22.0	54	12	13,412	113	25	29,318	69	15	3,955	......	......	......	17	4	8,018
		1,092,588	270,720	18,073,865	798,087	207,089	15,421,611	116,686	48,867	6,258,348	26,642	7,885	7,425,398	25,287	8,100	7,788,406

[a] The figures in this table were compiled from the records of the Bureau of Foreign and Domestic Commerce, United States Department of Commerce, by recalculation to short tons and to actual potash (K_2O) and by giving the totals for calendar years instead of fiscal years. The tons are calculated to the nearest even unit and the values are those given in the original records, so that the value given for a high-priced commodity received in small quantity may not be strictly applicable to the quantity given. For instance, 2,705 pounds of cyanide received in 1916 is reported as 1 ton, but the value given is that of the actual quantity received. Furthermore, the values are those placed on the commodities by the shippers, except where an ad valorem duty is charged, and may not represent the true values nor agree with market quotations.

The following tables represent in terms of K_2O approximately the total imports of potash for consumption in the United States during recent years. For the years 1905 to 1912, inclusive, they have been compiled from a report on the fertilizer industry prepared by the Federal Trade Commission,[1] recalculated from metric to short tons, and, for the years 1913 to 1917, they have been calculated from the preceding table of imports compiled from the records of the Bureau of Foreign and Domestic Commerce, United States Department of Commerce.

Potash (K_2O) imported for consumption in the United States, 1905–1917.

	Short tons.		Short tons.		Short tons.
1905	129,084	1910	279,780	1914	207,089
1906	155,974	1911	274,446	1915	48,867
1907	144,351	1912	253,678	1916	7,885
1908	136,057	1913	270,720	1917	8,100
1909	173,220				

POTASH REQUIRED BY THE UNITED STATES.

In 1913, the last complete year before the war, the United States imported 270,720 short tons of potash (K_2O), representing a little more than a million tons of crude and refined salts of various grades, valued at $18,073,865, or an average value as rated in import returns of about $67 a ton of potash ($K_2O$). Of this quantity 44 per cent came as potassium chloride (muriate), 24 per cent as kainite containing 12.4 per cent of K_2O, 18.5 per cent as manure salts containing about 20 per cent of K_2O, 8 per cent as potassium sulphate, and the other 5.5 per cent as various salts, including nitrate, carbonate, caustic, cyanide, and other salts.

An average of 269,656 short tons of potash (K_2O) was imported annually during the years 1910 to 1913, inclusive, and 207,089 tons was imported in 1914, making an annual average importation for the five years immediately preceding the war, including 1914, of 257,143 tons. During 1915 approximately 48,867 tons of K_2O was imported.

On the assumption that a surplus of at least 86,000 tons had accumulated at the end of 1914—and this assumption is believed to be warranted—more than 134,000 tons was available for consumption during 1915. After making due deduction for the oversupply that had permitted the accumulation of a reserve of potash just before the war, the former normal consumption is estimated at 240,000 tons of potash (K_2O) a year. Approximately 5 per cent of this quantity (12,000 tons) was used in manufactures and the remaining 228,000 tons was used in agriculture. These figures are in agreement with the report of the Federal Trade Commission, which by a different method of calculation estimates that a little more than 226,000 tons of potash was consumed in commercial fertilizers during 1913.[1] It is therefore conservative to assume that our demand for potash before the war was about 240,000 short tons a year.

A committee representing the fertilizer interests collected statistics of consumption of potash for fertilizer use, based on the actual average consumption as shown by the record of the fertilizer com-

[1] Report on the fertilizer industry, 1916, p. 115.

panies for the four years preceding 1917, and estimated that about 220,000 short tons of potash (K_2O) would be used in the country in 1917, if it were available at a reasonable price—for, example, $50 a ton for 80 per cent muriate, which is equivalent to $100 a ton for pure K_2O.

Wheeler[1] estimated the annual potash needs of the country by compiling the figures for needs of the individual States as given by the State agricultural experiment stations, or other local authorities. This method gave a total of about 150,000 short tons of potash (K_2O), which he considered the quantity needed for 1918.

Although there is considerable difference of opinion as to whether all the potash that has formerly gone into agriculture has been wisely used, potash for fertilizer is nevertheless pretty generally conceded to be an essential for maximum production of certain important crops and on certain soils. It has been estimated roughly that two-thirds of the potash consumed before the war was used on the cotton lands in the Atlantic coast belt. Potash is not so widely used in the more westerly cotton districts. The potato crop in certain localities is supposed to be dependent on the use of potash as fertilizer, and potash is desired to maintain the productiveness of truck gardens, especially in the older cultivated lands in the Eastern States. Considered with reference to food supply, as an adjunct to efficient crop production, potash therefore appears to be a prime war necessity.

Potash is also needed for military use, though not so largely needed as seems to be popularly supposed. Black powder, which was formerly the principal military explosive, has now been almost entirely superseded by other powders that do not require potash in their manufacture. Black powder is, however, still essential for certain special purposes. Its principal uses are believed to be in shrapnel where a slow-acting powder is desired, in fuses, in military pyrotechnics, and as an igniter for nitrocellulose powder charges.

FUTURE OF AMERICAN POTASH INDUSTRY.

The brine of Searles Lake, Cal., is estimated to contain enough potash to supply the United States for about 80 years. The Nebraska lakes contain much potash, but estimates of quantity are not available. Under present operating conditions about one-third of our annual requirement is recoverable from cement mills. About 380,000 short tons of potash, most of which is volatilized, is annually charged into blast furnaces. The best available estimates indicate that about 30,000 tons of potash has formerly gone to waste in molasses distillery slop and about 8,000 tons in Steffens waste water. Kelp and alunite are available in quantities sufficient to continue to yield a substantial production. Enormous quantities of leucite, greensand, sericite, and feldspar, are available so that the supply of potash-rich silicate rocks is practically inexhaustible. These statements are sufficient to show that raw potash material is abundant in the United States. The future of the American potash industry, therefore, depends on the development of processes of extraction sufficiently economical to permit the domestic product to compete with potash imported in normal times.

[1] Wheeler, H. J., The fertilizer needs of the United States: Quart. Jour. Economics, vol. 32, pp. 209–237, 1918.

Available data on the cost of producing potash from the various American sources are meager, but if the following estimates of cost production are correct they indicate that undoubtedly some of the large developments will survive. Condra[1] gives the cost of producing potash in the alkali-lake region of Nebraska as between \$20 and \$44 a short ton, or an average of \$30 a short ton, of crude salts. This corresponds to an average of about \$120 a ton of potash (K_2O). The conditions as regards labor, fuel, and supplies in this region are very difficult, and the cost should be considerably reduced if such conditions are improved. It has been stated that sulphate of potash can be produced from alunite at Marysvale, Utah, at approximately \$20 a ton[2] (equivalent to about \$40 a ton of K_2O), and that if an aerial tramway were installed the cost would be reduced 50 per cent. Porter[3] estimates that the present cost of production, exclusive of royalty, depreciation, and similar items, by the Security Cement & Lime Co., Hagerstown, Md., is about \$30 a ton of pure potash (K_2O) packed on board cars, and that under normal conditions the price might be reduced 50 per cent. Treanor,[4] from his experiences as manager of the Riverside Portland Cement Co., thinks the cost of saving potash from flue dust may run \$100 a ton of K_2O for the first month, may average \$40 a ton of K_2O the first year, and that it may ultimately be reduced to less than \$20 a ton of K_2O.

The cost of production from the German potash mines in the vicinity of Stassfurt has been stated as about \$20 a ton of muriate of potash (presumably the 80 per cent grade) before the war.[5] This is equivalent to about \$40 a ton of pure K_2O. The Kali Syndicate, under the supervision of the German Government, maintains a monopoly, fixes prices, and distributes the product. Prevailing market prices at New York or other eastern points in the United States for ordinary commercial grades of refined salts, such as the 80 per cent chloride (muriate) and sulphate, were about \$40 a short ton, equivalent to about \$80 a short ton of pure K_2O.

The prices before the war of the higher grade German potash salts delivered under special contracts for large quantities direct from the source of production to Gulf and Atlantic ports were as follows:

Prices of German potash salts, 1912–1914.

	1912–13	1914
Muriate of potash (80 per cent KCl, 50 per cent K_2O)	\$38.05	\$39.07
Sulphate of potash (90 per cent K_2SO_4, 48 per cent K_2O)	46.30	47.57
Manure salts (20 per cent K_2O)	13.30	13.58
Kainite (12.4 per cent K_2O)	8.25	8.36

A discount of 15.5 per cent from these prices was granted to purchasers of large quantities in bulk or 15 per cent if delivered in bags.

[1] Condra, G. E., Preliminary report on the potash industry of Nebraska: Nebraska Conservation and Soil Survey Bull. 8, Lincoln, 1918.

[2] Bloom, H. C., The importance of alunite as a source of potash: Manufacturers' Record, June 14, 1917, p. 58.

[3] Porter, J. J., The recovery of potash as a by-product in the manufacture of Portland cement, paper presented at meeting of the Portland Cement Asso., Chicago, September, 1917. Potash from cement: Met. and Chem. Eng., Dec. 1, 1917, p. 625.

[4] Treanor, John, The experience of the Riverside Portland Cement Co., paper read at meeting of Portland Cement Association, Dec. 11, 1917.

[5] The fertilizer industry, p. 110, Federal Trade Commission, 1916.

Germany is reported to have sold 1,004,285 tons of potash (K_2O) in 1917, which is almost as large as any record previously made. The boast has been published that Germany will hold the rest of the world at her mercy at the end of the war through her control of the world's main supply of potash salts. No such economic condition can possibly result. The United States has been essentially without potash for agriculture since 1914, but the domestic production is now increasing rapidly, and it has been demonstrated that this country can produce the potash it actually requires and does not need to draw on the German supply. So long as the demand far exceeds the available supply the price will undoubtedly remain high, but all the domestic development has been undertaken with full realization of the lower prices it may be necessary to meet when the German salts again come into the market, and all the projects that expect to endure are planned to meet that competition. Important by-product processes of recovering potash are being developed under the stimulus of the high war prices, and production from this source will not only be likely to survive after the war but promises to yield a very large proportion of the potash needed. The crude potash made at Searles Lake is yielding a good profit, and efforts have so far been directed chiefly toward increasing the output of the marketable salts rather than establishing processes of refining or obtaining the by-products on which the success of the enterprises there may ultimately depend. However, the foundation has been laid for the construction and maintenance of a great chemical industry at Searles Lake, and there is little doubt that it will be permanent.

POTASH FROM SALINES.

NEBRASKA LAKES.

GENERAL CONDITIONS.

The year 1917 was one of great activity in the potash industry of western Nebraska. Production was continued and augmented by the four large plants mentioned in the report for 1916, so that the State continued to rank first in the list of producers in 1917. The apparent success of these operators and the existence and wide distribution of alkali lakes or ponds throughout a large territory in western Nebraska has led to considerable local interest, the formation of new companies, and the construction of new plants. Many exploration parties have scoured the sand-hill region, and it is generally believed that many workable deposits are still undeveloped, but the interested parties already on the ground have secured control of most of the known deposits by option, contract, or purchase.

The plains north and south of Alliance are part of an extensive gently undulating upland having an elevation of about 4,000 feet. This is locally referred to as the "hard ground" in distinction from the sand hills which form an extensive belt east of the plains about Alliance.

The sand-hill region is one of very irregular topography, largely without continuous streams and with ponds and small lakes in many of the minor basins that were evidently inclosed by formerly shifting sand dunes. The region is now covered with grass, so that the shifting of the sand has practically stopped. The ponds are sometimes found in series, with marshy ground between them, as if they might

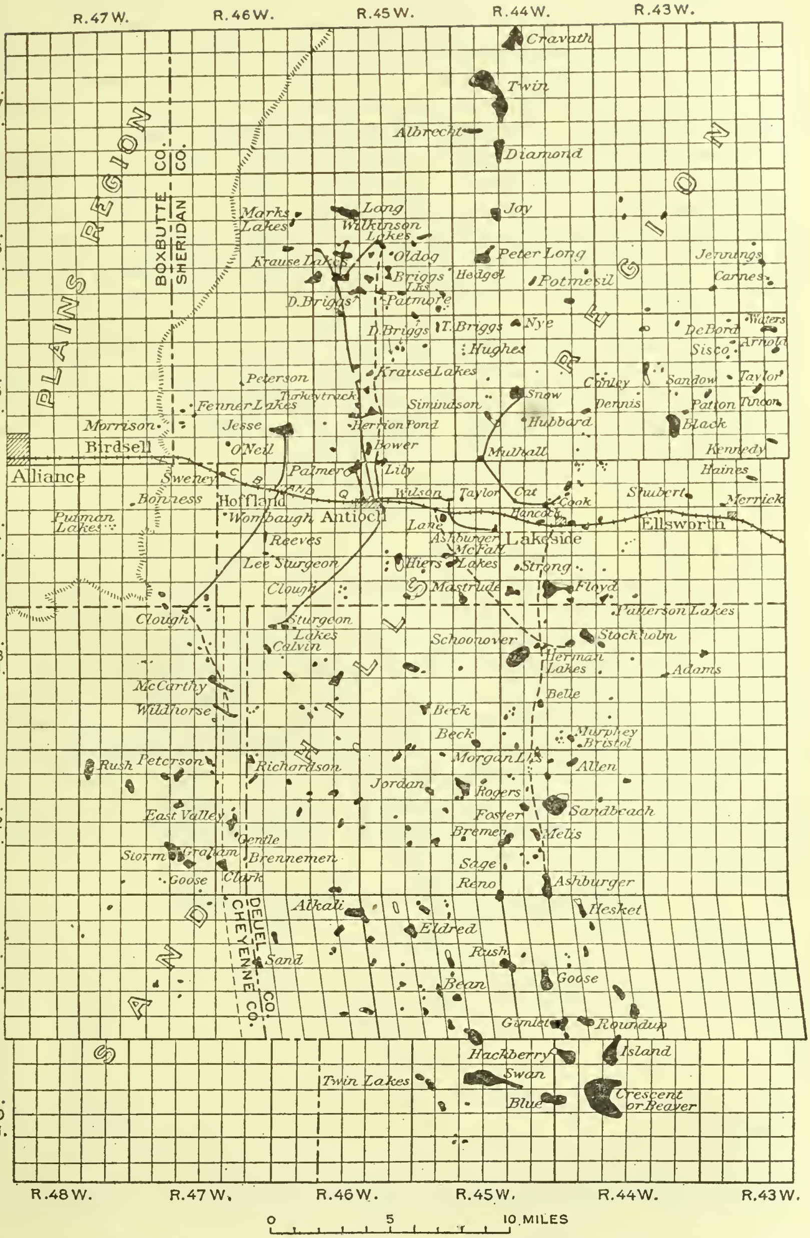

FIGURE 14.—Map showing potash lake district in western Nebraska. (After the Nebraska Conservation and Soil Survey.)

be connected at times of high water or might flow from one to another. This condition may explain why some are practically fresh while others near by are strongly alkaline. The portion of the sand-hill belt in which the ponds are abundant reaches far to the north and east of Alliance, and also to the south and southwest of that place. There are probably a thousand and possibly several thousand of these little bodies of water. (See accompanying map.)

The ponds and lakes range in size from less than an acre to about 600 acres and in depth from a few inches to about 3 feet. Many of them become dry during a portion of the year. They rest on a thin impervious or semi-impervious layer of hardpan whose nature has not been clearly defined, but which is believed to vary and to consist of mud, clay, or a lime-cement layer of sediment somewhat like the lime caliche of southern Arizona. Underlying the first hardpan and resting on a second layer of hardpan is clean sand impregnated with brine similar in composition to the brines at the surface. The thickness of this brine-bearing sand varies considerably; it is about 12 feet thick under Jesse Lake. Beneath the second layer of hardpan fresh or nearly fresh water usually occurs.

BRINE.

Potash brines are obtained both from the surface ponds and lakes and from the subsurface sands. They vary markedly in concentration and in their content of potash, but in general the dissolved salts in most of the brines throughout the sand-hill region are remarkably similar in composition. They consist essentially of a mixture of the sulphates, carbonates, and chlorides of sodium and potassium, a comparatively small amount of chlorides being present. The accompanying table gives the composition of the brine in Jesse Lake, which is typical of the best producing brines in the region. The lowest grade of the brine worked is said to contain about 2 per cent of solids, of which 20 per cent is potash. Between these two extremes all grades of brines are represented.

Composition of brine from Jesse Lake, Nebr.

	1	2
K_2O	27.16	30.85
Na_2O	28.69	25.31
CO_2	21.33	19.79
HCO_2	7.36	7.74
SO_3	12.25	13.77
Cl	3.22	4.07
	100.01	101.53
Total salts	12.39	19.32

1. Jesse Lake water, Colorado School Mines Quart., vol. 10, No. 3, p. 21, 1915. J. H. Show, analyst.
2. Sample of brine from subsurface sands 300 feet from shore collected in 1912. J. F. Breazeale, analyst.

There is much divergence of opinion in regard to the probable origin of the potash and alkali in the sand-hill region, but the explanation that ascribes it to the agency of vegetation appears to be the most plausible. The fact that the composition of the salts in adjacents ponds varies markedly may be explained by assuming the saline content of the ponds to be a mixture of leachings from ordinary soil and the potash salts derived from the burning or decomposition of vegetation. The concentration of the brines is dependent on the rainfall and condition of drainage.

The preservation of so high a percentage of potash in these liquors is a feature of special scientific interest and may be attributed to the absence of clayey material in the sand. Where solutions come into contact with clayey sediment the potash is slowly abstracted and fixed in a more or less insoluble form. This fact is believed to account in large degree for the relative scarcity of potash as compared to soda in many natural salt deposits. The sand hills, however, are composed of an unusually clean sand, with very little clayey material. The very absence of clay and the lack of external drainage may be sufficient to explain why potash in unusual quantity has remained in these liquors.

Sufficient data are not at hand to justify an estimate of the quantity of potash available in the sand-hill region. The problem is difficult because the greater part of the potash brine comes from the subsurface sands and has little relation, as regards quantity, to the lake waters at the surface. Condra[1] thinks that if factories already built or in contemplation should run at full capacity, the available supply of high-testing potash brines in this region would be greatly reduced in four years.

PROCESSES.

The method of operation in all the plants is much the same, although novel features have been introduced here and there. Details have been described frequently, so that only a brief outline of the process seems necessary. Brines from the ponds and lakes and from the subsurface sands are pumped through pipe lines directly, or in relays, to the plant. They are sometimes concentrated by solar heat in shallow evaporating tanks or in a solar tower. The brine is then evaporated in multiple-effect evaporators almost to saturation (about 30° to 35° Baumé). It is then fed through a rotary kiln drier and reduced to complete dryness. The solids are ground and sacked and are ready for shipment to be incorporated in fertilizer. As no attempt is made to refine the salts, the commercial product approaches the composition of the dissolved salts in the original brine, the content of potash ranging from about 20 to nearly 30 per cent.

PRODUCT.

As the commercial potash from the Nebraska lakes is obtained simply by evaporating the brines and drying the salts, the composition of the manufactured product is dependent on the composition of the dissolved salts in the brines and therefore varies with the brine used. Two analyses of Nebraska potash are given in the following table. No. 1 is the advertised composition of the product from one of the plants, and No. 2 represents a typical analysis submitted by one of the companies.

[1] Condra, G. E., Preliminary report on the potash industry of Nebraska: Nebraska Conservation and Soil Survey Bull. 8, p. 36, 1918.

Composition of commercial potash from Nebraska lakes.

Reported analyses.			Calculated salts.[a]		
	1	2		1	2
K_2O	28.49	22.37	K_2SO_4	31.60	35.64
Na_2	32.11	33.87	K_2CO_3	16.72	4.60
CO_2	21.91	22.88	Na_2CO_3	46.87	51.62
SO_3	14.53	16.39	NaCl	4.70	6.92
Cl	2.85	4.20	Loss on ignition	....	1.02
Loss on ignition	....	1.02	Insoluble	.11	.20
Insoluble	.11	.20		100.00	100.00
	100.00	100.93			

[a] The figures representing calculated salts were obtained by calculating all the SO_3 to K_2SO_4, the exces of K_2O to K_2CO_3, all the Cl to NaCl, and supplying enough Na_2CO_3 to make 100 per cent.

The Nebraska lakes produced 61,053 short tons of crude potash, containing 14,558 short tons of pure potash (K_2O), in 1917. This was about 45 per cent of the total domestic production for the year. The enlargement of producing plants and the construction of new plants are expected to increase several fold the productive capacity of the Nebraska field during 1918.

PRODUCING COMPANIES.

The Potash Reduction Co., of Hoffland (formerly the Potash Products Co.), the pioneer in producing potash from brines, still leads in the quantity of potash (K_2O) produced in 1917. This company has evolved one of the most complete plants and processes of manufacture of commercial potash salts from these brines. It owns or leases a number of lakes both north and south of the railroad, the largest of which, Jesse Lake, is 2½ miles north of Hoffland and has an area of about 235 acres. Most of the output of this company has been obtained from Jesse Lake, from the surface liquor and the brines in the subsurface sand. Brines are obtained from about 1,200 wells ("sand points") in Jesse Lake, covering a production area of about 100 acres. A pipe line has lately been run southwestward to Clough Lake and is to be extended to a number of smaller lakes. Another pipe line to the plant of the Nebraska Potash Works Co., at Antioch, for the handling of brines from the Potash Reduction Co., taps a number of small lakes southeast of Antioch. A refinery has been built at Omaha, where refined postassium and sodium salts are to be manufactured.

The American Potash Co., of Antioch, started construction of its plant in August, 1916, and made the first shipment of potash salts on November 4 of the same year. Since that date operation has been continuous and has yielded a substantial production. The plant has an advertised capacity of 2,500 to 3,000 tons a month. The supply of brine came first from Herrion Pond and the underlying sand, but later from Krause, Bauer, Hedge, and Annie Jessie lakes. Analyses furnished by the company indicate that the working brine contains from 6 to 8 per cent of solids, of which 20 to 25 per cent is potash (K_2O). In the later part of 1917 this company was purchased by interests affiliated with the Western Potash Works, of Antioch.

The Hord Co. (formerly the Hord Alkali Products Co.), at Lakeside, began active production at its new plant early in 1917 and continued throughout the year. Its supply of brine is pumped from Cook Lake, about a mile northwest of the plant, and other lakes in the vicinity of Lakeside. The raw brine is said to contain about 6 or 7 per cent of salts, and the product to range from 22 to 26 per cent of potash. An additional evaporating unit, which is expected to double the output, has been recently installed. Pipe-line extensions have been made accordingly.

The Nebraska Potash Works Co., of Antioch, began operations about April 10, 1917, pumping brine from Taylor Lake, but sufficient brine for the full capacity of the plant has not been available at all times. Pipe lines have been laid to Ashburger, Wilson, Palmer, and other lakes, from which much of the brine has come. The company has entered into contract with the Potash Reduction Co. to run some of that company's higher-grade brines, so that increased production is expected during 1918.

NEW POTASH PLANTS AND PROJECTS.

The Alliance Potash Co., of Antioch, Nebr., which is financed chiefly by Krause Bros. and Alliance people, has constructed a plant at Antioch, claimed to have a capacity of 100 tons a day. A pipe line has been laid to Big Sturgeon Lake, about 5 miles southwest of Antioch, and to small lakes along the route. Another source of supply will be Mitchell and other lakes north of Antioch. Production was expected to begin about the 1st of May, 1918.

The National Potash Co. has erected a plant at Antioch, said to have a capacity of 100 tons of solids a day. It will obtain its supply of brine from Beck Lake, about 10 miles southeast of Antioch, and other lakes in Garden County, 7 to 22 miles south of the plant. The brine to be pumped is reported to contain about 8 per cent of solids, 25 per cent of which is potash (K_2O). The company expected to be producing potash in May, 1918.

The Western Potash Works is building a plant at Antioch, said to have a capacity of 100 tons a day. The company controls about 30 lakes reported to be rich in potash, most of them north and south of Antioch. Among them are the Briggs lakes, Nos. 1, 2, 3, and 4, and Potmesil, Patmore, East Valley, and Clark lakes. Production was expected in the summer of 1918. This company is affiliated with the American Potash Co., at Antioch. The Process Engineering Co., of Philadelphia, Pa., is designing a modern plant with all labor-saving devices for manufacturing potash salts. Several lines of investigation are being followed to determine the best method of refining the salts, and the plant is being so laid out that the apparatus can be employed in later by-product work.

The Nebraska-Wyoming Potash Co., of Antioch, took over the interest and a 3-ton plant of the Sauerwein-Murrah Potash Co. late in 1917. The company expects to build several small plants producing from 3 to 10 tons a day. Production began in January, 1918.

The Commonwealth Potash Co. is reported to be erecting a plant at Birdsell, just west of Hoffland, and to be planning to utilize the brines from Boness and Putnam lakes.

Reports have been received of the organization of the following potash companies:

The Peterson Potash Co., Antioch.
United States Potash Co., Antioch.
Antioch Potash Co., Antioch.
Standard Potash Co., Lakeside.
Nebraska Refining & Pipe Line Co., Valentine.

SEARLES LAKE, CAL.

GENERAL CONDITIONS.

Searles Lake is in the northwestern part of San Bernardino County, Cal. Here a surface deposit of crystalline salt has an area of 7,000 to 7,500 acres and an average depth of 70 to 75 feet. It consists of a bed of crystalline salts impregnated with a saturated potash-bearing brine. It is now known that the brine extends far beyond the limits of the salt body exposed on the surface, so that workable brines may be pumped from an area of more than 13,000 acres. About 1,000 acres of this area at the north end of the lake is patented land and is a part of the 2,240 acres owned in that region by the Pacific Coast Borax Co. Practically all the rest, except a small portion at the south end of the lake, was located under the placer-mining law by the American Trona Corporation or its subsidiaries. The rights of the American Trona Corporation and its subsidiary the California Trona Co. were contested and have been in litigation for several years. A recent decision by the Secretary of the Interior accorded to the California Trona Co. the right to five claims (about 240 acres), and these claims may proceed to patent immediately.

The company filed a duly executed relinquishment of all other rights, title, claim, and interest to the locations upon Searles Lake, except those embraced in a compact body of 2,560 acres adjacent to its pipe line and a small area of claims located upon the trona reefs. The decision and relinquishment leaves that part of Searles Lake which is not controlled or claimed by the California Trona Co. and the Pacific Coast Borax Co. open to leasing under the act of October 2, 1917 (40 Stat., 297).[1]

BRINE.

The Searles Lake brine is a saturated solution which fills the interstices between the crystals in the salt body. It is undoubtedly the mother liquor which remained after the crystal salts were formed by the natural concentration of the waters from the ancient lake that occupied this basin. As a consequence the liquor is richer in potash and borax than the crystals. Samples of the brine from different depths in various parts of the deposits show a marked uniformity in composition. A representative analysis of the brine is given below:

[1] The law and regulations under it have been published as Circular 594, Department of the Interior, under the title "Potash regulations." A copy of this circular may be obtained by applying to the Commissioner of the General Land Office, Washington, D. C.

Composition of brine from Searles Lake, Cal.

[W. B. Hicks, analyst.]

K	6.17
Na	33.66
Cl	36.36
SO_4	12.86
CO_3	7.72
B_4O_7	3.23
	100.00
Total salts by summation	34.04
Specific gravity at 23° C	1.2938

AVAILABLE SUPPLY.

According to the original computation, which was based on an area of 11 square miles, a depth of 60 feet, and an interstitial space in the salt body occupied by the brine of 25 per cent, the quantity of potash (K_2O) in the brines of Searles Lake was estimated at 4,000,000 short tons. At the same time it was suggested that the figure was conservative and that the deposit might contain as much as 10,000,000 tons.

Masses of cleaved or broken mineral fragments contain an average of about 50 per cent interstitial space, masses of loose crystals of common salt about 60 per cent, and masses of needle-like and platy crystals—such as mercuric chloride and potassium perchlorate precipitated from a hot saturated solution—about 90 per cent. The interstitial space is reduced comparatively little by shaking.[1] These data indicate that the brine in Searles Lake occupies at least 50 per cent of the total volume of the lake and that it may reach 75 per cent or more. A conservative estimate is about 60 per cent.

The brine from different parts of the deposit varies slightly in composition. It has a specific gravity of about 1.295 and contains about 2.50 per cent of K_2O. Such a brine occupying 60 per cent of the volume represented by an area of 7,000 acres, and a depth of 60 feet would contain about 11,000,000 short tons of potash (K_2O). This estimate is low because the brine extends beyond the exposed salt area (7,000 to 7,500 acres) so far that productive brines may be pumped from an area of about 13,000 acres. Furthermore, a depth of 70 feet is probably a more accurate average for the exposed salt body. An area of 10,000 acres for a salt body 70 feet deep seems to be a conservative estimate. According to the data given above such a body would contain nearly 20,000,000 tons of potash (K_2O).

PROCESS.

The process used at Searles Lake is practically simple evaporation and crystallization, and hence the equipment of the different companies is essentially the same as to general features, consisting of vacuum evaporators and crystallizing pans, with accessory boilers,

[1] Unpublished data from the division of chemical and physical research of the United States Geological Survey.

pumps, and storage vats. The brine is first evaporated in vacuum apparatus to less than half its volume, and the solids, which consist largely of sodium chloride, sodium sulphate, and sodium carbonate, are removed as they are deposited and washed back into the lake by condensed water. The remaining liquor is run into crystallizing vats and allowed to cool, when a crop of crude potash is obtained. The mother liquor from this crystallization is at present returned to the evaporators to be mixed with fresh brine.

PRODUCT.

The crude product produced at Searles Lake contains 60 to 65 per cent of potassium chloride and about 15 per cent of anhydrous borax. A few carloads of refined salts have been produced, but practically the whole output so far has been marketed without refining.

PRODUCING COMPANIES.

The American Trona Corporation has practically overcome the many operative difficulties encountered at its plant at Trona, and the process may be considered as established. The company made the second largest production in the United States during 1917. Its production increased from 30 tons of crude potash a day to more than 50 tons, and its plant was in practically continuous operation. The plant at Searles Lake has cost considerably more than a million dollars. A second unit is in course of construction, and a fourth evaporator is being installed in connection with each set of triple-effect evaporators, so that sometime during 1918 the capacity of the plant will be increased to about 100 tons of crude potash a day. In addition four other units are being designed, and ultimately a much larger production may be expected. The corporation's refining plant at San Pedro is practically completed, and several carloads of a highly refined potassium chloride has been produced. It is not known to what extent this plant will be utilized in the immediate future. So far, however, the main efforts of the company have been devoted to the production of crude potash, which finds a ready market.

The Solvay Process Co. has erected a plant and refinery at Borosolvay, on Searles Lake, at a cost of about $700,000 and is drawing brine from the patented ground owned by the Pacific Coast Borax Co., about 2 miles from the plant of the American Trona Corporation. A large amount of experimental work has been done in an effort to produce high-grade salts. This has been a difficult undertaking, and only a small production was made in 1917. At the end of 1917 the production was reported to be about 200 tons a month of high-grade salts.

At the end of 1917 no new companies had entered this field, chiefly because of the uncertainty of obtaining title or leases to a workable portion of the deposit. The recent decision of the Secretary of the Interior makes about 9,000 acres of the deposit subject to lease under the leasing bill enacted in October, 1917. (See p. 465.)

GREAT SALT LAKE, UTAH.

Two companies are producing potash salts from the brines of Great Salt Lake, Utah. The plants were probably in more or less regular operation throughout the year, but their combined output was comparatively small. The plant of the Utah Chemical Co. is at Potash siding, on the branch of the Salt Lake Route running from Salt Lake City to Saltair. It was designed to recover potash as a by-product in the manufacture of salt. The plant of the Salt Lake Chemical Co., a subsidiary of the Diamond Match Co., is at Grantsville, about 30 miles west of Salt Lake City on the Western Pacific Railroad. It was designed to handle the lake water primarily for its potash content. The general nature of the operations of these companies was described in this report in Mineral Resources for 1916.

SALDURO SALT MARSH, UTAH.

The Solvay Process Co. has prospected the Salduro salt deposit systematically, but little can be added to the general description of the deposit given in the chapter on potash for 1916. The mud immediately below the salt is very impervious, but layers still lower, including one at a depth of 9 feet and one at 12 feet, yield a flow of brine similar in composition to that near the surface. A well sunk near Salduro station for fresh water encountered only mud, similar to that underlying the salt, to a depth of 400 feet. It was thought, but not proved, that brines were encountered in these deeper beds not unlike those at the surface.

The plant of the Solvay Process Co. is on the south side of the Western Pacific Railroad at Salduro station, in the center of the salt deposit. The buildings include an evaporator house, grainer building, boiler rooms, power house, and machine shop. The brine is pumped from the deposit into concentric solar vats for preliminary concentration, where the liquor flows from the outer rings toward the center as it becomes more concentrated. It is then treated in vacuum apparatus and the crystallization takes place in salt grainers. Production began in May, 1917, but the output in 1917 was small.

The brine from the Salduro deposit, like the mother liquor obtained from evaporation of Great Salt Lake water, is fundamentally of a different type from the chloride-carbonate-sulphate liquors that are found in most of the desert-basin saline deposits. The presence of large amounts of soluble magnesium salts and of small amounts of soluble carbonates and sulphates makes the Salduro brine similar in type to the artificial brines of the German potash works. The exact process adopted by the company at Salduro is not disclosed, but presumably it is essentially like the refining processes used at the German potash works. The Salduro brine can be concentrated by solar evaporation and then in evaporators until the potassium has reached a certain determined practicable maximum. If this liquor is then cooled to about the temperature of the air a crop of sylvite (potassium chloride) would probably be obtained. The mother liquor could then probably be again heated and reduced by evaporation so that upon second cooling a further crop would be obtained, which it is expected would come down as a relatively purified artificial carnallite (magnesium and potassium chloride). The first crop of crystals must be purified and the carnallite re-treated in order to obtain high-grade potassium chloride.

SEA-WATER BITTERNS.

The Oliver Chemical Co., Mount Eden, Cal., and the Whitney Chemical Co., San Mateo, Cal., each reported a small production of potash from sea-water bitterns in 1917. The product contained from 6 to 44 per cent of potash (K_2O). The Oliver Chemical Co. used only a small portion of the mother liquor from its salt-refining plant for producing potash. It manufactured also magnesium sulphate and magnesium chloride.

There are several plants that produce salt from sea water, and the residual mother liquor contains from 2 to 8 per cent of potash (K_2O). The quantity of such liquor available for potash production is not known, but is believed to be too small to yield a large output of potash.

EXPLORATIONS AND PROJECTS.

ARIZONA.

A discovery of a rich potash-bearing brine in an underground basin near Parker, Ariz., was reported and has received considerable publicity through the press. The deposit has not been investigated by the Survey, and inquiry by correspondence has not elicited any satisfactory evidence of such a discovery.

CALIFORNIA.

Many projects have been exploited for the recovery of potash from salts, brines, or saline muds in various parts of California, in addition to the commercial developments at Searles Lake. Most of these projects originate in the desert parts of the State. Those that have received most notice in the local papers are discussed in the following paragraphs.

The possibility of working the very unusual deposits of salt and brine in the Death Valley region continues to attract public attention, although little progress toward any practical accomplishment seems to have been made. Interest in potash in Death Valley seems to have started about the 1st of April, 1912, with a scramble to locate potash claims in the "sink" of this basin. The first locations are said to have been made by local men; later several outside companies were organized for exploration or development. Many surface samples were taken and analyzed, and reports issued quoted results as high as 12 per cent of potash, but these statements have not been confirmed. Among the many tests made the following analyses from Government laboratories give an idea of the general range of these random tests:

Potash analyses of samples from Death Valley, Cal.

[A. R. Merz, Cooperative Laboratory, Reno, Nev., analyst.]

Date reported.	Laboratory number.	Nature of sample.	Soluble portion (grams per 100 cubic centimeters).	Potash (K_2O) in the soluble portion.
1912.				*Per cent.*
Apr. 9	95-2	Water	3.21	2.04
May 2	131	Saturated brine	35.87	3.37
May 2	131	Saline water	3.92	1.69
May 2	131	Saturated brine	33.99	1.98
May 23	149	Saturated brine	36.6	4.08
May 23	149	Saturated brine	36.12	3.53
May 23	149	Saline water	8.9	4.04
June 25	209	Saturated brine	34.25	2.60
June 25	209	Brine	8.04	2.41
	306	Saturated brine (slough at road crossing below Furnace Creek)	36.51	3.42
	307	Water from pond northeast of Bennetts Wells	20.36	1.08
	326	Surface water near Eagle borax works	10.42	1.50
	329	Brine from hole in salt near the road crossing	36.81	3.31
	331	Brine from 4-foot hole dug at bench mark—272	33.80	.96
	338	Brine from dug hole in salt marsh below borax works north of Furnace Creek	33.28	3.08
	339	Water from dug hole on west side of valley due west from Furnace Creek	2.77	1.75
	341	Water from dug hole one-fourth mile nearer salt flat than No. 339	15.12	2.38
	342	Brine from 7-foot dug hole one-fourth mile from No. 341, on main salt flat	34.18	2.98
	*	Surface pool at old bridge on Skidoo trail due west of Furnace Creek	32.05	2.25

The analyses given above show that the saturated brines from the main salt deposit are commonly richer in potash than the more dilute tributary ground waters obtained on the sides of the valley. The average of the 11 samples of saturated brine is 2.87 per cent of K_2O in the total dissolved salts, or about 0.8 per cent of K_2O in the original solution.

During the winter of 1912–13 four wells were drilled in the lower part of Death Valley by the United States Geological Survey, and many more analyses were made of the salt and brine from these deposits. The results were published in detail in Survey Bulletin 540, pages 407–415. The general nature of the salts in the brine is represented by the following analysis:

Analysis of brine from 38-foot depth, Death Valley, Cal.

[R. K. Bailey, analyst.]

Chemical determinations.

	Per cent of dried residue.
K	1.35
Na (by difference)	36.54
Mg	.05
Cl	46.81
SO_4	14.81
B_4O_7	.44
	100.00

Total soluble salts 29.95 per cent (dried at 180° C.).

Calculated salts.[1]

	Per cent of dried residue.
KCl	2.57
NaCl	75.22
Na_2SO_4	21.60
$Na_2B_4O_7$	.57
$MgSO_4$	.25
	100.21

[1] This table of calculated salts was obtained by calculating all the K to KCl, the remaining Cl to NaCl, all the Mg to $MgSO_4$, the remaining SO_4 to Na_2SO_4, and all the B_4O_7 to $Na_2B_4O_7$. No account was taken of the amount of sodium. The method of calculation is purely arbitrary.

The potassium shown by this analysis is equivalent to 1.62 per cent as K_2O. Potash (K_2O) in the salts contained in the brine samples collected during this drilling ranged from 1.18 to 3.43 per cent, or as expressed in terms of potash in the original brine or solution from 0.32 to 0.96 per cent. The salt or mud samples carried soluble matter in which potash occasionally ran as high as 2.00 per cent and reached a maximum recorded determination of 3.28 per cent of K_2O in the water-soluble portion.

As a result of this work it was concluded that the potash in either brines, salts, or muds was not so exceptionally high that it could be interpreted as indicating much segregation of potash in the brine or unusually rich potash layers in the deposits penetrated, and no special hope of potash value could be held out. Death Valley contains an immense deposit of crystalline salts and a very great volume of brine saturated with dissolved salts, both of which contain chiefly common salt as a principal constituent and everywhere include a little potash. It is thought that this deposit has accumulated gradually layer by layer under intermittent lake conditions, so that there has been no opportunity for the segregation of a large body of rich potash brines or salts.

In January, 1914, deep boring with a heavy drilling rig was started by the Pacific Coast Borax Co. about 100 yards northwest of the center of the SW. ¼ sec. 30, T. 25 N., R. 2 E., in Death Valley. This hole was completed February 3, 1914, at a depth of a little over 1,000 feet. For the first 800 feet the hole was drilled in salt and clay in alternating strata. These strata carried anhydrous calcium sulphate (anhydrite) in amounts that increased with depth. Below 900 feet only salty clays were reported. This work seemed to confirm the conclusion that the potash in all these deposits had remained distributed through the whole mass of the deposit and is probably so mixed with clays and salt that it seems to offer no special hope for commercial development.

Two other holes were drilled later, the second to a depth of 524 feet, the lower half through hill-wash deposits evidently derived from the sides of the valley, and the third to a depth of 1,009 feet. The third hole yielded a record very similar to that of hole No. 1. This work was completed before April, 1914. The results of testing for potash did not differ materially from those obtained in the earlier tests.

In 1915 reports were received of the activity of a company organized in Michigan with the object of working the Death Valley brine as a source of potash and borax. This company is stated to have laid claim to the finding of only 1.2 per cent of potash (K_2O) in the brine, which is slightly higher than the record quoted above, but planned to make the recovery from this solution by evaporation in solar vats. So far as known no progress was made with this enterprise in 1916 or 1917, but it is understood that the project is still more or less actively pushed. Solar evaporation of brines like those of Death Valley may be made to yield other products besides common salt, and if the recovery can be made cheaply enough there is a possibility that a chemical industry may some day be established there. The supply of salt and brine is very great, and climatic and other conditions are to say the least, exceptional. It is to be hoped they will be turned to practical account.

Borings made in the "sink" of Deep Springs Valley, in the northern part of Inyo County, east of Big Pine, are said to have revealed brines and muds containing a high percentage of potash in the soluble salts. The basin is a distinct topographic feature bordered by mountains composed largely of granite, and a study of the nature of the salines in relation to the rocks from which they were probably derived would be interesting. Further investigations of the deposit are now in progress.

The following analysis is quoted from a private report on the property by consent of the interested persons.

Analysis of brine from Deep Springs Valley, Cal.

[Curtis & Tompkins, analysts.]

Determinations.	Per cent of dried residue.	Calculated salts (moisture-free basis).	Per cent of soluble portion.
K_2O	10.86	KCl	17.21
Cl	43.43	NaCl	58.00
SO_3	5.21	Na_2SO_4	9.22
B_2O_3	.43	$Na_2B_4O_7$	.64
CO_2 (alkalinity)	6.21	Na_2CO_3	14.93
			100.00

Total soluble salts not stated but computed from data given to be about 14 per cent.

The potash (K_2O) in the original sample is stated as 1.52 per cent. If this liquor were a saturated solution available in free flow and sufficiently large volume it would seem to offer interesting possibilities.

Saline Valley has also attracted considerable attention as a possible source of potash. This depression is an isolated basin containing an accumulation of salt and brine in the bottom. The salt is being mined and shipped. The record of a preliminary investigation of this deposit for potash is contained in United States Geological Survey Bulletin 540, pages 416–421. Potash claims in Saline Valley were filed March 31 and April 20, 1917, but no record of development has been received.

Potash locations have been filed on ground in the vicinity of Coso Hot Springs, Inyo County, but no record has been obtained of development there.

Potash locations have been filed in large areas for lands in the vicinity of Zabriskie, Inyo county, by the Pacific Exploration Co., of Los Angeles. This and several other groups of claims based on similar representations as to value or discovery have attracted considerable attention in the local press. It is claimed that rather extraordinary amounts of water-soluble potash have been found in samples of the loose surface soil or in clay on the barren hills that form the Amargosa Valley about Zabriskie and Shoshone, and some of the samples submitted to the Geological Survey have been analyzed with results showing them to be surprisingly high in soluble potash. The district has been examined carefully by several parties from the Geological Survey and many independent samples from pits and trenches have been taken and tested. This work was done in full cooperation with the company interested in the development, but for some reason the tests have failed to confirm the original reports of the chemists or the engineer on the property. It is of course possible that the rich material exists in these deposits and has not yet been found by the Survey parties.

Attention has been repeatedly directed to the vicinity of Rodriguez Dry Lake, sometimes referred to as Rogers Dry Lake, as a possible source of potash. This is a large intermittent lake deposit of fine mud, about 20 miles southeast of Mohave, in the southeastern corner of Kern County. It is crossed by the Santa Fe Railway. A considerable deposit of ordinary desert alkali near Buckhorn Springs at the south end of this area has been many times tested and found to consist chiefly of sodium sulphate, sodium carbonate, and sodium chloride, with very little potash. The greater part of the mud surface contains very little apparent salts. A sample of the surface mud near the railroad collected by the writers in 1914 contained 1.78 per cent of soluble matter (dried residue), of which 0.92 per cent was potash (K_2O). The salts were apparently chiefly chloride and carbonate with a little sulphate and borate. No special significance was attached to this result. A report states that local engineers have found a probable average of 3 per cent of potash, presumably in the mud, in an area of 26,000 acres out of a total area of the deposit given as about 40,000 acres. This material is recommended to be treated on the ground in reservoirs by evaporation for the separation of potash, which it is stated "contains no deleterious substances such as borax." However, when this locality was visited by a representative of the United States Geological Survey in the fall of 1917 a test well was being drilled near the center of sec. 20, T. 9 N., R. 9 W., about 5 miles south of Muroc station. The work was done by the California Kali Co., of Los Angeles. At the time of visit artesian water was flowing from the casing and the well was reported to be 145 feet deep. It is understood that the potash from the muds or water was of negligible quantity.

In February, 1917, exploration for potash was begun in Cadiz Lake (Dry Lake No. 9) in San Bernardino County, Cal., by Los Angeles people. Twenty-two wells were sunk and brines obtained at depths of 2 to 36 feet. Dry clay and salt covered the surface, then followed about 6 feet of clay mud, beneath which was about 26 feet of crystalline gypsum, salt, and brine. The following analysis of brine taken at a depth of 36 feet is reported to be representative of the brine encountered:

Composition of brine from Cadiz Lake, Cal.

[Smith, Emery & Co., analysts.]

Radicals in percentage of anhydrous residue.[1]		Calculated salts.	
K	1.41	KCl	2.69
Na	30.71	NaCl	78.04
Ca	6.12	$CaCl_2$	16.53
Mg	.56	$MgCl_2$	2.20
Cl	60.82	$CaSO_4$	.54
SO_4	.38		100.00
	100.00		
Soluble salts (fused)	7.36		

[1] Recalculated from statement of calculated salts as reported by Smith, Emery & Co.

The composition of this brine seems unusual, for it is reported as consisting almost entirely of chloride salts, very little sulphates, and no carbonates, and with soluble calcium salts present in such quantity that it may be considered partly a calcium chloride brine. This liquor might be considered available as a reagent for use in some of the processes in which salts or calcium chloride is used for rendering soluble the potash contained in silicate rocks.

COLORADO.

Lands in San Luis Valley, in Alamosa County, Colo., are being prospected for potash. Analyses showing a rather high content of potash in some of the soda lakes in this vicinity were quoted in the chapter on potash in Mineral Resources for 1916, Part II, page 105.

Considerable publicity has been given to a reported discovery of potash-rich brine from a well recently bored in sec. 5, T. 15 N., R. 94 W., about 9 miles east of Delta, Colo. The first reports of analyses indicated that this water was unusually rich in potassium and lithium salts. Investigation is reported to have shown that the water carried about 3.74 per cent total dissolved salts, 0.7 to 0.8 per cent being potash figured as potassium chloride and about 2.8 per cent as sodium chloride. The water is thus of about the same concentration as sea water, and if these results are correct, potash is contained in the salts to a rather unusual degree. A sample of the water from this well was collected by D. E. Winchester, of the United States Geological Survey, in June, 1918, and analyzed by W. B. Hicks in the chemical laboratory of the Survey. It contained 1.92 per cent of dissolved salts, including 0.092 per cent of potash figured as potassium chloride, corresponding to 4.78 per cent of the dissolved salts. The results obtained by the Survey do not indicate that the potash content of the water is unusual.

MONTANA.

Samples from supposed deposits of potash salts in Montana have been received by the Survey, among them several from the waters and muds of Bowdoin Lake, Phillips County, but chemical tests show that these waters contain very little potash.

NEVADA.

Numerous projects for the recovery of potash from salts, brines, or saline muds continue to be actively exploited in Nevada, and any developments will be followed with considerable interest in the hope that something of value may be found.

The Humboldt Salt Marsh in Dixie Valley (called Osobb Valley in the early geologic reports), in Churchill County, has been the scene of recent activity. This was examined with special reference to potash by the Geological Survey in 1912. The basin contains a dry lake or mud flat in its lowest part, which is about 40 square miles in area.

There is a deposit of salt covering about 9 square miles and ranging from 1 to 5 feet in thickness, near the center of the mud flat. The salt crust is underlain by saline mud, below which is found an alternating series of salt and mud strata. Samples taken in 1912 were analyzed with the following results:

Analyses of brine from Humboldt Salt Marsh, Nev.

	Reported as grams of dissolved salts per 100 cubic centimeters of solution.	Soluble portion dried at 105° C. (percentage).	Potash (K_2O), percentage in soluble portion.
1. Brine from hole in salt near center of deposit[a]		29.13	0.22
2. Liquor from an old salt vat[b]	43.47		6.04
3. Brine, locality unidentified[b]	37.05		.41
4. Brine, locality unidentified[b]	36.08		1.61

[a] R. K. Bailey, analyst. [b] A. R. Merz, analyst.

Prospecting in Dixie Valley was taken up in the fall of 1912 by the Railroad Valley Co., of Tonopah. The first boring near the center of the salt deposit passed through 10 feet of loosely crystallized salt and black mud and then black, gray, or yellowish saline mud or clay to a depth of 98 feet. The salt strata in the upper 10 feet all carried brine, but this brine yielded only 0.75 per cent of potash, figured as percentage of the total dissolved salts. The mud below this was wet but yielded no flow into the hole. Two other holes were bored that gave essentially the same results. The following analyses show very completely the character of the brines encountered in these borings:

Analyses of brines from Dixie Valley, Nev.

[Work of the Railroad Valley Co. A. R. Merz, analyst.]

Sample No.	Depth (feet).	Conventional combinations (grams per 100 cubic centimeters).					Total solids by evaporation (grams per 100 cubic centimeters).	Percentage of K_2O in total solids.
		NaCl.	Na_2SO_4.	Na_2CO_3.	KCl.	Total by addition.		
Hole No. 1:								
4	Surface.	27.01	5.02	3.83	0.41	36.27	37.62	0.69
2	4	26.37	4.39	4.12	.46	35.34	38.70	.75
1	26	26.91	4.03	2.65	.19	33.78	35.10	.34
50	64	25.08	4.37	3.30	.28	33.03	32.80	.54
51	71						34.48	.38
52	81						34.64	.42
53	91	23.71	3.73	3.48	.24	31.16	31.57	.48
54	98						31.70	.41
Hole No. 2:								
55	2.5						36.48	.54
56	6.5						35.82	.47
57	10.5						35.63	.43
58	21						35.19	.33
59	28						35.50	.40
60	38						33.24	.33
61	55	28.02	4.69	3.25	.31	36.27	36.29	.54
62	67						35.66	.50
63	78						36.47	.50
64	85						34.34	.51
65	91.5						36.02	.57
66	94.5	27.79	4.56	3.53	.33	36.21	37.16	.56
Hole No. 3:								
67	1.3						34.99	.28
68	2.5	28.99	3.65	1.77	.15	34.56	34.81	.27
69	5.5						35.00	.27
70	11						35.60	.25
71	14.5						33.92	.25
72	25						35.79	.23
73	35						34.65	.19
74	45	28.42	4.68	2.21	.16	35.47	35.30	.29
75	55						35.77	.35
76	63						35.01	.30
77	71						28.70	.25

This gives a rather conclusive and valuable record concerning the character of the brines in this deposit. Analyses of the crystallized salts are also available but show little potash.

In December, 1917, an association of persons from Fallon, Nev., again took up the Dixie Valley potash project, and formed the Nevada Potash Syndicate to explore and develop the field. Attention is now being centered on the muck or mud that is found in the deposit which, it is stated, analyses show to carry about 2 per cent by weight of soluble potash. A sample of brine from the deposit is reported to have had the following composition:

Analysis of brine from Dixie Salt Marsh, Nev.

[Smith, Emery & Co., analysts.]

Radicals in percentage of dissolved salts.[1]		Calculated salts.	
K	2.26	KCl	4.32
Na	36.85	NaCl	80.15
Cl	50.70	Na_2SO_4	9.48
So_4	6.41	Na_2CO_3	3.84
Co_3	2.17	$NaHCO_3$	1.87
HCO_3	1.36	$NaNO_3$	.34
NO_3	.25		100.00
	100.00		
Total dissolved salts	29.41		
Specific gravity	1.242		

This is equivalent to 0.81 per cent of potash (K_2O) in the original sample, which is substantially higher than the results obtained by the Railroad Valley Co., but does not seem to have special significance.

The United States Geological Survey has given much study to the muds in Columbus Marsh, Nev., with special reference to the potash contained in them and in the brines or waters that are obtained from them. Borings in this basin were made in the summers of 1912 and 1913. A record of this work is contained in United States Geological Survey Professional Paper 95, pages 1–11. The percentage of potassium in the soluble salts in a section from 18 to 38 feet in depth in a well called "400" was found to be exceptionally high, but the total amount of salts in the samples was so low that the average content of soluble potash in the mud was no greater than is found quite generally in such deposits. The waters obtained from these borings were rather dilute solutions, averaging only about 0.5 per cent of salts, and their potash content was found to be not unusually high for such solutions.

In making analyses of the soluble constituents contained in the Columbus Marsh muds ammonium chloride was at first used as an agent to clarify the solution so that it could be more readily filtered. By this method, however, from 1 to 10 times as much soluble matter and from 2 to 40 times as much potassium is dissolved from the muds as is done if only pure water is used. Thus the results at first obtained in the laboratory seemed to indicate that rather an unusual proportion of potash was extractable from the Columbus Marsh muds, but after the matter had been more thoroughly studied it was

[1] Recalculated from statement of calculated salts as reported by Smith, Emery & Co.

found that the total potash actually present was comparatively uniform throughout the deposit. This ranged from 2.64 to 3.72 per cent of the dried sample, of which only a small part is extracted by pure water, while from 10 to 40 per cent is brought into solution with ammonium chloride. From this it is believed that much of the potash in such muds as these is held in loosely combined form, though the exact manner of retention is not known. It has long been recognized that clays selectively absorb potash, and this fact possibly offers the best explanation of the apparent disappearance of considerable quantities of potassium salts from natural solutions associated with muddy or clayey deposits.

Activity late in 1917 and early in 1918 indicated that some project was under way to utilize these muds as a possible sourse of potash, reference to which appeared in some of the technical journals. It is not known what the outcome of this work was or whether it is to be continued.

Some interesting claims have been made for Fish Lake Valley, which is near and probably was formerly tributary to Columbus Marsh. Locations have been made on and about a salt basin near what is known as The Crossing. Samples of two brines taken from holes in the deposit said to have been much diluted by rain waters are represented by the following analyses:

Analyses of saline liquor from Fish Lake Valley, Nev.

[As reported by private analyst. Calculated salts, moisture-free basis, percentage in soluble portion.]

	1	2
KCl	14.48	13.40
NaCl	50.69	54.00
Na_2SO_4	20.69	19.56
Na_2CO_3	11.38	9.78
$Na_2B_4O_7$	2.76	3.26
	100.00	100.00

Seven samples submitted to the Geological Survey have been analyzed for potash with the following results:

Partial analyses of brines and mud from Fish Lake Valley, Nev.

[W. B. Hicks, analyst.]

	Dissolved salts dried at 180° C. (percentage.)	Percentage of potash (K_2O) in dried salts.
1. Brine, SW. ¼ sec. 9, T. 1 N., R. 36 E	3.29	2.88
2. Brine, SE. ¼ sec. 26, T. 1 N., R. 36 E	1.14	.66
3. Brine, SE. ¼ sec. 23, T. 1 N., R. 36 E	.82	2.54
4. Brine, SE. ¼ sec. 15, T. 1 N., R. 36 E	15.24	1.91
5. Brine, SE. ¼ sec. 34, T. 1 N., R. 36 E	28.50	1.88
6. Brine, collected at Rhodes station	29.42	.45
7. Earthy salts, SE. ¼ sec. 27, T. 1 N., R. 36 E	75.70	.66

The quantity of soluble potash shown in these samples is not considered important, although samples 1 and 3 gave relatively high values for potash.

Reports of continued interest in the possibility of recovering potash from Silver Peak Marsh, Nev., have appeared from time to time in the local press. The salines of this marsh were investigated with special reference to potash by R. B. Dole in 1912. The record of this work is contained in United States Geological Survey Bulletin 530, pages 330–345. Silver Peak Marsh is an extensive salt deposit of the intermittent lake type, and borings indicate it to be made up of alternating layers of mud, salt, and gypsum. It is the concentration pan of a basin having an area of about 500 square miles, and the area of the surface of the salt and mud is about 32 square miles. The upper 5 to 20 feet of this deposit is composed of brown saline mud, which usually is crusted with a thin layer of white salt at the surface. This mud is filled with fine salt crystals and is permeated very slowly by water, although what moisture it does contain is strongly saline. The northeastern two-thirds of the dry lake pan is underlain at a depth of about 20 feet by beds of crystalline salt 5 to 15 feet thick, mixed with more or less clay. Besides these beds practically all other strata to a depth of 50 feet contain appreciable portions of salt, which readily dissolves in water percolated through them. The deposit, at present explored only to a depth of about 50 feet, seems to have been formed by the periodic evaporation of a saline lake and the deposition of salt beds, which were buried in silt such as is gradually washing into the basin from the surrounding region. Saturated brines from several of the borings showed on analysis the following composition, which is doubtless representative for the deposit:

Analyses of composite samples of brines from Silver Peak Marsh, Nev.

[W. Van Winkle, analyst.]

	1	2	3	4
Na	36.12	36.54	32.87	34.65
K	2.71	2.26	3.12	2.95
Ca	.67	.36	1.92	1.25
Mg	.24	.11	2.49	.04
Cl	59.37	59.01	57.35	60.11
SO_4	.88	1.70	1.30	.99
CO_3	.01	.01	.83	.01
SiO_2	....	.01	.12	....
	100.00	100.00	100.00	100.00
Total dissolved salts	27.88	26.40	4.28	23.34

1. Composite from samples from boring No. 3 at 15.5 feet and No. 6 at 21 and 40 feet.
2. Composite from samples from boring No. 11 at 27 and 35 feet and No. 12 at 10, 20, and 27 feet.
3. Composite from samples from boring No. 13 at 16, 31.5, and 40 feet.
4. Composite from samples from boring No. 14 at 11 and 17 feet.

The salts in these brines consist almost wholly of sodium and potassium chlorides, and in the central deposit they are mainly saturated solutions. The potash in the brine is not extraordinarily high in any test so far recorded, but the simple character of the solution might offer some inducement to anyone desiring to experiment with solar evaporation.

The existence of an outcropping ledge of rock salt in Tertiary deposits on one side of this basin is reported.

Groups of claims containing clay like that at Zabriskie and Shoshone, Cal., have been located in Ash Meadows, Nev., along the

California-Nevada State line. It is stated in a prospectus issued from the same source from which the Zabriskie-Shoshone enterprises originated that a stratum of brown, spongy clay encountered in numerous holes, the deepest of which was bored 38 feet, invariably carried 4 to 8 per cent of potash (K_2O). The potash in this brownish clay is stated to be over 90 per cent soluble in water. At some places, it is said, hard sedimentary rock was encountered carrying 3 to 9 per cent of potash which was only 35 per cent soluble in water but which became 86 per cent soluble after being exposed to the sun for 10 days. It is stated in the prospectus that samples have been taken from every one of the placer claims that go to make up 8,620 acres covered by locations and that on every claim potash was found in paying quantities. A long list of analyses is quoted showing potash determinations ranging from scarcely more than a trace to about 25 per cent. No confirmation has yet been obtained for any of these statements, and such claims need verification by someone experienced in the practical aspect of such potash ventures before too much reliance can be placed on them. The average amount of potash found in muddy sediments for the entire earth's surface has been computed to be 3.25 per cent.[1] Some materials that occur in large quantity contain much more potash than this, but it is very questionable whether many of these substances can be worked as commercial sources of potash.

Notices in the local press have announced the discovery and intended development of a supposed deposit of potash salts near Lovelocks, Nev. One description of the deposit states that it is about 7 miles north of Lovelocks, near Willard. Salts are found under cliffs where they have been protected and in one place are found under the soil, which has been taken as an indication that more may be found below. Samples sent to the laboratory of the Geological Survey consisted of siliceous, probably volcanic, rock incrusted and impregnated with sodium chloride and a very small amount of sodium sulphate containing scarcely more than a trace of potash. Determination on some of the salts scraped from these samples showed that of the salts scraped off 72.93 per cent remained after drying and igniting a water solution made from the sample and that 0.10 per cent of the dried soluble portion was potash (K_2O).

Other reports state that a potash property has been discovered about 8 miles northeast of Lovelocks, at the mouth of Coal Creek Canyon. A considerable number of samples from deposits near Lovelocks submitted to the Nevada State Mining Laboratory are reported to have been decomposed rhyolite containing traces of soluble potash but in no sample as much as 1 per cent. It appears, therefore, that soluble salts containing some potash may have been found in seams in these volcanic rocks, but that the finding of deposits of this sort large enough for commercial exploitation is rather unlikely.

A report on samples from these deposits is contained in the Los Angeles Times, August 13, 1917, as follows:

> Responding to the numerous inquiries received by the Times regarding the ores and minerals carrying potash near Lovelocks, Nev., we shall give you a quantitative analysis on the samples, as they are representative of the locality in question.

[1] Clarke, F. W., The data of geochemistry, 3d ed.: U. S. Geol. Survey Bull. 616, p. 28, 1916.

The rock (matrix) is altered rhyolite, and it analyzes 4.1 per cent water-soluble potash (K_2O). In the mass two crystals of sylvite were detected under the microscope, and these cubes were white in color, of vitreous luster, water-soluble, and of the composition of potassium chloride. Traces (twinned crystals) of the potassium calcium silicate, phillipsite, also appear under the microscope. The greater per cent of [soluble] potassium in the rhyolitic rock is that of sulphate, and sodium chloride is more or less present.

The locality was visited by Frank L. Hess, of the United States Geological Survey, July 17, 1917. Mr. Hess thinks that the face of the hills in this vicinity marks a fault zone containing evidence of extinct springs which may have altered the feldspar in the rhyolitic country rock, possibly freeing part of the potassium of the feldspar.

Samples of marls from a locality about 50 miles north of Las Vegas, Nev. (exact locality not specified), submitted as potash bearing, were tested in the United States Geological Survey laboratory giving results of possible significance. Although most of the samples carried very little water-soluble matter, the analysis of two of them yielded the following results:

Samples from unspecified locality near Las Vegas, Nev.

Sample.	As percentage of original sample.		As percentage of soluble portion.
	Total soluble salt dried at 180°C.	K_2O.	K_2O.
2	3.10	0.59	18.96
4	9.71	2.31	23.88

It seems unlikely that marl deposits carrying water-soluble salts of this character exist in sufficient quantity to make them worth exploiting. The deposits are in a rather inaccessible situation, and the matter has not been thought to be of sufficient promise to demand special investigation. The occurrence will be investigated if it can be arranged in conjunction with other work in the vicinity.

NEW MEXICO.

In the spring of 1917 the E. J. Longyear Co., of Minneapolis, Minn., drilled a deep well near Carlsbad, N. Mex., which was reported to contain unusual quantities of potash. Samples of salt from the saline layers encountered were submitted to the Survey and were found to be practically free from potassium salts. Later it was authentically stated by the chemist of the company that this reported discovery of potash was in error.

The Red Peaks potash prospect near Tucumcari was visited by a member of the Geological Survey. Samples of the water and of the underlying strata were collected and examined, but potash was not found in appreciable quantity.

The Toltec Oil Co., of Roswell, bored a hole to a depth of 3,120 feet in sec. 31, T. 8 S., R. 24 E., New Mexico principal meridian, in the "Red Beds" region of New Mexico. No notable content of potash salts were found in any of the brines or salt crystals encountered.

The American Tobacco Co., of Louisville, Ky., has investigated the waters of springs and lakes in the vicinity of Grant, N. Mex. Potash in appreciable quantity has been noted in some of these waters, though not in commercial quantity. The matter is worthy of further attention.

OKLAHOMA.

The drilling of deep holes near Alva, Gate City, Woodward, and Boise, Okla., in 1917 was watched with interest. The various saline zones were carefully sampled and tested by R. K. Bailey, of the United States Geological Survey, but no appreciable quantities of potash salts were discovered.

OREGON.

Preparations were made to carry out a process for separating potash from the brines in the pool known as Little Alkali Lake, in Alkali Valley, Lake County, Oreg. A sample from this pond taken in August, 1915, contained 10.63 per cent of dissolved matter (ignited residue), in which potash ran 3.25 per cent as potassium, or 6.19 per cent if calculated as potassium chloride. This is somewhat richer than many of the other natural brines found in the West. The deposit is small, but as the project was carefully planned it has evidently been estimated that a sufficient amount of potash might be recovered to make a profit from the enterprise by using an inexpensive method of recovering the salts. It is stated that some disagreement concerning the method of handling the matter led to the abandonment of the work after it was well under way.

The project for recovering soda and potash from Summer Lake, in Lake County, Oreg., is still being actively promoted. The water is an alkaline saline solution, the concentration of which varies considerably with the season but is usually about the same as that of sea water. The potash in the salts is only slightly more than in the salts of ordinary sea water, but it is conceivable that by solar evaporation concentrated liquors might be produced that could be worked for potash and other products. Little progress was made during 1917. The locality is at present far from railroad connections.

Notice appeared of the location of deposits known as the Swingle potash claims in T. 26 N., R. 16 E., northwest of Lake post office, in northern Lake County. Inquiry by correspondence has not elicited any further information concerning them.

A project for the utilization of Stinking Lake, in Harney County, south of Burns, has received considerable notoriety through the local press. Stinking Lake is a shallow body of water in Harney County, about 25 miles southwest of the town of Burns. It lies in the central part of T. 26 S., R. 28 E., between Silver Lake and Harney Lake. It is surrounded by sand dunes and low basalt-capped mesas. It is fed on its southern or western side by a large spring, the volume of which is about sufficient to account for normal evaporation on the surface exposed in this water body. It appears, therefore, that the saline constituents of this water body are derived by concentration of the dilute solution from springs in a shallow inclosed basin in the desert sands. An analysis made by a Portland chemist, first published in a nitrate prospectus, showed 2,626 grains per gallon of mineral salts (equivalent to about 4.5 per cent of dissolved solids) in a sample from the lake, of which a small percentage was reported as potassium nitrate. No confirmation seems to have been obtained of the presence of nitrate salts in the water. Samples of the liquor or water taken by the senior author of this paper in 1915 and analyzed by R. K. Bailey in the laboratory of the United States Geological Survey showed 7.18 per cent of total dissolved salts (dried at 180° C.), and in this dried residue potash was shown to be only 1.68 per cent as K_2O (2.68 per cent as KCl). In 1916 announcement was made[1] that the Stinking Lake fields were about to be developed and that machinery for a large plant had been ordered. A letter from the promoter of this enterprise stated that he had found 14.85 per cent solids in solution (a factor which will, of course, vary with the season) and that after a year of observation he had also found 14.85 per cent potassium chloride in the dissolved salts. The proposed plant, it was stated, was to produce caustic soda and potassium.

In March, 1917, a sample of liquor from Stinking Lake was shipped to a Buffalo firm that advertises as a testing laboratory and also has evaporation machinery for sale, and as the preliminary tests received hearty approval, an outfit of evaporators, driers, and a 600-horsepower Babcock & Wilcox boiler was ordered. However, before this apparatus reached the field it was diverted to other uses, and the project may now be considered in abeyance.

TEXAS.

As stated in the report on potash in 1916, the United States Geological Survey's deep boring at Cliffside, Tex., had reached a depth of 386 feet on January 1, 1917. The section given below includes both the summary for the work done before 1917 and of the operations to the end of the work on October 12, 1917, when a depth of 1,703 feet had been attained. The record of the salt and rock formations was anticipated in an estimate published by the Survey in a press bulletin, but no potash of special significance was found, although a great quantity of crystalline rock salt was penetrated.

Section of strata from log of United States Geological Survey boring at Cliffside, Tex.

	Thickness.	Depth to base.
	Feet.	*Feet.*
Soil and clay, surface deposits	15	15
Tevocas shale (Triassic):		
Clay, variagated, white, and bright yellow	85	100
Quartermaster formation (Permian):		
Clay, mostly red, with some nodules of lime	80	180
Dolomite; compact strata separated by a stratum of red clay	15	195
Shales, brick-red, sandy, with several strata of gypsum in lower part	65	260
Sandstone, brick-red, and red shale in alternating strata	70	330
Gypsum and red sandy clay	30	360
Sandstone and shale, predominating brick-red color	118	478
Greer formation (Permian):		
Limestone, siliceous	10	488
Limestone dolomitic, and anhydrite	22	510
Clay, red, sandy, mottled with gray, containing some gypsum	50	560

[1] Burns Tribune, Oct. 25, 1916.

Section of strata from log of United States Geological Survey boring at Cliffside, Tex.—Continued.

	Thickness	Depth to base.
Beds as yet undifferentiated stratigraphically:	*Feet.*	*Feet.*
Sandstone	22	582
Limestone and anhydrite	6	588
Clay red, sandy	73	661
Anhydrite	4	665
Clay, darkbrown and red, sandy beds and salt	78	743
Salt	16	759
Anhydrite, limestone, clay, and some salt	20	779
Salt	40	819
Anhydrite	16	835
Anhydrite and limestone in thick beds, with some clay	137	972
Salt and anhydrite	24	996
Salt	33	1,029
Salt and anhydrite	8	1,037
Salt	21	1,058
Anhydrite and limestone, with thin beds blue clay	58	1,216
Salt with red clay intercalated strata	99	1,215
Salt	98	1,313
Limestone and some anhydrite between blue clay beds	79	1,392
Salt	48	1,440
Limestone, anhydrite, intercalated sandstone, clay and salt	130	1,570
Clay, red, with intercalated beds of anhydrite and limestone	133	1,703

It is thought, however, that at least 350 feet below the depth reached thick salt beds, alternating with strata of anhydrite and red shale or clay, would be passed if the hole were sunk deeper, beyond which there is not at present a very good basis for prediction, although the massive salt beds may continue much deeper.

The chemical tests on samples from this well have shown no significant quantity of potassium. The following analyses of saturated brines taken from the well during the drilling as noted are given for illustration:

Analyses of brine samples from well at Cliffside, Tex.

[R. K. Bailey, analyst.]

Depth.	Percentage of salts dissolved.	Percentage of potash (K_2O) in soluble portion of sample.
Feet.		
755- 760	26.72	0.07
805- 810	26.63	.07
1,026-1,030	27.71	.06
1,035-1,044	26.48	.14
1,135-1,140	26.25	.17
1,208-1,213	26.28	.24
1,220-1,225	26.45	.82
1,240-1,245	26.17	.83
1,272-1,276	26.10	.37
1,430-1,440	26.34	.36
1,466-1,473	26.36	.40
1,473-1,475	26.28	.25
1,525-1,530	26.73	.23
1,605-1,612	26.59	.45
1,665-1,670	26.22	.65
Average	26.49	.34

This average is equivalent to only 0.09 per cent of potash (K_2O) in the original brine, which is small as compared with an average of 0.59 per cent in 14 saturated chloride brines from Death Valley, Cal.; 1.24 per cent in saturated chloride brine from Salduro, Utah;

1.62 per cent in saturated chloride, sulphate, and carbonate liquors from Soda Lake, San Luis Valley, Colo.; and 2.50 per cent in the saturated chloride, carbonate, and sulphate liquor of Searles Lake, Cal.

The negative results obtained from this one well should not be a discouragement to drillers in looking for potash elsewhere in this general region or deeper in this same vicinity, as it is entirely possible that potash-bearing zones may be struck at any time in association with thick salt deposits in the United States and may prove a valuable asset when found.

UTAH.

Sevier Lake, Millard County, Utah, has been prospected as a possible source of valuable potash salts. Rumor of rich potash-bearing waters in the vicinity of Deep Springs, south of Wendover, remains unconfirmed.

WASHINGTON.

The International Chemical Co. of Seattle (Inc.) advertises salts of various kinds, including potash salts, derived from some of the soda lakes of Washington, but little information has been obtained concerning these claims.

WYOMING.

Published analyses[1] of the Hot Springs at Thermopolis, Wyo., state that this water contains potash equivalent in potassium chloride to about 8 per cent of the total salts. A sample of the water from the main spring at the bathhouse, known as the Big Horn Hot Springs, was taken recently by one of the members of the Geological Survey and analyzed in the Survey laboratory at Washington, but failed to confirm this result. Total salts (ignited residue) in this sample were found to be 0.22 per cent of the original weight of the water sample and the potash (K_2O) to be 3.57 per cent of the dried salts, equivalent to 5.64 per cent if figured as potassium chloride. It has been argued that high potash reported in this spring water and in the spring water at Demars Hot Spring, near Cody, indicate some potash-rich concentration in the deposits through which these waters pass. The clue is a very slight one and is not thought worthy of special attention, unless some more tangible evidence is offered.

POTASH FROM ALUNITE.

NATURE OF ALUNITE.

Alunite is a hydrous basic sulphate of potassium and aluminum (K_2O, $3Al_2O_3$, $4SO_3$, $6H_2O$) and when pure has the following percentage composition:[2] K_2O, 11.40; Al_2O_3, 37.00; SO_3, 38.60; H_2O, 13.00. It is usually contaminated with silica and other impurities and often has a part of its potash replaced by soda. It is widely disseminated through porphyritic volcanic rocks as an alteration

[1] Fisher, C. A., U. S. Geol. Survey Prof. Paper 53, p. 62, 1906.
[2] Dana's System of mineralogy.

product of feldspars, but it usually occurs in such small quantity or is contaminated with so much gangue material that it has no commercial value.

Extensive deposits of high-grade alunite occur in the vicinity of Tolfa, Italy, where they have been utilized in the manufacture of potash alum since the thirteenth century. The only occurrence of alunite in the United States that has been demonstrated to be of sufficient purity and massive form to warrant development as a source of potash is found in the Tushar Mountains at the head of Little Cottonwood Canyon, a few miles southwest of Marysvale, Utah.[1] Other alunite deposits, notably those near Sulphur, Nev., and Rico, Colo., have attracted considerable attention and may eventually become productive.

Alunite contains potash and alumina in an insoluble combination. On ignition the water and a part of the sulphur trioxide are driven off, the potash is rendered soluble in the form of potassium sulphate, and the alumina remains insoluble. The completeness of this decomposition reaction depends on the temperature of ignition and on the purity of the alunite. Waggaman and Cullen[2] found that calcination at 750 to 800° C. gave the best results for potash extraction and that ignition above 800° C. in the presence of silica rendered a portion of the potash insoluble.

PRODUCTION OF POTASH FROM ALUNITE.

Several processes,[3] most of which have not yet been used commercially, have been devised for the extraction of potash and alumina from alunite. Among these may be mentioned processes by Chappell, Cameron, Morgan, MacDowell, and Detwiler. The processes in present use require an alunite high in potash and low in silica, especially if alumina is to be produced as a by-product. Alunite in the Marysvale district, Utah, meets this requirement better than in any other known deposit and occurs in good quantity and form for extraction. Three companies operated in this field in 1917; one company produced a high-grade potassium sulphate, one marketed roasted alunite, and the third shipped raw alunite. The total output of potash material was 7,153 tons containing 2,402 tons of pure potash (K_2O), valued at $892,763.

The Mineral Products Corporation, which operates on the Gillan-Custer group of claims in the Marysvale district, is a pioneer in the production of potash from a mineral source. It uses the Chappell process of extraction,[4] which consist in calcining the alunite at 750° C., leaching the residue with water, filtering, and evaporating the solution. The product marketed is a refined sulphate containing about 50 per cent K_2O. The alumina, contaminated with a small amount of potash and other impurities, is stored for possible future use, the original intention of the company to utilize the alumina not having been realized, although experiments are being conducted with this end in view. The plant was in continuous operation from Janu-

[1] Butler, B. S., and Gale, H. S., Alunite, a newly discovered deposit near Marysvale, Utah: U. S. Geol. Survey Bull. 511, 1912. Loughlin, G. F., Recent alunite developments near Marysvale and Beaver, Utah: U. S. Geol. Survey Bull. 620, pp. 237–270, 1916.

[2] U. S. Dept. Agr. Bull. 415, 1917.

[3] Gale, H. S., Potash: U. S. Geol. Survey Mineral Resources, 1916, pt. 2, p. 117, 1917.

[4] Chapell, H. F., U. S. patent No. 1070324, 1913.

ary to October, 1917, when it burned, which delayed production for the remainder of the year. At present there is an unusual demand for sulphuric acid, but so far as known to the Survey no recovery of sulphuric acid has been made from the sulphuric anhydride volatilized in the treatment of alunite.

The Florence Mining & Milling Co. has claims located on the northern extension of the veins of the Gillan-Custer group west of Marysvale. It commenced roasting alunite in August, 1917, and the plant was in more or less continuous operation during the rest of the year. The product consists of calcined alunite said to contain about 16 per cent K_2O and was shipped to fertilizer manufacturers in Southern States for incorporation in fertilizers.

The Utah Potash Co. (Inc.), with offices in New York, shipped raw alunite during the year from the Santa Cruz claims for treatment at the reduction plant at Trenton, N. J., where the Detwiler process[1] for extraction of potash is intended to be used, but no production of manufactured salts was reported for the year. The claims are located east of Belknap siding, at the southwestern base of Twin Peaks, at an altitude of 6,450 feet, and are owned by the Utah Fertilizer & Chemical Co. The alunite occurs in a rhyolitic formation in a zone 200 feet wide, which extends in an east-west direction for about 1,000 feet. The better-grade material is quarried in large blocks from a section 60 to 70 feet wide and is hauled in wagons or motor trucks to Vaca siding on the Denver & Rio Grande Railroad for shipment.

MISCELLANEOUS DEVELOPMENTS IN MARYSVALE DISTRICT.

The Pittsburgh-Utah Potash Co. is reported to control large deposits of alunitized material on the north side of Deer Creek canyon, about half a mile west of Sevier River, and for 2 miles west toward its source. These are known as the American Flag, Potash King, Sly, and Pittsburgh group of claims. This company has constructed a railroad spur about 3,600 feet from the main line at Belknap siding to its mill site and has laid a pipe line from the mill site to a dam built on Deer Creek, which gives a 60-foot fall. During 1917 there were unloaded at the end of the railroad spur on the mill site a crusher and other equipment, but at last advices actual construction of the potash plant had not begun. Some development work was done on the American Flag group of 11 mining claims to the west and adjoining the mill site. Average samples taken from this property appear to be very siliceous in character. The Potash King group of 12 claims farther west is said to contain a better grade of potash rock. Little information is at hand to show the quality and availability of the ore for commercial utilization.

The Copper Butte potash claims are west of the property of the Pittsburgh-Utah Potash Co. and are of inferior appearance. The deposit is said to form a lens covering an area of 1,800 by 1,000 feet. A specimen of fine-grained alunite of good quality reported to have been taken from this property was sent to the Survey by Homer McCarty.

The American Smelting & Refining Co. owns the Yellow Jacket group of 12 claims near Twin Peaks and other property in the

[1] Met. and Chem. Eng., Oct. 1, 1917, p. 433.

Marysvale district, and is reported to have begun the construction of a plant at the end of 1917 or early in 1918 at Murray, Utah, to make potash alum from alunite. Production is said to have commenced in the early summer of 1918.

The Alunite Chemical Co. is said to be erecting a potash plant at East St. Louis, Ill. This plant is intended to treat 100 tons of alunite a day for the extracting of potash and alumina. It is planned to obtain raw alunite from the Wilson potash property, which lies within 1½ miles of Belknap siding in Antelope Hollow, in the Marysvale district. The alunite is to be mined, hauled by tramway to Belknap, and shipped to the plant in Illinois.

The Iron Cap (Krokti) claims are east of the Wilson potash property and are owned by Homer McCarty, of Richfield. Some development work has been done on this property, but no potash was shipped in 1917.

ALUNITE IN NEVADA.

The alunite claims[1] located by W. H. Goss and F. E. Kimberly early in 1917 and leased by the Alunite Co. of Nevada are located in the low hills about 3 miles from Sulphur, Nev., and about a mile south of the Western Pacific Railroad. They are readily accessible by an automobile road from Sulphur. The alunite is in veins that are nearly vertical, strike north, and cut a rhyolite tuff. Four such veins have been prospected, and other smaller veins are known to be present on the claims. The prospected veins vary considerably in width and show some tendency to wedge out within a short distance or to become zones of brecciation along the strike. Locally one of the veins attains a thickness of 13 feet, and the veins are commonly from 3 to 6 feet across. These alunite veins appear to be related to the surface deposits of sulphur that are on the gentle slopes above the alunite veins and that have been worked for many years.

The vein filling is chiefly a white, friable, finely crystalline alunite. Quartz is not abundant and is present chiefly in lenses or streaks near the walls. Hematite is present locally. A partial analysis of a sample of the chalky vein material, without visible quartz and of somewhat higher grade than the average vein filling, was made in the chemical laboratory of the United States Geological Survey, with the following results:

Composition of alunite from Sulphur, Nev.

[George Steiger, analyst.]

SiO_2	1.56
Al_2O_3 (includes a little Fe_2O_3)	37.00
MgO	.19
CaO	1.44
Na_2O	1.98
K_2O	9.54
SO_3	37.06
H_2O (by difference)	11.23
	100.00

[1] These data were supplied by E. S. Larsen, jr., of the U. S. Geological Survey, who visited the field in the fall of 1917.

These results indicate a fairly pure alunite that is reasonably high in potash. A considerable quantity of what appears to be of nearly as good grade as the sample analyzed can be considered as probable alunite, but further prospecting, sampling, and analyses would be required to establish the quantity and average grade of the ore. There are some reasons to suspect that the veins may not be persistent, but on the other hand more veins are likely to be found on further prospecting.

The Alunite Co. of Nevada reported a considerable amount of development work on the deposit in 1917 and shipped several carloads of ore for experimental purposes.

A specimen of alunite of fair grade was sent to the Survey from the vicinity of Beatty. The presence of alunite in this region is also mentioned by Knopf[1] in his paper on the cinnabar deposits in western Nevada, where it occurs in connection with the quicksilver deposits.

An alum property 14 miles north of Fenelon on the main line of the Southern Pacific Railroad, 20 miles east of Wells, has been reported. The following is a chemical analysis of material from this deposit:

Analysis of alum from deposit near Fenelon, Nev.

[Herman Harms, analyst.]

Aluminum sulphate	34.33
Iron sulphate	.03
Calcium sulphate	2.09
Potassium sulphate	9.93
Silica	.15
Water of crystallization	53.25
Undetermined and loss	.22
	100.00

Upon a water-free basis the mineral would contain 21.25 per cent of potassium sulphate (K_2SO_4). According to the analysis, the material is too high in water and too low in potash to represent a true potash alum.

ALUNITE IN COLORADO.

An endeavor was made during 1917 to interest capital in the development of the Calico Peak, Rico County, Colo., alunite deposits. According to A. E. Custer, a mining engineer of Salt Lake City, Utah, the entire peak has been altered into a quartz alunite of low potash content, with at least four veins or dikes which are composed of alunite of high potash content. Four samples taken from the Mammoth vein are reported to have given on analysis from 8.80 to 10.75 per cent K_2O. Analysis of a sample submitted to the Survey gave 6.04 per cent of total potash (K_2O).

POTASH FROM CEMENT DUST.

HISTORICAL NOTE.

Probably the first intimation of the value of the potash wasted in the dust from cement mills was made as early as 1904 by W. F. Hillebrand, now of the Bureau of Standards but at that time a mem-

[1] Knopf, Adolph, U. S. Geol. Survey Bull. 620, pp 59–68, 1916.

ber of the chemical force of the United States Geological Survey, as shown by the following extract from an article by Clifford Richardson:[1]

In the course of the investigations conducted by Dr. W. F. Hillebrand, at the request of the Committee on Uniform Methods of Analysis of Materials for the Portland Cement Industry, he found that when a raw mixture which contained 0.69 per cent of potash and 0.22 per cent of soda was ignited in a platinum crucible for one hour over an ordinary blast lamp, the resulting cement contained but 0.07 per cent of potash and 0.09 per cent of soda. The alkalies had been nearly completely volatilized and the potash more completely so than the soda.

It at once became of interest to determine whether the same thing took place in the industrial production of Portland cement clinker. It was found that from a raw mixture, made from marl and clay, which contained the percentages of alkalies mentioned above and which should, in consequence, contain 1.26 per cent of potash when burned if none of it was volatilized, since the loss on burning was 37.50 per cent, 0.65 per cent was carried off in the flue gases at the temperature of the rotary kiln. An investigation of the flue dust proved that the alkalies were carried further than the point where this material is deposited, and it is apparent that by conducting the gases through a long horizontal chamber where the temperature could be reduced to a point low enough to permit of the deposit of the potash, this could all be collected, perhaps aided by a spray of water or steam.

The importance of this discovery is apparent if a calculation is made of the actual weight of potash which is produced and lost in this way in a cement plant turning out 4,000 barrels a day, or 700 tons of material. Six-tenths of 1 per cent of this would mean 4.2 tons of potash, which now goes to waste, but which could be readily collected and have a value of at least $12 per ton, that of kainite with 12 per cent of potash, and with a probable value of $45 per ton, that of the commercial muriate used for fertilizing purposes. In the latter form our 4.2 tons of potash would be the equivalent of 6.6 tons of muriate, so that, allowing the excessive sum of $50 per day for the expense of the process and interest charges, the profit from a single plant of the size mentioned would be between $100 and $200 per day. It would seem that the development of the process would be of commercial interest.

In conclusion, it may be said that Dr. Hillebrand has an application pending for a patent covering it.

PRODUCTION IN 1917.

Eight cement mills reported production of potash salts or potash-rich dust sold as fertilizer during 1917. They marketed 13,582 tons of potash material containing 1,621 tons of pure potash (K_2O), valued at $700,523. In 1916 only two mills reported production. At least three distinct dust-collecting processes are in use—the Cottrell,[2] the Fleming,[3] and the Clarke.[4]

The Riverside Portland Cement Co., Riverside, Cal.,[5] which was the first cement mill to install the Cottrell dust-precipitating system, continued operations with an increased production in 1917. It now leaches the flue dust, evaporates the solution, and markets a high-grade potassium sulphate. For a time feldspar was incorporated in the raw mix in order to increase the perecentage of potash present, calcium fluoride was added to the raw mix to increase the amount of potash volatilized and was later recovered. Much of the potash in flue dust is only slowly soluble in water. A process of leaching

[1] Some possible by-products in the Portland cement industry: Am. Soc. Testing Materials Proc., vol. 4, p. 465, 1904.

[2] Bradley, L., Cottrell process in practice: Met. and Chem. Eng., vol. 16, p. 336, 1917.

[3] Hanna, W. C., Am. Inst. Chem. Eng. Trans., vol. 8, p. 65, 1915.

[4] Cement Era, August, 1917, p. 53.

[5] Huber, F. W., Reath, F. F., and Treanor, J., Concentrated potash a by-product of cement mills: Eng. News-Record, vol. 78, p. 630, 1917; Met. and Chem. Eng., vol. 16, p. 701, 1917.

and filtering at 85° C. has been developed whereby all the potash is said to be extracted and only about 5 per cent remains in the filters. The improvements are reported to have resulted in a volatilization of 90 per cent, 80 per cent of which is caught with the flue dust. Ninety-five per cent of the potash in the dust is recovered, making a final saving of about two-thirds of the potash in the raw mix.

The Security Lime & Cement Co.,[1] of Hagerstown, Md., was the second cement mill to install the Cottrell dust-collecting system for the recovery of potash. In 1917 it marketed a large quantity of flue dust containing from 4.5 to 9 per cent of soluble potash (K_2O) for incorporation in fertilizer. It adds about 1 per cent of salt to the raw mix in order to increase the amount of potash volatilized. The best recovery of potash is secured coincidently with the best-burned clinker, and the operation of the potash plant has been the means indirectly of increasing the production of cement clinker and also of fuel economy.

The Alpha Portland Cement Co. has installed the Cottrell dust-precipitating system in the plant at Alsen, N. Y. It placed on the market in 1917 flue dust containing soluble potash for incorporation in fertilizers. The company contemplates the installation of a leaching and concentration plant to recover the potash in the form of a high-grade sulphate.

The Coplay Cement Manufacturing Co., at Coplay, Pa., had completed the installation of a Cottrell dust-collecting system at the end of 1917. It made a small initial production of flue dust during the year.

The California Portland Cement Co., Colton, Cal., has installed the Fleming dust-collecting system for the recovery of potash.[2] The dust and gases from the flues are sent into large settling chambers, where the velocity of the gases is greatly reduced and much of the dust settles. The gases then go to wet washers, where they are forced up and down, following a serpentine course through a system of seven baffle chambers supplied with sprays of water. By this treatment the potash is dissolved. The solution is then evaporated and potassium sulphate is obtained.

The Santa Cruz Portland Cement Co., Davenport, Cal., has installed a potash plant said to be of its own design. It markets a high-grade potassium sulphate.

The Southwestern Portland Cement Co. has installed a potash plant at Victorville, Cal., and markets a high-grade potassium sulphate. The Clarke dust-collecting system, which consists in cooling the gases to 200–250° F. and passing them through suction filters, is used.

The Atlas Portland Cement Co. has marketed a large quantity of flue dust carrying about 6 per cent of soluble potash. No dust-collecting system is used by this company, and the product marketed represents the dust gathered under kiln stacks in the plants at Northampton, Pa., and Hannibal, Mo.

The Louisville Cement Co., with headquarters at Louisville, Ky., undertook investigations covering the possibility of saving potash at

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[1] Porter, J. J., The recovery of potash as a by-porduct in the manufacture of cement; paper presented at the fall meeting of the Portland Cement Association, Chicago, September, 1917.

[2] Hanna, W. C., Am. Inst. Chem. Eng. Trans., vol. 8, p. 65, 1915.

its plant at Speeds, Ind., about the middle of 1917. An installation for separating and saving the richer potash-bearing dust by a combination wet and dry process was developed by H. E. Brookby. The operations during 1917 were chiefly experimental.

The product marketed by four of the cement mills producing potash was in the form of potassium sulphate, which contained about 39 per cent of potash (K_2O). It was obtained by leaching the dust with water and evaporating the solution. It represents nearly half the production from cement works.

The product from the other four producing plants was sold in the form of flue dust for incorporation in fertilizers. It contained from 2½ to 9 per cent of water-soluble potash (K_2O) as potassium sulphate and also a considerable amount of potash that is only slowly soluble in water. This potash is probably partly in the form of a silicate resulting from a recombination of the potash with flue dust or ash, especially where coal is used as fuel, and partly as the mineral syngenite, a double sulphate of calcium and potassium ($CaK_2(SO_4)_2H_2O$).[1] A large part of the slowly soluble potash goes into solution when heated with water under pressure,[2] or when boiled for several hours, or after long digestion with cold water. Lime and moist soil promote its solubility.[3] Hence it is considered to be available for plant growth.

PROSPECTIVE PRODUCTION.

The production of potash as a by-product in the manufacture of cement has been continuous for more than two years, and the industry is fast emerging from the experimental stage. At the end of 1917 arrangements had been made for the installation of Cottrell dust-collecting systems for the recovery of potash in the following cement mills:

Dexter Portland Cement Co., Nazareth, Pa.
Ironton Portland Cement Co., Ironton, Ohio.
Clinchfield Portland Cement Co., Kingsport, Tenn.
Newaygo Portland Cement Co., Newaygo, Mich.

The first three plants named had already begun construction, and production was expected about the middle of 1918.

Data are not at hand to show what developments have been made in the use of the Fleming, Clarke, or other processes in the recovery of potash as a by-product from cement works. However, much investigative work has been done by cement companies throughout the country looking toward a recovery of potash, and it is probable that other plants not mentioned will be producing potash in 1918.

In 1914 there were 110 cement-producing plants in the United States with an annual capacity of about 90,000,000 barrels. W. H. Ross[4] and others of the Bureau of Soils have made a careful study of the potash content of the raw mixed and clinker and of the operating conditions in nearly all the cement plants in the United States and Canada with the view of determining the quantity of potash recoverable from the dust from these plants. Their conclusion is that

[1] Huber, F. W., Reath, F. F., and Treanor, J., Concentrated potash as a by-product of cement mills: Eng. News-Record, vol. 78, p. 630, 1917.
[2] Ross, W. H., Jour. Ind. and Eng. Chemistry, vol. 9, p. 467, 1917.
[3] Nestell, R. J., and Anderson, E., Nature of cement-mill potash: Jour. Ind. and Eng. Chemistry, vol. 9, p. 646, 1917.
[4] U. S. Dept. Agr. Bull. 572, 1917.

under the present operating conditions about 1.65 pounds of potash is recoverable in available form for each barrel of cement produced, representing a total annual recovery of nearly 75,000 short tons of potash (K_2O), and that by changing the operating conditions slightly so as to increase the proportion of potash volatilized to 65 per cent of that charged into the kilns the quantity recovered could be increased to 100,000 tons.

The cost of producing potash as a by-product in the manufacture of cement, not including royalty and depreciation, has been estimated by Porter[1] to be about $30 a ton of pure potash (K_2O). Under normal conditions the cost might be reduced 50 per cent. Treanor[2] thinks the cost of production might run as high as $100 a ton of potash ($K_2O$) during the first month of operation; $40 during the first year; and that the cost could be reduced ultimately to $20 or $10 a ton. Experience in the industry and improvements in the processes are expected to continue to reduce the cost of production.

Careful estimates[3] indicate that the cost of installing a Cottrell dust-collecting system, together with leaching and evaporating systems, for a cement mill of 1,000,000-barrel annual capacity is approximately $150,000. Accordingly for all the cement mills of the United States with an annual production of 90,000,000 barrels of cement, the cost would be about $13,500,000, which would represent an investment of about $150 to $200 for each ton of potash produced annually. In other words, estimates indicate that $13,500,000 invested in potash plants in connection with cement mills would produce in the neighborhood of 70,000 to 100,000 tons of potash (K_2O) annually.

The cost of producing potash from the German mines before the war was about $20 a ton of muriate, corresponding to $40 a ton of potash ($K_2O$). Estimates[4] indicate that there is invested in German potash mines about $140 to $150 for each ton of potash (K_2O) produced annually. Although the investment in the domestic cement plants would thus be relatively larger, the foregoing data on cost of production indicate that domestic potash from cement mills may be reasonably expected to compete successfully with German potash when importation has been resumed.

POTASH FROM BLAST FURNACES.

Three steel companies—the Bethlehem Steel Co., South Bethlehem, Pa.; the Thomas Iron Co., Hokendauqua, Pa.; and the Tennessee Coal, Iron & Railroad Co., Birmingham, Ala.—marketed blast-furnace dust for its potash content in 1917. The product contained from 6 to 9 per cent of water-soluble potash and represented merely the dust that settles in stoves and boiler flues, where the blast furnace gases are finally consumed.

In a comprehensive paper on potash as a by-product from the blast furnace, Wysor[5] estimates that in the Bethlehem steel plant 22.4

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[1] Porter, J. J., op. cit.

[2] Treanor, J., The experience of the Riverside Portland Cement Co. in the recovery of potash from cement flue dust; paper presented at the annual meeting of the Portland Cement Association, Dec. 11, 1917.

[3] According to Treanor (op. cit.) the total cost would be in the neighborhood of $100,000, and according to Meade (Met. and Chem. Eng., vol. 17, p. 84, 1917) the total cost, including the installation of waste-heat boilers, would approximate $300,000.

[4] Meade, R. K., The possibilities of developing an American potash industry: Met. and Chem. Eng., vol. 17, p. 87, 1917. MacDowell, C. H., German and other sources of potash: Am. Inst. Min. Eng. Trans., vol. 51, p. 427, 1915.

[5] Wysor, R. J., Am. Inst. Min. Eng. Bull. 121, pp. 1–32, January, 1917.

pounds of potash are charged into the furnace for each ton of pig iron produced, but considers that quantity above the average for the country. Catlett[1] thinks that by selection of raw materials the potash content of the charges of some blast furnaces could be increased far beyond that reported at Bethlehem. If 20 pounds of potash (K_2O) per ton of pig iron produced, which appears to be a reasonable estimate from the data at hand, is an average of the whole iron industry of the United States, then 380,000 tons of potash (K_2O) was charged into blast furnaces in the production of 38,000,000 tons of pig iron in 1917. A 50 per cent recovery, which is moderate compared with what some cement mills are doing, would result in the production of 190,000 tons of potash, or nearly 80 per cent of our normal consumption.

The problem of potash recovery in blast-furnace dust deserves careful and systematic study because of the enormous quantity of volatilized potash now going to waste. This source may eventually produce a substantial part of our supply, but it is not likely to yield a large quantity in 1918.

POTASH FROM SILICATE ROCKS.

INTRODUCTION.

The possible recovery of potash salts from silicate rocks still commands attention, though no output from this source in 1917 was reported to the Geological Survey. Many processes have been devised for extracting potash from silicates, and considerable experimental work on a comparatively large scale has been done to demonstrate the practicability of some of these processes, but so far only a very small production from raw materials of this class has actually been made.

It has been generally assumed that there are three essential points to a successful commercial recovery of potash from silicate rocks—an enormous quantity of raw material, a specific use for the residue after extraction of the potash, and the proximity of an almost unlimited market for the product made from the residue. This combination of conditions is not easily attained, and, so far as known by the United States Geological Survey, the only practical utilization of silicate rocks as a source of potash to the end of 1917, was their incorporation into the raw mix fed to cement kilns. It is of interest to note in this connection that this contention that some byproduct is essential to enable profitable recovery of potash from silicates is not universally accepted, and much work is being done apparently with a view to the extraction of potash alone.

AVAILABLE SUPPLY OF POTASH-RICH SILICATE ROCKS.

Among the raw materials to be considered in this connection are the deposits of greensand[2] (glauconite) in New Jersey, Delaware, and Maryland, which carry about 7 per cent of potash; the feldspar deposits from Maine to North Carolina;[3] the potash-bearing rocks of

[1] Catlett, Charles, Potash from Alabama gray ores: Manufacturers' Rec., Mar. 29, 1917, p. 49.

[2] Ashley, G. H., Notes on the greensand deposits of the eastern United States: U. S. Geol. Survey Bull. 660, pp. 27–58, 1917.

[3] Bastin, E. S., U. S. Geol. Survey Bull. 420, 1910. Watts, A. S., Bur. Mines Bull. 53, 1913; Bull. 92, 1916.

the Leucite Hills in Sweetwater County, Wyo.,[1] which carry about 10 per cent of potash; sericites and slates of Georgia, said to contain about 9 per cent of potash;[2] and the tailings[3] collected in certain dumps at copper and gold mines in the West, which carry probably from about 5 to possibly as high as 10 per cent of potash. Feldspar often contains from 10 to 14 per cent of potash (K_2O), but a series of analyses (unpublished) by the United States Geological Survey indicates that the average quarry product rarely contains over 7 to 7.5 per cent.

No estimates of quantity for feldspar and sericite are available, but the quantity of these materials is known to be very large. Washington[4] estimates the potash in the greensands of New Jersey at 2,034,000,000 metric tons. Schultz and Cross estimated the potash in the Leucite Hills at 197,000,000 tons. Butler's figures indicate that in 1914 more than 100,000,000 tons of mill tailings had accumulated in the dumps at copper and gold mines and that many hundred million tons of unmined ore had been developed. These data are sufficient to show the magnitude of the supply of this class of raw materials.

SPECIAL ACTIVITIES IN 1917.

FELDSPAR.

The North American Reduction Co., Milwaukee, Wis., has an experimental plant for the extraction of potash from feldspar by the Gillen process,[5] which consists in heating finely ground feldspar with a solution of the hydroxide or carbonate of sodium or potassium, adding a borate, and precipitating the silica with carbon dioxide.

The International Feldspar Co., with offices at 52 Broadway, New York City, is said to own about 900 acres of feldspar land on Connecticut River above Middletown, Conn. It is affiliated with the Potash Extraction Co., 2 Rector Street, New York City, which controls the Glaeser patents. These companies conducted experiments at Fullerton, near Allentown, Pa., in 1917, on the extraction of potash from feldspar by the process invented by Walter Glaeser.[6] The average extraction of water-soluble potash is reported to have been more than 90 per cent of the total potash contained in the raw material.

The Rush Chemical Co., of Benwood, W. Va., claims to have perfected a process for extracting potash from feldspar, using caustic soda and causic potash as reagents. The product is said to be a high-grade potash particularly suited for use in optical glass and for work where pure potash is required.

The Advance Chemical Co., Pittsburgh, Pa., has built a small experimental plant for the extraction of potash from feldspar and is planning to erect a commercial unit in the near future in the vicinity of Buffalo, N. Y. Details of the process are not divulged.

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[1] Schultz, A. R., and Cross, Whitman, Potash-bearing rocks of the Leucite Hills, Wyo.: U. S. Geol. Survey Bull. 512, 1912.
[2] McCallie, S. W., Eng. and Min. Jour., vol. 104, p. 643, 1917.
[3] Butler, B. S., Potash in certain copper and gold ores: U. S. Geol. Survey Bull. 620, pp. 227-236, 1916.
[4] Washington, H. S., Italian leucite lavas as a source of potash: Met. and Chem. Eng., vol. 18, p. 71, 1918.
[5] Gillen, F. C., U. S. patent 1215517, Feb. 13, 1917.
[6] U. S. patents 1237197, Aug. 14, 1917, and 1239787, Sept. 11, 1917.

GLAUCONITE.

The Kaolin Products Corporation[1] (name changed to the American Potash Corporation) continued operations at its experimental plant at Jones Point, N. Y., and claims to have solved the difficulties of extracting potash on a commercial scale from the greensand of New Jersey, though this company did not report a production of potash in 1917. The plant has a capacity of about a ton of potash a day. The process consists in digesting under pressure finely ground greensand with lime and water, thereby obtaining very pure caustic potash and at the same time converting the residue into a material of value used as agricultural lime or in the manufacture of brick, tile, and artificial stone.

F. Tschirner has conducted experiments on a rather large scale in demonstrating the commercial feasibility of his process for the extraction of potash from glauconite. In the summer of 1917 experiments at Yorktown, Va., in the presence of members of the Geological Survey showed an extraction of 70 to 80 per cent of the potash present. The process consists in heating greensand, lime, and salt in a rotary kiln, and leaching out the potash salts from the clinker with water.

Edward Hart, of Easton, Pa., has developed a process of treating glauconite whereby 80 per cent potassium chloride is obtained, the iron is completely removed, and the bulk of the residue is silica containing about 2 per cent potash. The chemical operations are said to be simple. Patents are pending, and negotiations are in progress for putting the process into commercial operation.

Considerable experimental work has been done by William Miles, of Atlantic City, N. J., and others, in developing a secret process for the extraction of potash from potash-bearing silicates, such as greensand and the muds of Columbus Marsh, Nev. At the close of 1917 plans were reported to be about ready for the construction of the first commercial unit of a plant to utilize greensand.

The Atlantic Potash Co. (Inc.), with offices in New York City, was organized early in 1917 to produce potash from greensand by the process invented by G. F. von Kolnitz.[2] It has mined a considerable amount of greensand at Marlton, N. J., and has extracted the potash therefrom in its experimental plant at Stockertown, Pa., in demonstrating the commercial feasibility of the process, which consists in preheating greensand as it comes from the mine to 350° C., mixing it with calcium chloride, passing the mixture through a furnace at about 850° C., leaching the product, and finally obtaining potassium chloride by evaporation and crystallization.

W. T. Hoffman, Birmingham, N. J., is reported to have sold 318 tons of greensand in 1917 for experimental purposes in connection with potash investigations.

LEUCITE.

Interest in the possibility of extracting soluble potash salts from the leucite rocks of Wyoming was renewed in 1917. A firm consisting of T. W. Boyer and Guy Sterling, of Salt Lake City, claims to

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[1] Charlton, H. W., Jour. Ind. and Eng. Chemistry, vol. 10, p. 6, 1918.
[2] U. S. patent 1201396, Oct. 17, 1916.

have perfected a process which is so inexpensive that nothing but the potash salts need be utilized. An experimental plant with a capacity of about 500 pounds of 70 to 80 per cent potash is in operation in Salt Lake City. Plans are drawn for the erection at the deposit of leucite of the first unit of a commercial plant, provided a lease covering the land desired is granted to this company. In this process the leucite is ground to pass about a 30-mesh sieve, mixed thoroughly with some reagent, and run through a rotary cement kiln, and the fumes are collected. The clinker is discarded.

MILL TAILINGS.

The Vindicator Consolidated Gold Mining Co. has conducted many experiments, using various methods in efforts to recover the potash from its mill dump at Victor, Colo. The dump contains about 2,000,000 tons of tailings, which are rather coarse, but which are being crushed to 40-mesh for flotation treatment.

The Morse Bros. Machinery Co., Denver, Colo., which owns the dumps at Florence and Manitou, Colo., has done a large amount of experimentation with the Hopkins process[1] of heating with dry caustic alkali in efforts to render the potash soluble. The Manitou dumps contain between 2,000,000 and 3,000,000 tons of tailings, and the two dumps at Florence about 600,000 tons.

The Portland Gold Mining Co., Colorado City, Colo., has nearly 2,000,000 tons of mill tailings on the dumps. This company is taking up the problem of recovery of the potash from these tailings.

SERICITE AND SLATE.

The State geologist of Georgia[2] has described a slate deposit near White station, Bartow County, Ga., which is 6 miles long, a quarter of a mile wide, and 300 feet thick. The deposit is composed almost entirely of an intimate mixture of sericite and feldspar and contains about 9 per cent of potash. Two companies are interested in this deposit. The American Potash Co., of Atlanta, Ga., shipped about six cars of material to its experimental plant at Portland, Ga., for treatment in 1917. The Vithumus Co., Norfolk, Va., did a considerable amount of prospecting, but so far as known made no shipments.

Experimentation on the slates of Polk and Montgomery counties, Ark., is reported. An average of 60 analyses is said to show 4.96 per cent of K_2O. About 20 tons of rock have been handled in these experiments, which have been conducted near Carnegie, Pa. An extraction of about 70 per cent of the potash is reported. The process consists of treatment with acid, leaching, and evaporation, but little detail of the process is given. A brick and tile by-product is to be made from the residue.

PATENTS.

Many other processes have been devised for the extraction of potash from silicate rocks, some of which were subjected to experimental tests in 1917, while others were inactive as a result of litiga-

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[1] Frazer, J. C. W., U. S. patent 1196734, Aug. 29, 1916.
[2] McCallie, S. W., Eng. and Min. Jour., vol. 104, p. 643, Oct. 13, 1917.

tion or other causes. The more important of these processes were described or mentioned in the chapter on potash salts for 1916. A list of patents covering such processes is given below.

The processes are best represented by patents that have been granted. Actual tests of a few of the proposed processes have been made, and the results have been discussed in the technical journals. Any of these processes that may be put into actual use will doubtless be modified through the experience gained in its practical operation. The patents listed below are arranged under three classes. Printed copies of these patents may be obtained from the United States Patent Office for 5 cents each.

1. United States patents for treating silicates, by other means than furnacing, for possible subsequent extraction of potash salts.

772206, Oct. 11, 1904, Blackmore, H. S. Feldspar is heated, cooled, mixed with water and subjected to action of carbon dioxide.

772612, Oct. 18, 1904, Gibbs, W. T. Powdered feldspar is boiled with sulphuric and hydrofluosilicic acids.

772657, Oct. 18, 1904, Gibbs, W. T. Powdered feldspar is treated with hydrofluosilicic acid. (*See* Jour. Ind. and Eng. Chemistry, vol. 4, p. 377, May, 1912.)

851922, Apr. 30, 1907, Cushman, A. S. Potash is recovered by electrolysis. (*See* Am. Chem. Soc. Jour., vol. 30, p. 779, 1908.)

910662, Jan. 26, 1909, Gibbs, W. T. Silicates are digested with milk of lime under steam pressure to obtain caustic potash.

947795, Feb. 1, 1910, Coates, L. R. Silicates are broken up by use of bacterial cultures.

993463, May 30, 1911, Schäcke, F. Eruptive rocks carrying at least 4 per cent of potash are finely ground and mixed with lime and other material to form manure.

1029378, June 11, 1912, Lawton, C. F. Crushed feldspar, etc., is mixed with organic material and fermented to liberate plant food.

1030122, June 18, 1912, Peacock, Samuel. Feldspar is ground and after being strongly heated is treated with concentrated solutions of potassium or sodium carbonate under low pressure.

1036879, Aug. 27, 1912, Peacock, Samuel. Alkali aluminate derived from feldspar is treated with carbon dioxide and potash is separated by digestion.

1054518, Feb. 25, 1913, Doremus, C. A. Feldspar is treated with hydrofluoric acid to form potassium silico-fluoride (?) and a soluble aluminum compound, and the residue is treated with sulphuric acid.

1076508, Oct. 21, 1913, Messerschmitt, A. Feldspar powdered with calcium nitrate, water, and lime is digested under pressure to obtain potassium nitrate.

1083691, Jan. 6, 1914, McIlliney, P. C. Alumina is separated from feldspar, potash being obtained as a by-product.

1148156, July 27, 1915, Dougherty, E. E. Leucite is treated with sulphuric acid and hydrochloric acid.

1174795, Mar. 7, 1916, Anderson, E. L. Feldspar is decomposed with small amounts of hydrofluoric acid in the presence of sulphuric acid.

1182668, May 9, 1916, Firebaugh, F. L. Nepheline, leucite, and other minerals are leached with sulphuric acid.

1197556, Sept. 5, 1916, Slater, H. B. Alkali, particularly potash, is obtained from minerals or mineral residues by electrolysis, in a solvent rich in chlorides.

1215517, Feb. 13, 1917, Gillen, F. C. Ground potash rock is heated under pressure with water and a fixed alkali hydrate. An alkaline borate is added and carbon dioxide passed through the solution to precipitate the silica.

1215518, Feb. 13, 1917, Gillen, W. H. Ground potash rock is heated under pressure with water, an alkaline borate, and a fixed alkali hydrate, and carbon dioxide passed through the solution.

1220989, Mar. 27, 1917, Huber, F. W. and Reath, F. F. Flue dust is leached with water at a temperature of 90°–100°.

1232452, July 3, 1917, Richardson, W. D., assignor to Swift & Co. Ground potash rock, phosphate rock containing a fluoride, and sulphuric acid are mixed, placed in a dump, and allowed to stand for some time.

1233273, July 10, 1917, Jackson, L. L. The silicate is heated with calcium oxide and water under pressure.

1234626, July 24, 1917, Charlton, H. W., assignor to Kaolin Products Corporation. Greensand is heated with milk of lime, and a solution of $CaCl_2$ under a pressure of about 150 pounds.

1234905, July 31, 1917, Kalmus, H. T., assignor to the Exolon Co. Nephelin-syenite is digested with a 2 per cent solution of SO_2, and the potash, etc., is obtained in solution.

1237488, Aug. 21, 1917, Doremus, C. A., assignor to J. S. Hoyt, process for obtaining aluminum fluoride from feldspar. Feldspar is decomposed with Aq. HF at about 50° C. to form an insoluble fluosilicate of the alkali metals.

1249708, Dec. 11, 1917, Anderson, Evald, Assignor to International Precipitation Co. Flue dust is exposed to steam above 100° C. to render a larger portion of the potash soluble..

2. United States patents for treating silicates by heat without volatilization of potash, which is recovered by leaching the frit.

5381, Dec. 4, 1847, Tilghman, R. A. Feldspar is treated with sulphate or muriate of another base.

16111, Nov. 25, 1856, Bickell, C. Feldspar, calcium phosphate, and lime are heated together in a furnace and leached or used for fertilizer.

43534, July 12, 1864, Vanderburgh, G. E. Ground feldspar and soda ash are vitrified and then digested with steam.

49891, Sept. 12, 1865, Klett, Frederick. Feldspar, lime, calcium fluoride, and phosphate of lime are heated to make fertilizer.

376409, Jan. 10, 1888, Kayser, A. Alumina is produced from clays and potash is separated as a by-product. (*See* Eng. and Min. Jour., vol. 94, pp. 535–536, 1909.)

513001, Jan. 16, 1894, Blackmore, H. S. Powdered feldspar, calcium chloride, lime, and water are heated under pressure.

521712, June 19, 1894, Heibling, J. Clay, ammonium sulphate, and potassium sulphate are heated together.

641406, Jan. 16, 1900, Rhodin, J. G. A. Feldspar, lime, and sodium chloride are heated together and then leached with acid. (*See* Soc. Chem. Industry Jour., vol. 20, p. 439, 1901.)

847856, Mar. 19, 1907, Wadman, W. E. Soluble lithia salts are obtained from lepidolite, potash alum being a by-product.

862676, Aug. 6, 1907, Swayze, A. J. Feldspar is first heated and is then treated with caustic potash under pressure.

869011, Oct. 22, 1907, McKee, R. H. Potash-bearing mineral containing mica is heated with lime and salt.

959841, May 31, 1910, Carpenter, F. R. Granite potash is made more soluble by heating and sudden chilling.

987436, Mar. 21, 1911, Cushman, A. S. Feldspar is decomposed by heating with lime, salt, and calcium chloride.

995105, June 13, 1911, Thompson, Firmin. Ground feldspar is heated with sodium acid sulphate and sodium chloride.

997671, July 11, 1911, Hart, E. Orthoclase is fused with barium sulphate and coal. (*See* Am. Ceramic Soc. Trans., vol. 13, p. 683, 1910, and Eighth Internat. Cong. Appl. Chemistry Trans., vol. 2, p. 117, 1912; Jour. Ind. and Eng. Chemistry, vol. 7, p. 679, August, 1915.)

1034281, July 30, 1912, Neil, J. M. Crushed feldspar is added to melted sulphate or bisulphate of alkali metal and fused.

1035812, Aug. 13, 1912, Peacock, Samuel. Ground feldspar and calcium carbonate are calcined and are then boiled with added soda or potash.

1040893, Oct. 8, 1912, Cowles, A. H. Mixture of feldspar and phosphate rock is ground and sintered, and is then leached with acid.

1040894, Oct. 8, 1912, Cowles, A. H. Crushed feldspar is added to melted sulphate or bisulphate of alkali metal and is then fused.

1040977, Oct. 8, 1912, Cowles, A. H. Similar process to 1040894.

1041327, Oct. 15, 1912, Morse and Sargent. Feldspar is heated with gypsum and, in a separate operation, with sodium chloride.
1041598, Oct. 15, 1912, Cowles, A. H. A mixture of feldspar and phosphate rock is sintered and is then treated with acid.
1041599, Oct. 15, 1912, Cowles and Kayser. Similar process to 1041598.
1046327, Dec. 13, 1912, Peacock, Benjamin. Silicates are heated with phosphate rock and are then treated with steam.
1058686, Apr. 8, 1913, Gelléri, S. Silicates are heated with lime and are then treated with vapor of ammonium carbonate under pressure.
1062278, May 20, 1913, Hart, Edward. Feldspar is heated with potassium or sodium sulphate and carbon, is then treated with acid, and yields potash alum.
1072686, Sept. 9, 1913, Bassett, H. P. A mixture of feldspar and salt is heated and is then leached with water.
1078495, Nov. 11, 1913, Gelléri, S. Silicates are treated with vapor of ammonium carbonate under pressure and yield alkali carbonate; various reagents are used.
1078496, Process similar to 1078495.
1083287, Jan. 6, 1914, Lindblad, A. R. Feldspar, iron, and charcoal are heated together.
1087132, Feb. 17, 1914, Messerschmitt, A. Alkali metal nitrates are prepared from the product obtained by decomposing silicates with limestone.
1089716, Mar. 10, 1914, Messerschmitt, A. Feldspar, limestone, and other materials are calcined and leached.
1091033, Mar. 24, 1914, Bassett, H. P. Ground feldspar is mixed with sodium acid sulphate, sodium chloride, and carbon and heated, and the product is leached with water.
1091034, Mar. 24, 1914, Bassett, H. P. Process similar to 1091033.
1091230, Mar. 24, 1914, Messerschmitt, A. Feldspar and by-product calcium carbonate are heated and then leached with water.
1095306, May 5, 1914, Bassett, H. P. Aluminous silicates are fused with carbonate and chloride of soda and the clinker is leached with water.
1103910, July 14, 1914, Willson and Haff. A mixture of feldspar and phosphate rock is fused, ground, and treated with sulphur dioxide.
1106984, Aug. 11, 1914, Stillman, T. B. Potash-bearing silicate is ground and mixed with alkali carbonate and melted, and is then pulverized and treated with water.
1111490, Sept. 22, 1914, Perino, Josef. Finely ground feldspar is mixed with magnesium chloride and is then heated in steam.
1111881, Sept. 29, 1914, Cowles, A. H. Feldspar and clay are furnaced in vapors of salt and water.
1123693, Jan. 5, 1915, Cowles, A. H. Feldspar and clay are heated in the presence of salt and water. (*See* Eighth Internat. Cong. Appl. Chemistry Trans., vol. 25, p. 119, 1912; also Met. and Chem. Eng., vol. 10, p. 659, 1912.)
1125007, Jan. 12, 1915, Coolbaugh and Quinney. Silicate rock is heated with gypsum or lime and is then leached with dilute sulphuric acid.
1125318, Jan. 19, 1915, Herzefeld and Hauser. Powdered feldspar is heated with mother liquor obtained in producing potassium chloride from crude carnallite.
1129224, Feb. 23, 1915, Peacock, Samuel. Feldspar or other silicate minerals are heated with ground coke or coal in a reducing atmosphere, yielding a carbide of potassium.
1129505, Process similar to 1129224.
1129721, Process similar to 1129224.
1134413, Apr. 6, 1915, Peacock, Samuel. Silicate is heated with finely ground coke in a reducing atmosphere, as above.
1144405, June 29, 1915, Wilson and Haff. Potash mineral and calcium phosphate are heated together.
1148850, Aug. 3, 1915, Melkman, S. E. Silicates are heated with concentrated sulphuric acid and then roasted.
1150815, Aug. 17, 1915, Drury, C. W. Feldspar is heated with lime and iron ores in blast furnace, yielding potash in siliceous slag, which is useful as fertilizer.
1151498, Aug. 24, 1915, Rody and Burkey. Silicate is heated with lime and sodium carbonate.

1151533, Aug. 24, 1915, Rody, F. A. Silicate is treated with alkali earth chloride without lime.
1159464, Nov. 9, 1915, Bassett, H. P. Greensand is heated with sodium acid sulphate and sodium chloride.
1160171, Nov. 16, 1915, Heyman, A. W. Silicates are furnaced with lime and are then leached, leaving cement-making material.
1160172, Process similar to 1160171.
1165154, Dec. 21, 1915, Coolbaugh and Quinney. Feldspar and gypsum are heated and then are leached with dilute sulphuric acid. (*See* Chem. Engineering, vol. 21, p. 171, April, 1915.)
1172420, Feb. 22, 1916, Bassett, H. P. Feldspar and phosphate rock are heated together.
1194464, Aug. 15, 1916, Bassett, H. P. A silicate is heated with sodium acid sulphate and sodium fluoride or calcium fluoride.
1196734, Aug. 29, 1916, Frazer, J. C. W., and others. Silicates are heated with dry caustic alkali at moderate temperature and the product is leached. (*See* special pamphlet issued under title "The Hopkins process.")
1201396, Oct. 17, 1916, Kolnitz, G. F. von. Greensand is heated with calcium chloride to produce potassium chloride.
1202215, Oct. 24, 1916, Peacock, Samuel. Greensand is melted in a closed furnace under pressure; the potash is extracted by means of alkali solution and later is treated with milk of lime to recover alkali hydroxide.
1209201, Dec. 19, 1916, Radman, P. A mixture of silicates and powdered gypsum is heated at a temperature below fusing point and then leached with water.
1217388, Feb. 27, 1917, Bassett, H. P. The potash rock is heated with three-fourths part of $NaHSO_4$ and one-fourth part H_2O to about 480–540° C. in a tubular furnace with a reducing flame. The SO_3 produced in the last stages of the heating is returned to the first stages of heating to aid in the decomposition.
1217389, Feb. 27, 1917, Bassett, H. P. The potash rock is heated with phosphate rock, H_2SO_4 H_2O, and C to about 500–650° C.
1217390, Feb. 27, 1917, Bassett, H. P. Greensand or similar K-bearing silicate is heated with $CaSO_4$ H_2SO_4 H_2O and C or S to about 550–650° C.
1214003, Jan. 30, 1917, Blumenberg, H. Finely ground orthoclase is fused with an equal part of sodium nitrate in a closed crucible at 1200–1500° F.
1222960, Apr. 17, 1917, McKee, R. H. A silicate of the sericite type is furnaced with lime or limestone and a chloride.
1232977, July 10, 1917, Rhodin, J. A mixture of sulphur dioxide, steam, and air is passed over a heated mixture of ground feldspar and sodium salt.
1237197, Aug. 14, 1917, Glaeser, W., assignor to G. T. Bishop. Feldspar is heated to redness, suddenly cooled, mixed with lime, fused at 1600° C., and treated with sulphuric acid to form alum.
1239787, Sept. 11, 1917, Glaeser, W. Feldspar is heated to redness, suddenly cooled, mixed with $CaCl_2$ and fused at 1200–1800° C.

3. United States patents for treating silicates by heat with volatilization of potash, which is condensed and collected by electrical precipitation or other means.

789074, May 2, 1905, Swayze, A. J. Feldspar, gypsum, and carbon are heated and then volatilized, the potassium salts being collected from exit pipe of furnace in water spray.
912266, Feb. 9, 1909, Spencer, A. C., and Eckel, E. C. Potash is volatilized from hydraulic cement mixture containing greensand.
999494, Aug. 1, 1911, Ellis, C. Cement materials are heated in electric furnace for recovering potash.
1011172, Dec. 12, 1911, Eckel, E. C. Glauconite is heated and potash volatilized and then condensed from the vapor.
1011173, Dec. 12, 1911, Eckel, E. C. Glauconite and limestone are treated in a blast furnace to produce potash and also pig iron.

1018186, Feb. 20, 1912, Haff, M. M. Orthoclase and calcium phosphate are fused to produce volatilized phosphoric acid and potash, which are collected by a water spray.

1035812, Aug. 13, 1912, Peacock, Samuel. Feldspar and limestone are heated to volatilize the potash which is condensed, and the residue is worked up for other products.

1036897, Aug. 27, 1912. Process similar to 1035812.

1064550, June 10, 1913, Schott, F. A system of collecting cement dust.

1121532, Dec. 5, 1914, Newberry, S. B. Potash is volatilized with furnace gases, collected, and leached.

1123841, Jan. 5, 1915, Brown, H. E. Calcium chloride, calcium carbonate, and feldspar are fused and volatilized potash is condensed.

1124238, Process similar to 1123841.

1124798, Jan. 12, 1915, Peacock, Samuel. The insoluble potassium contained in cement flue dust is digested with a solution of monocalcium phosphate.

1146532, July 13, 1915, Spencer, A. C. A potassiferous natural magnesian cement rock is treated to obtain potash and by-products.

1150295, Aug. 17, 1915, Newberry, S. B. Alkalies are recovered from cement kilns by means of water spray or on wet porous surfaces.

1156108, Oct. 12, 1915, Spencer and McElroy. Potassium cyanide is retained from silicates in a blast furnace.

1157437, Oct. 19, 1915, Spencer, A. C. Silicates are treated with lime in less amount than that needed to form Portland cement.

1186522, June 6, 1916, Ellis, C. Hydraulic cement is made from potassium silicates by melting with lime and calcium chloride, and potassium chloride is collected from fumes by water spray.

1194344, Aug. 8, 1916, Huber and Reath. Silicates are heated with calcium fluoride and calcium carbonate; Portland cement is obtained from residue.

1200887, Oct. 10, 1916, Schmidt, W. A. Feldspar or similar minerals are heated as in the manufacture of cement, but with the added factor of hot gases containing sulphur dioxide, which increases the amount of potash obtained by condensation and collection of the fumes.

1202327, Oct. 24, 1916, Spackman and Conwell. Potash obtained from cement materials is made soluble by regulating temperature and using water vapor in the kiln.

1209135, Dec. 19, 1916, Eckel and Spencer. Cement clinker and potassium compounds are made from raw mixture containing feldspar.

1209219, Dec. 19, 1916, Spencer and Eckel. In making cement from greensand or other rocks recovery of potash is facilitated by mixing in a small proportion of calcium chloride.

1209220, Dec. 19, 1916, Spencer, A. C. "Feldspathoid" rocks (leucite, nephelite, etc.) are used in cement mixtures and potash is volatilized and recovered.

1219315, Mar. 13, 1917, Huber, F. W., and Reath, F. F. Flue dust is furnaced with CaF_2, and the dust collected and treated with H_2O and CaO or $CaSO_4$ to recover the F. and K.

1224454, May 1, 1917, Ellis, C. Feldspar and limestone are heated below volatilization point of potash, product quenched with $CaCl_2$ solution, and then furnaced, volatilizing KCl.

1226811, May 22, 1917, Reid, J. H. Feldspar is heated with calcium carbide and N by an electric current to a temperature sufficient to volatilize the KCN formed.

1226812, May 22, Reid, J. H. Orthoclase and $CaCl_2$ are heated by an electric current to a temperature sufficient to volatilize the KCl formed.

1236903, Aug. 14, 1917, Breyer, F. G. Slate, shales, etc., are furnaced with limestone and potash volatilized.

1239616, Sept. 11, 1917, Newberry, S. B. Flue dust is refurnaced with strong blast of high-pressure air and the volatilized alkalies condensed.

1247619, Nov. 27, 1917, Beckett, J. S. Feldspar is furnaced with limestone and calcium chloride and potassium chloride volatilized.

1250291, Dec. 18, 1917, Ellis, C. Ground potash rock is furnaced with an alkaline earth chloride and the potash volatilized.

POTASH FROM KELP.

PRODUCTION IN 1917.

Potash products were made from kelp during 1917 by 10 companies, which reported a total production of 11,306 tons containing 3,572 tons of pure potash (K_2O), valued at $2,114,815. About one-fourth of the product consisted of dried and ground kelp containing about 16 per cent of potash (K_2O); one-fourth was kelp char and ash containing from 30 to 35 per cent of potash; and one-half was refined salts containing about 50 per cent of potash. The producing plants are all located along the southern coast of California and have a combined estimated productive capacity of 12,000 tons of potash (K_2O) a year. The methods of operation were described in considerable detail in the chapter on potash salts in Mineral Resources for 1916. Several new processes have been developed, but so far as known are not used commercially.

Four potash companies began production from kelp in 1917, and three of the producers in 1916 became inactive. The new companies will be referred to later. The companies which discontinued operations were the National Kelp Products Co., Long Beach, Cal.; the Kelp Products Co., San Diego, Cal.; and the National Potash & Iodine Co., Bremerton, Wash. The National Potash & Iodine Co., has been superseded by the Puget Sound Potash & Kelp Fertilizer Co., but no production was reported in 1917.

KELP POTASH PRODUCERS.

The companies which reported production of potash from kelp during 1917 are as follows:

- Hercules Powder Co., Chula Vista, Cal.
- Diamond Match Co., Wilmington, Cal.
- Sea Products Co., Long Beach, Cal.
- Pacific Products Co. of California, Long Beach, Cal.
- Swift & Co., San Diego, Cal.
- Lorned Manufacturing Co., Summerland, Cal.
- Southern Reduction Co., San Diego, Cal.
- United States Department of Agriculture, Summerland, Cal.
- Occidental Chemical Co. (formerly the California Chemical Co.), Summerland, Cal.
- San Simeon Reduction Co., San Simeon, Cal.

The first six companies listed were active producers in 1916 and were described in the report on potash in 1916. The Hercules Powder Co., of Chula Vista, has by far the largest plant. It produces high-grade muriate of potash, acetone, iodine, and other chemicals, but does not market low-grade potash material.

Early in 1917 the Lorned Manufacturing Co. moved its plant from Long Beach, Cal., as described in the report for 1916, to Summerland, Cal. This organization is still a subsidiary of the Simmons Hardware Co., of St. Louis, and is now engaged primarily in the manufacture of kelp ash, most of which is shipped to the Eastern States for use as fertilizer. The site at Long Beach was abandoned in favor of the Santa Barbara coast because of competition for the supply of kelp accessible to Long Beach, difficulties as to harbor facilities at the old site, and the available kelp stands to be had in the Santa

Barbara channel, which extend from the company's present pier in both directions for many miles.

The Southern Reduction Co., the Occidental Chemical Co., the plant of the United States Department of Agriculture, and the San Simeon Reduction Co. produced potash for the first time during 1917. All produce a kelp char or ash containing from 30 to 35 per cent of potash.

PLANT OF DEPARTMENT OF AGRICULTURE.

As noted in the report for 1916, an appropriation of $175,000 was granted by Congress to the Department of Agriculture for the construction and operation of an experimental plant for extracting potash from kelp. This work was put under the direct charge of Dr. J. W. Turrentine. The site was selected at Summerland, Santa Barbara County, Cal., because of special advantages in accessibility to a supply of kelp, relative freedom from competition of other kelp-harvesting companies, and the availability of dock and building site. The site is in the midst of an almost exhausted oil field.

Construction of the plant was begun in April, 1917. The equipment installed consists of a harvesting barge, a pier fitted with unloading devices, a chopper, a chain conveyor, storage bins on the beach, and buildings containing drying, distilling, lixiviating, and other apparatus, besides a machine shop, office, and other accessory buildings. The chopped kelp is lifted from the conveyor on the wharf or pier to two storage bins, which are arranged to be filled and emptied alternately. A feed by way of a chain conveyor leads direct from the storage bins to a battery of three rotary driers, which dry the kelp in two stages. The wet kelp is fed into the drier at the end opposite the fire, travels down the drier by gravity toward the flame, and is gradually cooked and partly dried, being rid completely of its mucilaginous coating. Two of the rotary driers are utilized for this preliminary drying process, and the product from both is then fed to the third drier, where most of the remaining moisture is removed. These driers are designed to drive off the moisture as effectively as possible without losing other volatile or combustible constituents.

From the rotary driers the product is transferred to a vertical kiln or retort, which is closed and fitted with valves for controlling the outlet of vapors at the top and for extracting the charred kelp at the bottom. This is fired by an oil burner. The temperature of the kiln used in the preliminary work is about 800° F. The volatile matter yields a tar containing creosote and other products that have not yet been investigated and that will be used also as fuel for the preliminary drying kilns. The product after distillation is a light charcoal, which still retains the mineral salts and from which the potash is to be separated by leaching with water. A special counter-current device to accomplish the lixiviation has been installed, in which the char is passed against a percolating stream of hot water. This part is, however, entirely experimental and may be modified by trial. The water solutions obtained will be concentrated by evaporation, and the resulting salts will be separated by fractional crystallization. Iodine, or potassium iodide, is quite likely to be one of the important by-products, and the charcoal residue will undoubtedly be utilized in some special way.

A considerable output of commercial char was produced in 1917, and at the close of the year the equipment was practically complete, except the leaching and crystallizing systems. It has been necessary to proceed slowly and with considerable caution in order to continue the work throughout the season and keep within the appropriation, as well as to avoid so far as possible the losses due to alteration of plans such as are inevitable in developing experimental processes. The hope is to be able to make potash at a price that will enable the production to continue commercially after war emergency conditions have passed, and the belief is now expressed that this can probably be done only by developing valuable by-products that will bear part of the costs of operation.

SUPPLY OF KELP.

During the year considerable difficulty was experienced by manufacturers of potash from kelp in getting a sufficient supply of the raw material. Controversy between the potash and the fishing interests prevented the cutting of kelp in certain sections for brief periods, it being argued that the cutting of the kelp interfered with the propagation of the fish. It was also contended, especially in the Santa Barbara region, that the cutting of the kelp destroyed the natural protection of the harbor against storms. Representatives of all parties primarily interested in the matter were called into consultation and a bill was passed by the California legislature providing that the State Fish and Game Commission and the Scripps Marine Biological Institution should have supervision of all kelp in the waters of the State of California, should close beds when necessary, and should collect a tax on each ton of kelp harvested. The controversy at Santa Barbara has been settled by permission being granted for the cutting of kelp during April and May and September and October.

The Santa Barbara kelp beds suffered severely during the winter of 1916–17 from an undetermined disease which destroyed the kelp completely for the time being. This same disease affected other kelp beds to a less degree. The beds affected had not been previously harvested. It is thought that the new growth of kelp resulting from periodic cutting will be more thrifty and better able to withstand disease.

The nature, distribution, and methods of gathering and harvesting kelp and the methods of extracting potash from it were discussed in some detail in the chapter on potash in Mineral Resources for 1916, to which the reader is referred.

POTASH FROM MOLASSES DISTILLERY SLOP.

In the manufacture of alcohol molasses is diluted with water, treated with an acid, and allowed to ferment. The alcohol thus formed is finally removed by distillation, which leaves a dilute liquor containing all the nonsugar solids, including the potash, of the original molasses. This liquor contains about 4 per cent of solids, including 2 per cent of mineral salts, and is ordinarily discarded. It is known as molasses distillery slop. In 1917 four companies produced from this source 8,589 tons of material containing 2,846 tons of potash (K_2O), valued at $1,130,907. The product consisted of ash and char containing from 25 to 37 per cent of potash (K_2O). It was obtained by evaporating the distillery slop and charring the residue.

The producing companies and the location of their plants are as follows:

Western Industries Co., Agnew, Cal.
Jefferson Distilling & Denaturing Co., Harvey, La.
Swift & Co., Harvey, La.
Puerto Rico Distilling Co., Arecibo, Porto Rico.

It is estimated[1] that 106 short tons of potash was lost daily in 1915 from 25 or more distilleries in the United States which were manufacturing alcohol from molasses. This estimate corresponds to a loss of 38,690 tons of potash a year (365 days). In order to verify these figures and to get more exact data on the amount of potash recoverable from molasses distillery waste, inquiry was sent to the 29 distilleries in the United States reported to be manufacturing alcohol from molasses in 1917. Nine of these reported that little or no molasses was used in 1917; four did not reply; one refused to give the data requested; and 15 reported a total consumption of 633,612 short tons of molasses. From the surveyed capacity of the five plants from which no data were received, it is estimated that those plants used about 46,388 tons of molasses in 1917. These data indicate a total consumption of molasses by distillers for the year of approximately 680,000 short tons.

Molasses contains about 4.5 per cent of potash (K_2O).[2] Accordingly 680,000 tons of molasses consumed by distilleries in the United States in 1917 contained approximately 30,600 tons of potash (K_2O). This estimate agrees roughly with that made in the Commerce Reports. Practically all the potash remains with the distillery slop and is recoverable. A number of the distilleries are making efforts to recover the potash, so that a considerable increase in production may be expected from this source in 1918.

POTASH FROM STEFFENS WASTE WATER IN BEET-SUGAR MANUFACTURE.

PRODUCTION IN 1917.

Attention has lately been directed to the recovery of potash from the large quantities of beet molasses now annually reworked for sugar, chiefly by the Steffens process. Five companies reported production from this source in 1917 amounting to 2,642 tons of crude material containing 369 tons of pure potash (K_2O), valued at $147,830. The product consists of concentrated potash liquors and potash char. Concentrated liquors containing from 7.5 to 11 per cent of potash obtained by evaporating Steffens waste liquors were produced by three companies. Potash char, containing from 24 to 35 per cent of potash, obtained by evaporating the waste liquors and charring

[1] U. S. Dept. Commerce Rept. 253, Oct. 28, 1915.
[2] Zitkowski, H. E., The composition of various American molasses: Sugar, vol. 18, pp. 181–182, 1916.

the residue, was produced by two companies. A small amount of crude potassium sulphate containing 35 per cent of potash (K_2O) was also produced. The following companies reported production in 1917:

American Beet Sugar Co., Oxnard, Cal.
Poindexter & Co., Los Angeles, Cal.
Spreckels Sugar Co., San Francisco, Cal.
Great Western Sugar Co., Denver, Colo.
Columbia Sugar Co., Bay City, Mich.

The United Disposal & Recovery Co., Chicago, Ill., has a potash plant at Blissfield, Mich., and one at Decatur, Ind., for utilization of Steffens waste water. These plants were installed in 1917 and were probably in operation at the end of the year, but no production from them for 1917 was reported to the Survey.

POTASH CONTENT OF DOMESTIC BEETS.

Approximately 6,000,000 short tons of sugar beets have been produced annually in the United States since 1911. The production in 1917 was 5,980,377 tons.[1] The composition of beets including the potash content varies somewhat with the season, locality, and soil conditions. The following analyses from three widely separated localities in the United States may serve as a basis:[2]

Composition of sugar beets.

	Colorado.	California.	Wisconsin.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	78.36	63.99	74.37
Sugar	15.40	25.60	18.70
Nitrogen	.199	.254	.182
Chlorine (Cl)	.102	.065	.040
Sulphur trioxide (SO_3)	.028	.034	.024
Phosphorus pentoxide (P_2O_5)	.046	.121	.023
Potash (K_2O)	.320	.269	.320
Soda (Na_2O)	.097	.106	.089
Lime (CaO)	.032	.078	.041
Magnesia (MgO)	.058	.051	.047
Ferric oxide and alumina (Fe_2O_3, Al_2O_3)	.042	.014	.027
Silica (SiO_2)	.005	.016	.036
Undetermined	5.311	9.402	6.101
	100.00	100.00	100.00

The undetermined portion is probably chiefly nitrogenous and other organic matter.

The average potash (K_2O) content of beets as shown by these analyses is 0.303 per cent. If 0.3 per cent is an average for the entire sugar-beet industry, the 6,000,000 short tons of beets produced annually in the United States contain 18,000 tons of potash (K_2O).

RECOVERY OF POTASH FROM SUGAR-BEET WASTE.

MANUFACTURE OF SUGAR.

In the manufacture of beet sugar the beets are sliced and then lixiviated with water. The pulp is used for cattle feed. The solution contains about 90 per cent of the potash from the beets, together

[1] U. S. Dept. Agr. Monthly Crop Rept., April, 1918.
[2] Zitkowski, H. E. The recovery of potash from beet sugar house waste liquors: Met. and Chem. Eng., vol. 17, pp. 17–19, 1917.

with most of the sugar and other soluble constituents. Through a process of heating, liming, carbonation, and evaporation, the solution is reduced to a purified sugar sirup, from which sugar is crystallized. Continued crystallization of the sugar finally yields a molasses so rich in nonsugar solids that further crystallization of the sugar is impracticable. The molasses thus remaining from American beet-sugar factories represents about 6 per cent of the weight of the beets and contains an average of approximately 4.61 [1] per cent of potash (K_2O), or a total of a little more than 16,000 tons of potash, which corresponds very closely to the quantity estimated as having been separated from the beet pulp. The approximate composition of the molasses is as follows:

Composition of beet-sugar molasses.

Moisture	20
Sugar	50
Inorganic salts	15
Organic salts	15
	100

From 5 to 10 per cent of the beet molasses produced is used in the manufacture of alcohol, and potash recovery from such material is discussed under potash from molasses distillery slop. Approximately 40 per cent is used as feed for stock, and from this portion the potash is recovered in proportion as the manurial value of the feed is recovered. The remainder of the beet molasses produced in the United States, containing about 8,000 tons of potash (K_2O), is desugarized almost exclusively by the Steffens process.

STEFFENS PROCESS.

The Steffens process in brief consists in diluting the molasses with six or seven times its weight of water, precipitating the sugar with lime as dicalcium saccharate, and separating the precipitate from the solution by filtration. The filtrate is known as Steffens waste liquor and is ordinarily discarded. It contains some lime, practically all the potash, and most of the other nonsugar solids from the molasses. It is very dilute, containing only about 4 per cent of solids, including about 0.35 per cent of potash. It is this waste liquor that is beginning to be used in the manufacture of potash as a by-product in the beet-sugar industry. The following table indicates roughly the chief constituents of the liquor:

Composition of Steffens waste liquor.

	Per cent.
Sugar	0.30
Organic nonsugar solids	1.70
Nitrogen	.16
Potash (K_2O)	.35
Lime (CaO)	.35
Solids	4.00

TREATMENT OF STEFFENS WASTE LIQUOR.

Steffens waste liquor contains about 4 per cent of solids composed of much nitrogenous and other organic matter, lime, soda,

[1] Zitkowski, H. E., Composition of various American and European molasses: Sugar, vol. 18, pp. 181–182, 1916.

potash, etc. In order to recover the potash, the lime is removed by carbonation, and the liquor is evaporated in vacuum pans. Some plants market a concentrated liquor containing about 50 per cent of solids including 10 per cent of potash and all the nitrogenous matter originally present. This product is incorporated in fertilizers and conserves both the potash and the nitrogen values. Other plants reduce the liquor to complete dryness, char the residue, and market a potash char, containing from 24 to 34 per cent of potash (K_2O).

The composition of potash char is represented by the following analysis:

Composition of potash char.

[Smith, Emery & Co., analysts.]

Insoluble portion:		
Carbon and other organic matter	12.03	
Inorganic matter	12.17	
		24.20
Water-soluble portion:		
Potash (K_2O)	31.12	
Soda (Na_2O)	9.70	
Sulphur trioxide (SO_3)	6.14	
Chlorine (Cl)	10.80	
Carbon dioxide (CO_2)	11.30	
Phosphorous pentoxide (P_2O_5)	.05	
Loss on ignition	9.14	
	78.25	
Less excess oxygen	2.45	
		75.80
		100.00

The char contains about 30 per cent of soluble potash in the form of chloride, carbonate, and sulphate, and is therefore a valuable fertilizer. By more complete burning the organic matter may be removed and a product obtained carrying as high as 34 per cent of potash (K_2O).

Dry distillation of the residue from Steffens waste liquor with the production of cyanides, ammonia, fuel gases, and other products whereby both the organic and inorganic constituents are conserved may eventually result from efforts to recover the potash. The problem of saving both the potash and the nitrogen values deserves careful consideration.

POTASH FROM WOOL WASHINGS AND OTHER INDUSTRIAL WASTES.

In 1917 three companies were engaged in producing potash from wool washings and other industrial wastes. The production amounted to 645 tons of material containing 305 tons of potash (K_2O) and was valued at $113,875. The product consisted of refined muriate and of ash containing about 44 per cent of K_2O mostly in the form of carbonate. The producing companies were the Diamond Match Co., Lawrence, Mass.; Arlington Mills, Lawrence, Mass.; East St. Louis Cotton Oil Co., East St. Louis, Ill.

Raw wool received at factories contains by weight from 30 to 80 per cent of dirt, fat, and mineral salts. The fat is the natural oil of the wool fiber; the mineral salts consist chiefly of dried perspiration.

These impurities are generally removed by washing, and the waste water is ordinarily discarded. Thorpe[1] states that raw wool will yield 14 to 18 per cent of salts, including about 5 per cent of potassium carbonate.

Many processes[2] have been devised for cleansing the wool and for treating the waste liquors to prevent stream pollution and to recover the grease and potash. For the recovery of the grease and potash the best method is to wash the wool first with naphtha to remove the grease, and then with water to remove the potash. This second waste solution is free from grease, and can be evaporated to dryness without difficulty, and calcined to produce an ash containing about 45 per cent of potash (K_2O), mostly in the form of carbonate.

The average wool-scouring plant discharges about 100 tons of waste daily, containing about 2,500 pounds of potash, 1,600 pounds of which are recoverable. This estimate corresponds to about 240 tons of potash a year. The cost of a plant for the recovery of the grease and potash from the waste would rarely exceed $40,000. No data are at hand to show the total quantity of potash recoverable from this source.

POTASH FROM WOOD ASHES.

Forty-nine firms reported the production in 1917 of 1,035 short tons of crude potash from wood ashes, estimated to contain 621 tons of pure potash, valued at $549,150, or about $884 a ton of pure potash (K_2O.) The production was an appreciable increase over that for 1916, which was 825 tons of crude potash. The following firms reported production from this source during the year:

OHIO.

Phillip Englehart, Luckey.
E. W. Butler, Napoleon.

TENNESSEE.

Union Chemical Co., Mallory Branch P. O., Memphis.

WISCONSIN.

Erskine Potash Co., Washburn.
Baldwin Bros., Oconto.
Wisconsin Potash Co., Tomahawk.
Wisconsin Potash Co., Shawano.
Antigo Potash Co., Antigo.
John Heinzkill, Appleton.
West Lumber Co., Lugerville.
J. B. Maier, Medford.
Northern Potash Co., 1610 Grant Street, Marinette.
Goodman Lumber Co., Goodman.
Marinette Potash Co., 436 Ogden Street, Marinette.
Wausau Soap Co., Wausau.
Cotter Bros., Park Falls.
Forest County Potash Co., Soperton.
Wausau Potash Factory, 111 Edwards Street, Wausau.
Rhinelander Potash Co., Rhinelander.
Abbotsford Soap & Potash Co., Abbotsford.
Robert Purdy, Crandon.

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[1] Thorpe, Edward, Dictionary of applied chemistry, rev. ed., vol. 4, pp. 361–362, 1913.
[2] The data given are based on a paper by R. S. Weston (Recovery of potash from wool-scouring waste: Soc. Chem. Ind. Jour., vol. 37, pp. 17–19T, 1918).

Oshkosh Potash & Chemical Co., Oshkosh and Rice Lake.
H. Fagon, Merrill.
Ladysmith Potash Co., Ladysmith.

MICHIGAN.

Baraga Potash Co., Baraga.
Riley Potash Factory, St. Johns.
H. Streeter Potash Factory, R. F. D. 3, Elsie.
Anderson Bros., R. 1, Traverse City.
Isham & Isham, Detroit.
G. E. Teachman, Ithaca.
James McClory, 115 Spratt Street, Alpena.
Wm. T. Campbell Potash Co., Trout Creek.
William C. Burley & Co., Munising.
R. W. Trapp, R. 1, Mount Clemens.
Silas E. Wood, Maple Rapids.
Albin Johnson, Jennings.
Peter Bloomquist & Co., 730 Lake Street, Cadillac.
Orson W. Prentice, West Branch.
E. A. Thomas, 400 Wisner Street, Saginaw.
O. W. Martin, Bay City.
A. Schwartz, Pellston.
Salling Hanson Co., Grayling.
John Thomas, Montrose.
Boyne City Potash Co., Boyne City.
Monroe Chemical Co., 1605 Kresge Building, Detroit.
C. M. Slade, Gaylord.
East Jordan Potash Co., Lock Box 124, East Jordan.
Escanaba Potash Co., 511 Hale Street, Escanaba.
Menominee Potash Co., Menominee.

The process used in the manufacture of potash from wood ashes is very crude. The ashes are collected from sawmills and other sources in the vicinity of the potash plant. They are sifted, moistened, and packed into a leaching tub or vat, the bottom of which is inclined and contains a straw filter and sometimes a layer of lime. From time to time water is poured over the ashes and the leachings containing the dissolved salts are collected from the bottom of the vat. An extraction of 80 to 90 per cent is said to be obtained in this way. The leachings are then evaporated to dryness in open pans using coal or wood as fuel. This product is usually molded in large lumps and sold in barrels. It is sometimes marketed in the form of a concentrated lye. It is composed chiefly of a mixture of carbonate and caustic and is reported to contain from 50 to 75 per cent of potash (K_2O). The average potash content is probably above 60 per cent. The relative proportion of carbonate and caustic depends on the method of manufacture. If lime is used in the leaching vats, the product is high in caustic; otherwise it is high in carbonate.

The average selling price of the crude potash in 1917 was $532 a ton, or about 26.5 cents a pound. The present cost of production, including fuel, labor, and cost of ashes, is estimated by Edgar[1] to be about 6 cents a pound of crude salts or $120 a ton. Labor and fuel are the big items in the cost. Ashes are usually bought for $2 or $3 a ton, but sometimes competition raises the price to $9 or $10 a ton. The present method of manufacture is very wasteful with regard to fuel and labor. Installation of modern methods of leaching and evaporation would probably reduce the cost of production enormously and might possibly enable the industry to compete with Ger-

[1] Edgar, C. T., Northern Potash Association, Wausau, Wis., private communication.

man potash after the war. As a matter of fact, a small amount of wood-ash potash was produced in this country before the war and successfully competed in the markets with imported potash.

The wood-ash potash industry centers around the hardwood lumber districts of Michigan and Wisconsin. Fresh ashes are required for good results. The districts in Michigan and Wisconsin are thoroughly worked at present, so that production from these States could not be much increased. Conditions in other States with regard to the supply of hardwood ashes are not so well known. Production in many other localities is probably feasible.

From time to time ashes from plants of various kinds have been suggested as possible sources of potash. The Phoenix Chemical Works, of Los Angeles, Cal., produced a small amount of high-grade potassium chloride in 1917 from cottonseed-hull ashes. Hibbard[1] has investigated the potash values of tule and other marsh plants. Others have suggested hay, water hyacinth, cactus, sagebrush, the Gobernadora plant of southern Texas, castor bean, and pomace as sources of potash, but no commercial production has resulted from any of these raw materials.

POTASH FROM FOREIGN SOURCES.

INTRODUCTION.

Extensive foreign deposits of potash, accessible to Allied countries, have been reported. The Alsace deposits of Germany lie near the French border and may fall under control of the Allies at any time. A brief description of the more important of the foreign deposits is presented here in order to give some idea of the possibilities of obtaining a supply of potash from these sources.

ABYSSINIA.[2]

A large deposit of potash salts said to resemble those at Stassfurt, Germany, was discovered in 1911 near the boundary between Abyssinia and Eritrea. It is in a desert about 46 miles inland from the settlement of Fatimari, which is opposite the island of Baca in the Red Sea. In 1914 the Compagnia Mineraria Coloniale, an Italian company, undertook to develop this property. A considerable output of potash was carried to the coast by camel. Construction of a railroad to the deposit and of a port at Fatimari was begun, but, owing to difficulties connected with the management of the operating company the railroad and port have never been completed. The company estimates at least 850,000 tons of salts high in potash in the deposit.

ALSACE.[3]

Potash salts were discovered at Wittelsheim, 6 miles northwest of Mülhausen, in upper Alsace, in 1904, in drilling for oil. Sub-

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[1] Hibbard, P. L., Potash from tule and the fertilizer value of certain marsh plants: Calfornia Exper. Sta. Bull. 288, November, 1917.

[2] These data were submitted by the American consul at Aden, Arabia, May 28, 1917; Manufacturers' Rec., Aug. 16, 1917, p. 56.

[3] Förster, B., Ergebnisse der Untersuchung von Bohrproben im Tertiär Oberelsass: Geol. Landesanstalt Elsass-Lothringen Mitt., vol. 7, No. 4, 1911. Binder, Félix (and others). Mines de potasse dans la Haute-Alsace: Soc. Ind. Mulhouse Bull., vol. 32, No. 4, pp, 207–300, April, 1912. Wehrlin, A. (chairman of commission), Die Kalibergwerke in Oberelsass: Jahresh. der Ind. Ges. von Muelhausen, Stuttgart, 1913. The world's supply of potash: Imperial Institute of the United Kingdom, London, 1915. Kestner, Paul, The Alsace potash deposits: Soc. Chem. Industry Jour., London, Nov. 15, 1918, pp. 291T–299T.

sequent explorations and developments indicate that the deposits underlie an area of more than 70 square miles, and that the workable beds have a depth of about 2,000 feet and range in thickness from 6 to 30 feet. The salts consist essentially of sylvinite, a mixture of sylvite and rock salt. Practically no carnallite or magnesium chloride is present. Estimates place the amount of potash salts in the deposit at 1,472,058,000 tons, which on a basis of 22 per cent of potash (K_2O) gives more than 300,000,000 tons of potash (K_2O). The first mining shaft was completed in 1909 and production began in 1910. In 1913, 40,707 tons of potash (K_2O) were produced from this source. The German Kali Syndicate, which controls these mines as well as those at Stassfurt, determined the proportion of potash to be produced by the Alsatian mines at about 4 per cent of the total annual production from Germany. The main object in limiting the output was to prevent overproduction and thus a lowering of the price.

AUSTRALIA.[1]

Alunite deposits occur in Australia at Carrickalinga Head and near Warnertown, South Australia, and at Bullahdelah, New South Wales. They contain alunite of good quality, and small shipments have been made to chemical houses in England. Few data are at hand, however, to show the quantity and availability of the ore for commercial utilization.

AUSTRIA.[2]

The potash deposits near Kalusz, Galicia, occur at four different horizons in lenticular beds which attain a thickness of 20 feet and are interbedded with rock salt and saline clay. They contain kainite and sylvinite with relatively small amounts of carnallite and yield an average of about 10 per cent of potash (K_2O). The explored portion of the uppermost bed is estimated to contain more than 100,000 tons of potash salts. The deposits are controlled by the Austrian Potash Syndicate, which consists of the Austrian Government and a group of private capitalists. The present production is about 1,000 tons of K_2O annually, which is not sufficient to supply the Galician demands. Potash deposits are reported[3] to occur also at Stebnik, Dolhe, Rosulno, Morszyn, Holoskow, Truskawiec, Uteropy, Strupkow, Bolechow, and Turza.

CANADA.

A Portland cement company at Durham, Ontario, is recovering potash as a by-product in the manufacture of cement. Feldspar is added to the raw mix in order to increase the yield of potash. The production is said to be from 12 to 15 tons of potash a day. Canada produced a little more than 8,700,000 barrels of Portland cement in 1914.[4] If 1.65 pounds of potash is recoverable for each barrel of

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[1] Alunite deposits of Australia: Executive Comm. Advisory Council Sci. and Ind. Bull. 3, Melbourne, 1917.

[2] The potash supply, with special reference to the United States, pamphlet published in 1913 by the Kali Syndicate, p. 18, Berlin. The world's supply of potash, pamphlet published by the Imperial Institute of Great Britain in 1915, p. 6. Niedzwiedski, J., Geological sketch of the salt deposits of Kalusz, Galicia: Kali, vol. 7, p. 9, 1913.

[3] Machalske, F. J., Potash salts of Galicia: Am. Fertilizer, Mar. 25, 1911, p. 6.

[4] Cement: U. S. Geol. Survey Mineral Resources, 1914, pt. 2, p. 253, 1915.

cement produced, as has been estimated for the cement industry of the United States,[1] then more than 7,000 tons of potash (K_2O) is recoverable as a by-product in the cement industry of Canada.

The General Research & Development Co. (Ltd.), 96 West King Street, Toronto, Canada, holds the patent rights and formulas of the phospho-potash process, which consists in grinding feldspar or other potash material to about 80 mesh and subjecting it for a short time, under pressure, to the action of a solution of phosphoric acid, whereby about 90 per cent of the potash is said to be converted into potassium phosphate. The solution of potassium phosphate is filtered off and the phosphoric acid recovered by treatment with sulphuric acid. Potassium sulphate and alumina or aluminum sulphate are to be marketed.

The extraction of potash from kelp off the coast of British Columbia by the International Chemical Co. (Ltd.) is also reported.

CHILE.

The caliche of the Chilean nitrate fields contains from a trace to more than 17 per cent of potassium nitrate.[2] Probably the average is about 2 or 3 per cent. The DuPont Nitrate Co.[3] began the production of potassium nitrate from the caliche as a by-product in the manufacture of sodium nitrate in 1914 and now has an annual productive capacity of 10,000 tons of a 25 per cent potassium nitrate, representing nearly 1,200 tons of potash (K_2O). The process consists in evaporating the mother liquors from the crystallizing pans to a high density and then cooling the concentrated brine thus causing a product containing about 25 per cent potassium nitrate to be deposited. The details of this process have been given by the DuPont Nitrate Co. to other Chilean nitrate producers. The DuPont Co. produces only about 1 per cent of the total output of the sodium nitrate from the Chilean fields. Potash recovery by all the nitrate-producing companies would result in an estimated annual saving of 120,000 tons of potash (K_2O). Projected improvements in the process may recover practically all the potash from the caliche, which would represent a total estimated output of 320,000 tons of potash for the nitrate industry.

A saline deposit[4] covering about 6,000 acres in the Pintados Salar, in the Pampa of Tamarugal, about 50 miles southeast of the port of Iquique, is comparatively rich in potash. It consists of a saline crust averaging a little more than a foot in thickness and underlain by several feet of granular glauberite and gypsum impregnated with brine. A portion of the saline crust is estimated to contain 6,840,000 tons of salts composed largely of chlorides and sulphates of sodium and potassium. The average potash (K_2O) content of different areas varies from 3.5 to 6.3 per cent and the total amount of potash (K_2O) in the crust is estimated to be more than 300,000 tons. The saline

[1] U. S. Dept. Agr. Bull. 572, p. 22, 1917.

[2] Clarke, F. W., The data of geochemistry, 3d ed.: U. S. Geol. Survey Bull. 616, p. 255, 1916.

[3] Barton, C. M., Met. and Chem. Eng., vol. 18, p. 248, 1918.

[4] Gale, H. S., Potash in the Pintados Salar, Tarapaca, Chile: Eng. and Min. Jour., vol. 105, p. 674, 1918.

crust is at best a low grade of raw potash material, and the feasibility of commercial extraction has not been determined, although experiments have been carried out showing that a considerable enrichment of the potash can be obtained by a single leaching and crystallization of the raw material.[1]

GERMANY.

In addition to the Alsace deposits already described, Germany contains by far the largest known segregation of potash salts in the world. Beds of rock salt occupy an enormous basin in the plains of northern Germany.[2] Extensive deposits of potash salts occur in the upper layers of these beds in certain localities, notably in the vicinity of Stassfurt. In 1910 the Geological Institute of Berlin[3] estimated that the potash deposits occupied a volume of 10,790,000,000 cubic meters and contained about 20,000,000,000 metric tons of potash salts, corresponding to about 2,000,000,000 metric tons of potash (K_2O), a quantity sufficient to supply the world for 2,000 years at the present rate of consumption. The chief potash salts in the deposit are carnallite, kainite, and sylvite.

The potash deposits were discovered by the Prussian Government in 1843 at Stassfurt, while boring for rock salt. The first shaft for working the salt was completed in 1857. Later on the value of the potash salts began to be recognized, and they soon became the most valuable minerals of the deposit. Many borings in search for potash were made by the State governments and by private companies, and shafts were sunk where workable deposits were discovered. At the present time potash mines are being worked in Anhalt, Brunswick, and in the Prussian provinces of Hanover and Saxony.

Some idea of the rapid development of the potash industry in Germany in recent years may be gained from the fact that in 1902[4] there were about 20 producing mines; in 1910,[5] 60; in 1913,[6] 115; and in 1916,[7] 204. The potash-producing companies all belong to the Kali Syndicate, which under the supervision of the German Government determines the production for each mine, distributes the product, and regulates the prices.

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[1] Wells, R. C., The extraction of potassium salts from the Pintados Salar: Eng. and Min. Jour., vol. 105, pp. 678–679, 1918.

[2] Beyschlag, F., Everding, H., and others, Deutschland Kalibergbau: K. preuss. Geol. Landesanstalt Abh., Neue Folge, Heft 52, Berlin, 1907. (Contains maps showing location of mines and general geology of the region of the potash districts.)

[3] Friedenburg, F., Kalivorkommen ausserhalb des deutschen Reichs: Kali, vol. 6, p. 572, 1912.

[4] Groth, L. A., The potash salts, p. 17, London, The Lombard Press (Ltd.), 1902.

[5] Handbuch der Kaliwerke, Salinen, Tiefbohr Unternehmungen, und der Petroleum Industry, 1910, p. 71.

[6] The potash supply with special reference to the United States, pamphlet published in 1913 by the Kali Syndicate, Berlin, p. 32.

[7] The potash industry, pamphlet published in 1916 by the German Kali Works (Inc.), New York City, p. 5.

The magnitude of the industry is indicated by the figures of production given in the following table:

Production of potash in Germany,[a] 1880–1917.

[Metric tons of 2,204 pounds.]

Year.	Raw salts.	Fertilizer and concentrated salts.							Total K_2O.
		Muriate of potash, 80 per cent.	Sulphate of potash, 90 per cent.	Sulphate of potash and magnesia, 48 per cent.	Sulphate of potash and magnesia, 40 per cent.	Manure salts.	Kainite and sylvinite. [b]	Total crude and concentrated salts.	
1880	668,596	96,832	....	7,000	....	9,500	127,518	240,850	68,550
1890	1,279,265	134,760	13,839	10,830	907	17,620	305,015	482,971	122,302
1900	3,037,035	206,471	31,255	12,150	932	129,908	1,098,661	1,479,377	303,610
1910	8,160,778	434,243	93,208	41,529	168	524,874	3,051,258	4,145,280	857,883
1911	9,706,507	443,357	110,123	49,014	144	645,724	3,211,911	4,460,273	939,927
1913	11,607,511	484,254	110,784	58,269	119	956,606	....	....	[c] 1,110,274
1914	....	....	....	....	....	....	....	....	[c] 904,137
1915	....	....	....	....	....	....	....	....	[c] 679,975
1916	....	....	....	....	....	....	....	....	[c] 883,696
1917	....	....	....	....	....	....	....	....	[c] 1,004,285

[a] The potash supply with special reference to the United States; pamphlet published by the Kali Syndicate, Berlin, p. 32, 1913; The potash industry; pamphlet published by German Kali Works (Inc.), pp. 35, 39, and 40, New York, 1916.
[b] The potash industry, p. 40, 1916.
[c] [Postcript added in proof]. Sales according to Frankfurter Zeitung, July 10, 1918, quoted in Commerce Reports, Oct. 9, 1918.

These data indicate that the average production per mine in Germany is between 5,000 and 10,000 metric tons of potash (K_2O) a year. MacDowell[1] estimates that a fully equipped potash plant with two shafts, of an annual capacity of 12,000 to 15,000 tons of K_2O would cost from $1,750,000 to $2,000,000, corresponding to about $140 a ton of potash produced annually. Meade[2] estimated that about $150 is invested in potash plants in Germany for each ton of potash produced annually. If these estimates are approximately correct, about $150,000,000 is invested in the potash industry in Germany.

The salt beds vary in depth and composition. In some places they are much tilted and folded; in others they are nearly horizontal. The thickness and composition of the different strata or regions of the beds also vary considerably. Primary salts have undergone extensive alteration, so that secondary salts frequently predominate. Moreover, the strata are irregular, are often ill defined, and shade into one another. These conditions make a brief comprehensive description of the deposit difficult, but the following summary will give a general idea of the deposit as it occurs at Stassfurt.

[1] MacDowell, C. H., Germany and other sources of potash: Am. Inst. Min. Eng., vol. 51, p. 427, 1915.
[2] Meade, R. K., The possiblities of developing an American potash industry: Met. and Chem. Eng., vol. 17, p. 78, 1917.

Summary of the Stassfurt salt deposit.[a]

Region.	Description of region.	Thickness of region.	Depth from surface.
		Feet.	*Feet.*
Region overlying main salt deposit.	440 feet of red and blue clay slates; 80–100 feet of practically pure rock salt; 133–300 feet of anhydrite ($CaSO_4$); 20–30 feet of saline clay.	840	840
Carnallite	The region consists of about 55 per cent of carnallite ($KCl.MgCl_2.6H_2O$), 25 per cent of rock salt (NaCl.), 16 per cent of kieserite ($MgSO_4.H_2O$), and 4 per cent of various other salts. Sand, clay etc., kainite, sylvine, and other alteration products are prominent in certain places. The average percenage of potash (K_2O) in the region is 9.27.	140	980
Kieserite	The region contains about 65 per cent of rock salt, 17 per cent of kieserite, 13 per cent of carnallite, 3 per cent of bishofite ($MgCl_2.6H_2O$), and 2 per cent of anhydrite ($CaSO_4$). The average percentage of potash (K_2O) is 2.17.	187	1,167
Polyhalite	The region consists of about 91 per cent of rock salt, 6.6 per cent of polyhalite ($2CaSO_4.MgSO_4.K_2SO_4.2H_2O$), 1.5 per cent of magnesium chloride, 0.7 per cent of andydrite, and 0.2 per cent of sulphur, bituminous substances, etc. The average precentage of potash (K_2O) is 1.02.	207	1,374
Anhydrite	The region consists of layers of rock salt about 4 inches thick, separated by bands of anhydrite about one-fourth of an inch thick. By mechanical separation rock salt 99 per cent pure is obtained on a large scale. Only traces of potassium are present.	2,000	3,374

[a] Thorpe, Edward, Dictionary of applied chemistry, vol. 4, p. 339, New York, 1913, Longmans, Green & Co.

The carnallite zone furnishes all the commercial potash coming from the Stassfurt deposits. The raw materials used in the manufacture of potash are crude carnallite ($KCl.MgCl_2.6H_2O$), kainite $KCl.MgSO_4.3H_2O$), and hartsalz—a mixture of 20 per cent of sylvine (KCl), 25 per cent of kieserite ($MgSO_4.H_2O$), and 55 per cent of rock salt (NaCl). Kainite is not much worked at the present time, but considerable quantities of the high-grade material are marketed without previous treatment. Hartsalz enters more or less into the manufacturing process, both as a supply of raw material and in the form of a washing brine, but the bulk of the potash comes from crude carnallite. The approximate average composition of these different raw materials entering into the manufacture of potash is given below:

Approximate composition of raw materials used in the manufacture of potash at Stassfurt, Germany.

Conventional combinations.[a]				Radicals in per cent of water-soluble anhydrous residue.[b]			
	Crude carnallite.	Crude kainite.	Hartsalz.		Crude carnallite.	Crude kainite.	Hartsalz.
KCl	15.7		20.0	K	11.5	12.9	13.4
K_2SO_4		24.0		Na	11.8	14.7	22.2
NaCl	21.5	31.0	55.0	Ca	.1		
$MgCl_2$	21.3	13.0		Mg	11.2	7.2	3.6
$MgSO_4$	13.0	15.5	22.4	Cl	50.9	34.3	46.4
$CaCl_2$	.3			SO_4	14.5	30.9	14.4
H_2O	26.2	14.0	2.6				
Insol	2.0	2.5					
	100.0	100.0	100.0		100.0	100.0	100.0

[a] Thorpe, Edward, Dictionary of applied chemistry, vol. 4, p. 342, 1913.
[b] Recalculated from conventional combinations.

The following description of the methods used in manufacturing potassium chloride (muriate) will give a general idea of the manufacturing processes:

The raw material after being crushed is dissolved by water or more commonly by waste liquors at elevated temperatures and under pressures varying from one to several atmospheres. After settling, the solution is separated from the residue by decantation. The undissolved matter is washed with water and discarded, the washings being used in dissolving fresh batches of carnallite. On the cooling of the decanted solution about 80 per cent of the potassium chloride is deposited. The decanted mother liquor on further concentration and cooling yields practically all the remaining potassium chloride as a crop of carnallite crystals. The final mother liquor obtained by the last treatment contains very little potash and is discarded. The crop of artificial carnallite obtained above is decomposed by hot water and subjected to crystallization when most of the remaining potassium separates as chloride. This second product is usually purer than the first. The mother liquor resulting from the working up of the artificial carnallite is usually added to the first mother liquor.

The potassium chloride is purified by crystallization when the content is less than 50 per cent, and by washing when the percentage exceeds this figure. The first product usually contains about 60 per cent potassium chloride, so that the latter process is followed in most cases. Advantage is taken of the fact that at low temperatures potassium chloride is less soluble than the chlorides of sodium and magnesium and that these salts produce a lowering of the temperature when brought in contact with the water. The washing is accomplished in special tanks by two treatments, one with wash water from a previous operation and one with pure water. The wash waters are finally utilized in dissolving fresh carnallite. The moisture in the purified product is reduced to about 8 per cent by draining and to 5 per cent by centrifuging. The remaining moisture is reduced to below 2 per cent by heat in special apparatus. The composition of the purified product varies from 80 to 98 per cent potassium chloride.

ITALY.

Extensive deposits of alunite occur near Tolfa, Italy, and are utilized in the production of potash salts. Estimates[1] in 1908 placed the amount of ore available at 150,000 to 200,000 metric tons. The quantity[2] of alunite utilized was 3,700 metric tons in 1914 and 4,850 metric tons in 1915.

The leucite lavas of Italy are under investigation as a source of potash. Washington[3] has shown that the leucite lavas contain from 7.5 to 9 per cent of potash and that the several deposits have a combined estimated content of 8,786,200,000 metric tons of potash (K_2O).

JAPAN.

Japan is now producing potassium chlorate far in excess of her own consumption and is exporting it not only to the United States

[1] Soc. de l'industrie minérale Bull., 4th ser., vol. 9, p. 563, 1908.
[2] Rivista del Servizio minerario, 1915, p. 182.
[3] Washington, H. S., Potash in leucite lavas of Italy: Met. and Chem. Eng., vol. 18, pp. 65–71, 1918.

but to China, British India, the Dutch East Indies, Russia, and Great Britain. Japanese muriate is also finding a ready market in the southern part of the United States.

The chief sources of supply of the Japanese potash are believed to be kelp,[1] found in the northern part of the Japanese Sea in large quantity, sea-water bitterns,[1] and ashes from wild banana stalks, tobacco refuse, etc.[2] The Asano Portland Cement Co., Tokyo, Japan, is recovering potash by the Cottrell dust-collecting system.

RUSSIA.

Russia produced a considerable amount of potash in 1917 from wood and sunflower ashes and exported several thousand tons of crude carbonate to the United States. A large deposit of potash is reported [3] to have been discovered in the Solikamsk region.

SPAIN.[4]

Potash deposits were discovered a few years ago in the Province of Barcelona, Spain, near the villages of Suria and Cardona. The salts occur in Oligocene Tertiary formations. They consist of irregular beds of carnallite and sylvinite interbedded with and occurring in rock salt. Explorations to a depth of several hundred feet show that in the Suria district potash beds occupy an area of not less than 75 acres and occur at depths from 125 to 200 feet. The average combined thickness of the carnallite beds is estimated to be about 56 feet, and of the sylvite about 13 feet. The Cardona deposits occur in the axis of a sharp anticline about 220 yards from Cardona. The upper beds are interbedded with gypsum and clay, but the lower beds contain nearly pure white salt, which is that principally mined. After the discovery of potash at Suria, these beds were searched for potash and nearly pure sylvite was found. Estimates [5] for the area prospected place the amount of carnallite at 2,550,000 tons and sylvinite at 1,150,000 tons.

The Asland Portland Cement Co., Barcelona, Spain, is installing a Cottrell dust-collecting system for the recovery of potash.

MISCELLANEOUS.

Reports have reached the Survey of the discovery of potash salts in quantity in Brazil, Colombia, Peru, and Venezuela, but no authentic information concerning them is at hand. The Dalen Portland Cement Co., Brevik, Norway, has closed a contract for the installation of a Cottrell dust-collecting system for the recovery of potash. In the later part of 1917 it was reported that a plant for the production of potash from the palma de cano tree was in course of construction in Cuba.

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[1] Beckman, J. W., Mineral industry in 1916, vol. 25, pp. 602–607, 1917.

[2] Yatsugi, M., Jour. Chem. Ind. Japan, vol. 19, pp. 1035–1044, 1916; Chem. Abstracts, vol. 11, p. 385, 1917.

[3] Am. Fertilizer, Dec. 8, 1917, p. 8.

[4] Rubio, César, and Marin, Augustin, Sales potásicas en Cataluña: Inst. geol. España Bol., vol. 34, pp. 173–230, and maps, 1914. The world's supply of potash, London, Imperial Institute of the United Kingdom, 1915.

[5] Beckman, J. W., Mineral industry, vol. 24, p. 586, 1915.

SIMPLE TESTS FOR POTASH.

INTRODUCTION.

Two simple methods for the detection of potash applicable for field use are here described for the benefit of those who may be interested in potash exploration. Before undertaking to apply them to unknown substances, the inexperienced manipulator should first familiarize himself with the details of the methods by experiments on small quantities of pure potassium chloride and on mixtures of potassium chloride and sodium chloride. The water used in making the solutions should be as pure as possible, preferably distilled or rain water. If ground water is used, it should first be tested for potash.

PREPARATION OF SAMPLE.

The common natural materials generally to be tested for potash are brines, soluble salts, saline residues, saline earths, ashes, alunite, and silicate rocks. The detection of potash in these materials requires them to be in solution. Brines may be tested directly. Soluble salts, saline residues, saline earths, and ashes should be dissolved or leached with a small amount of pure water, the mixture should be allowed to stand until all sediment has settled to the bottom, and the clear supernatent liquid should be decanted or filtered from the insoluble residue and used in making the potash tests. Alunite should be powdered finely, roasted at a strong red heat for half an hour, leached with water, and the clear leachings used in testing for potash. Silicate rocks and minerals should be powdered finely, mixed with an equal amount of pure gypsum or pure calcium carbonate, moistened with hydrochloric acid, and a small amount of the wet mixture removed on a loop of platinum wire and examined for potash by the flame test.

FLAME TEST.

Equipment.—(1) Lamp for volatilizing the potash compound. An alcohol lamp with an asbestos wick will often suffice for this purpose, but a small gasoline or alcohol blast lamp which requires no wick is far better. (2) Small platinum wire about 4 inches long, one end of which is bent into the form of a loop. (3) Merwin color screen. (4) Hydrochloric acid.

Procedure.—First clean the loop of platinum wire by dipping it in hydrochloric acid and igniting it until the flame is no longer colored. By means of the clean platinum loop remove a drop of the solution to be tested which has been acidified by hydrochloric acid, carefully evaporate it to dryness by holding over the flame, finally ignite, and observe the color of the flame through the Merwin color screen. The best results are obtained by using a black background in a dark room, holding the Merwin screen close up against the eyes, and looking through the central section of the screen. If potassium salts are present, the flame will appear reddish or reddish violet, and the intensity and duration of the color will give some idea of the amount of potassium.

COBALTINITRITE METHOD.

Reagents.—(1) Sodium nitrite solution prepared by dissolving 125 grams of sodium nitrite ($NaNO_2$) in 250 cubic centimeters of distilled water. (2) Cobalt nitrate solution prepared by dissolving

25 grams of cobalt nitrate ($Co(NO_3)_2.6H_2O$) in 100 cubic centimeters of distilled water and adding 50 cubic centimeters of concentrated (glacial) acetic acid. (3) Acetic acid.

Procedure.—Place a small quantity of the solution to be examined in a test tube, acidify slightly with acetic acid, add about an equal quantity of the sodium nitrite solution and about half as much of the cobalt nitrate solution. Mix and allow the mixture to stand until effervescence ceases and the cherry-red solution is transparent. If an appreciable amount of potash is present a yellow precipitate will have settled to the bottom of the test tube. By comparing the volume of the precipitate with that produced when a known quantity of potassium chloride is used, an idea of the amount of potash present can be obtained. Ammonium salts produce a similar precipitate, but are not usually present in appreciable amounts in natural materials ordinarily to be tested for potash.

POTASH LEASING LAW.

The law providing for exploration and disposition of potash lands (40 Stat., 297) is given below.

An Act to authorize exploration for and disposition of potassium.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Interior is hereby authorized and directed, under such rules and regulations as he may prescribe, to issue to any applicant who is a citizen of the United States, an association of such citizens, or a corporation organized under the laws of any State or Territory thereof, a prospecting permit which shall give the exclusive right for a period not exceeding two years, to prospect for chlorides, sulphates, carbonates, borates, silicates, or nitrates of potassium on public lands of the United States, except lands in and adjacent to Searles Lake, which would be described if surveyed as townships twenty-four, twenty-five, twenty-six, and twenty-seven south of ranges forty-two, forty-three, and forty-four east, Mount Diablo meridian, California: *Provided,* That the area to be included in such permit shall not exceed two thousand five hundred and sixty acres of land in reasonably compact form.

Sec. 2. That upon showing to the satisfaction of the Secretary of the Interior that valuable deposits of one or more of the substances enumerated in section one hereof *have been discovered by the permittee* within the area covered by his permit, the permittee shall be entitled to a patent for not to exceed one-fourth of the land embraced in the prospecting permit, to be taken in compact form and described by legal subdivisions of the public-land surveys, or if the land be not surveyed, then in tracts which shall not exceed two miles in length, by survey executed at the cost of the permittee, in accordance with rules and regulations prescribed by the Secretary of the Interior. All other lands described and embraced in such a prospecting permit from and after the exercise of the right to patent accorded to the discoverer, and not covered by leases, may be leased by the Secretary of the Interior through advertisement, competitive bidding, or such other methods as he may by general regulations adopt, and in such areas as he shall fix, not exceeding two thousand five hundred and sixty acres, all leases to be conditioned upon the payment by the lessee of such royalty as may be specified in the lease and which shall be fixed by the Secretary of the Interior in advance of offering the same, and which shall not be less than two percentum on the gross value of the output at the point of shipment, which royalty, on demand of the Secretary of the Interior, shall be paid in the product of such lease, and the payment in advance of a rental, which shall be not less than 25 cents per acre for the first year thereafter; not less than 50 cents per acre for the second, third, fourth, and fifth years, respectively; and not less than $1 per acre for each and every year thereafter during the continuance of the lease, except that such rental for any year shall be credited against the royalties as they accrue for that year. Leases shall be for indeterminate periods, upon condition that at the end of each twenty-year period succeeding the date of any lease such readjustment of terms and conditions may be made as the Secretary of the Interior may determine, unless otherwise provided by law at the time of the expiration of such periods, and a patentee under this section may also be a lessee: *Provided*, That the potash deposits in the public lands in and adjacent to Searles Lake in what would be if surveyed townships twenty-four, twenty-five, twenty-six, and twenty-seven south of ranges forty-two, forty-three, and forty-four east, Mount Diablo meridian, California, may be operated by the United States or may be leased by the Secretary of the Interior under the terms and provisions of this Act: *Provided further*, That the Secretary of the Interior may issue leases under the provisions of this act for deposits of potash in public lands in Sweetwater County, Wyoming, also containing deposits of coal, on condition that the coal be reserved to the United States.

SEC. 3. That in addition to areas of such mineral land to be included in prospecting permits or leases the Secretary of the Interior, in his discretion, may issue to a permittee or lessee under this act the exclusive right to use, during the life of the permit or lease, a tract of unoccupied nonmineral public land not exceeding forty acres in area for camp sites, refining works, and other purposes connected with and necessary to the proper development and use of the deposits covered by the permit or lease.

SEC. 4. That the Secretary of the Interior shall reserve the authority and shall insert in any preliminary permit issued under section one hereof appropriate provision for its cancellation by him upon failure by the permittee or licensee to exercise due diligence in the prosecution of the prospecting work in accordance with the terms and conditions stated in the permit.

SEC. 5. That no person shall take or hold any interest or interests as a member of an association or associations or as a stockholder of a corporation or corporations holding a lease under the provisions hereof which, together with the area embraced in any direct holding of a lease under this act, or which, together with any other interest or interests as a member of an association or associations or as a stockholder of a corporation or corporations holding a lease under the provisions hereof, or otherwise, exceeds in the aggregate in any area fifty miles square an amount equivalent to the maximum number of acres allowed to any one lessee under this act; that no person, association, or corporation holding a lease under the provisions of this act shall hold more than a tenth interest, direct or indirect, in any other agency, corporate or otherwise, engaged in the sale or resale of the products obtained from such lease; and any violation of the provisions of this section shall be ground for the forfeiture of the lease or interest so held; and the interests held in violation of this provision shall be forfeited to the United States by appropriate proceedings instituted by the Attorney General for that purpose in the United States district court for the district in which the property or some part thereof is located, except that any such ownership or interest hereby forbidden which may be acquired by descent, will, judgment, or decree may be held for two years and not longer after its acquisition.

SEC. 6. That any permit, lease, occupation, or use permitted under this act shall reserve to the Secretary of the Interior the right to permit for joint or several use such easements or rights of way upon, through, or in the lands leased, occupied, or used as may be necessary or appropriate to the working of the same, or of other lands containing the deposits described in this act, and the treatment and shipment of the products thereof by or under authority of the Government, its lessees, or permittees, and for other public purposes: *Provided*, That said Secretary, in his discretion, in making any lease under this act may reserve to the United States the right to dispose of the surface of the lands embraced within such lease under existing law or laws hereafter enacted, in so far as said surface is not necessary for use of the lessee in extracting and removing the deposits therein: *Provided further*, That if such reservation is made it shall be so determined before the offering of such lease; that the said Secretary, during the life of the lease, is authorized to issue such permits for easements herein provided to be reserved.

SEC. 7. That each lease shall contain provisions deemed necessary for the protection of the interests of the United States, and for the prevention of monopoly, and for the safeguarding of the public welfare.

SEC. 8. That any lease issued under the provisions of this act may be forfeited and canceled by an appropriate proceeding in the United States district court for the district in which the property or some part thereof is located whenever the lessee fails to comply with any of the provisions of this act, of the lease, *or of the general regulations promulgated* under this act and in force *at the date of the lease*, and the lease may provide for resort to appropriate methods for the settlement of disputes or for remedies for breach of specified conditions thereof.

SEC. 9. That the provisions of this act shall also apply to all deposits of potassium salts in the lands of the United States which may have been or may be disposed of under laws reserving to the United States the potassium deposits with the right to prospect for, drill, mine, and remove the same, subject to such conditions as to the use and occupancy of the surface as are or may hereafter be provided by law.

SEC. 10. That all moneys received from royalties and rentals under the provisions of this act, excepting those from Alaska, shall be paid into, reserved, and appropriated as a part of the reclamation fund created by the act of Congress approved June seventeenth, nineteen hundred and two, known as the reclamation act, but after use thereof in the construction of reclamation works and upon return to the reclamation fund of any such moneys in the manner provided by the reclamation act and acts amendatory thereof and supplemental thereto, fifty per centum of the amounts derived from such royalties and rentals, so utilized in and returned to the reclamation fund shall be paid by the Secretary of the Treasury after the expiration of each fiscal year to the State within the boundaries of which the leased lands or deposits are or were located, said moneys to be used by such State or subdivisions thereof for the construction and maintenance of public roads or for the support of public schools.

SEC. 11. That the Secretary of the Interior is authorized to prescribe necessary and proper rules and regulations and to do any and all things necessary to carry out and accomplish the purposes of this act.

SEC. 12. That the deposits herein referred to, in lands valuable for such minerals, shall be subject to disposition only in the form and manner provided in this act, except as to valid claims existent at date of the passage of this act and thereafter maintained in compliance with the laws under which initiated, which claims may be perfected under such laws: *Provided*, That nothing in this act shall be construed or held to affect the rights of the States or other local authority to exercise any rights which they may have to levy and collect taxes upon improvements, output of mines, or other rights, property, or assets of any lessee.

SEC. 13. That the Secretary of the Interior is hereby authorized and directed to incorporate in every lease issued under the provisions of this act a provision reserving to the President the right to regulate the price of all mineral extracted and sold from the leased premises, which stipulation shall specifically provide that the price or prices fixed shall be such as to yield a fair and reasonable return to the lessee upon his investment and to secure to the consumer any of such products at the lowest price reasonable and consistent with the foregoing: *Provided*, That such lease issued under this act shall also stipulate that the President shall have authority to so regulate the disposal of the potassium products produced under such lease as to secure its distribution and use wholly within the limits of the United States or its possession.

Approved, October 2, 1917.

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MINERAL WATERS.

By Arthur J. Ellis.

CHARACTER OF STATISTICS.

The statistics given in this report [1] have been compiled from individual reports furnished by the owners or operators of springs and include, so far as can be ascertained, the following:

(*a*) Natural waters that are bottled and sold in their natural state or only slightly altered from their natural state.

(*b*) Natural still waters that have been artificially carbonated.

(*c*) Natural carbonated waters that have lost part of their carbon dioxide.

(*d*) Waters from which iron has been removed.

Statistics in regard to the following classes of waters are not included in this report if available information makes it practicable to exclude them:

(*a*) Artificial waters and natural waters that have been flavored, concentrated, fortified, diluted, or otherwise essentially modified in chemical character.

(*b*) Water given away or consumed at spring resorts.

(*c*) Waters sold at flat or meter rates, delivered to consumers through pipes, or otherwise obviously municipal supplies or adjuncts to them.

No distinction is made between mineral water flowing or pumped from a natural spring and that flowing or pumped from a dug, bored, driven, or drilled well. Many of the best-known mineral waters in the United States come not from natural springs but from wells.

Distinction for statistical purposes between table and medicinal waters is entirely arbitrary. Most table waters are clear, sparkling, and without distinct mineral taste or odor; many medicinal waters are highly mineralized and have distinct mineral taste and odor. Yet some table waters are more strongly mineralized than some medicinal waters, and many medicinal waters contain less mineral matter than certain city supplies. The basis here used for distinguishing medicinal from table waters is the report regarding the spring, and this distinction is based in turn on the operator's knowledge that some of his customers buy the water to use regularly on their tables and others buy it for an aid during illness. A few strongly mineralized waters are not sold as table waters, and a few widely sold table waters are not used medicinally, but many waters are sold for both uses.

[1] The statistics in this report were compiled by Miss B. H. Stoddard, of the United States Geological Survey.

MINERAL-WATER TRADE IN 1917.

OUTPUT AND VALUE.

The number of active mineral springs was smaller in 1917 than in 1916, as were the production and value.

The State of New York led in number of commercial springs and in quantity of mineral water sold, and was second to Wisconsin in total value of product and in the value of table waters; it ranked first in value of medicinal waters, and Indiana and California stood in second and third places, respectively. Virginia and Maine were also large producers of medicinal waters. In value of table waters Wisconsin and New York were followed in order by California, Maine, Massachusetts, and Ohio; and in total value of product Wisconsin and New York were followed in order by California, Maine, Virginia, and Indiana. More than 30 springs were active in each of 9 States, more than 1,000,000 gallons of mineral water was sold in each of the 15 States, and the value of the water sold amounted to more than $100,000 in each of 13 States.

Sales were reported from 717 springs in 1917, as compared with 802 springs in 1916. No reports of mineral-water sales were received from Arizona, Idaho, or Utah, and less than three active springs each were reported from Delaware, District of Columbia, Nebraska, and Nevada; three or more springs were active in every other State in the Union. Sales exceeded 5,000,000 gallons in New York and Wisconsin, and the total value of the product was more than $1,000,000 in Wisconsin and more than $500,000 in New York.

As shown in the following table, 82 per cent of all the mineral waters sold in the United States in 1917 came from 15 States. All other States than those mentioned in the following table furnished less than one-half of 1 per cent each:

Mineral water sold in the leading States and their respective percentages of total sold in the United States.

State.	Quantity.	Percentage of total.
	Gallons.	
New York	7,819,314	17
Wisconsin	6,296,634	14
Ohio	3,113,093	7
Minnesota	3,004,546	6
Massachusetts	2,908,638	6
California	2,566,491	6
Virginia	2,518,050	5
Connecticut	1,964,096	4
Pennsylvania	1,603,090	3
Illinois	1,370,461	3
New Jersey	1,283,157	3
Michigan	1,069,164	2
Maryland	1,036,045	2
Arkansas	1,020,463	2
Maine	1,014,084	2
	38,587,326	82
All other States	8,197,093	18
	46,784,419	100

Mineral waters sold in the United States in 1916 and 1917.

State.	Commercial springs.	Quantity sold.	Average price per gallon.	Value of medicinal waters.	Value of table waters.	Total value.
1916.		*Gallons.*	*Cents.*			
Alabama	16	103,944	12	$5,979	$6,195	$12,174
Arkansas	13	1,152,505	9	56,623	43,993	100,616
California	55	2,651,471	19	206,853	296,922	503,775
Colorado	12	542,185	22	6,301	114,208	120,509
Connecticut	34	2,837,878	5	1,920	131,848	133,768
Florida	7	202,970	8	1,424	14,252	15,676
Georgia	18	618,367	7	5,429	39,781	45,210
Illinois	21	1,777,741	5	7,765	86,291	94,056
Indiana	17	609,544	31	169,545	19,100	188,645
Iowa	7	148,732	10	5,304	9,100	14,404
Kansas	12	237,790	25	53,076	5,716	58,792
Kentucky	11	377,246	14	38,664	13,641	52,305
Louisiana	4	429,650	7	2,918	28,150	31,068
Maine	24	1,038,861	34	90,643	263,149	353,792
Maryland	9	1,312,788	8	5,000	94,020	99,020
Massachusetts	51	3,124,096	4	15,613	112,865	128,478
Michigan	18	996,875	11	7,209	101,658	108,867
Minnesota	18	4,188,434	3	555	145,027	145,582
Mississippi	12	399,248	12	47,409	1,030	48,439
Missouri	36	1,394,092	8	74,828	34,986	109,814
Montana	4	181,800	7	1,000	11,294	12,294
Nebraska	3	8,440	11	74	872	946
Nevada	3	346,260	1	12	4,148	4,160
New Hampshire	6	269,860	6	38	14,897	14,935
New Jersey	15	1,580,028	8	3,100	127,893	130,993
New Mexico	4	35,450	11	5	3,960	3,965
New York	68	7,746,490	9	86,713	610,937	697,650
North Carolina	19	137,817	14	12,923	6,087	19,010
North Dakota	6	766,000	2	750	13,750	14,500
Ohio	37	4,102,922	4	60,263	100,897	161,160
Oklahoma	13	1,353,513	3	3,705	36,484	40,189
Oregon	6	30,920	26	1,076	6,885	7,961
Pennsylvania	42	1,671,637	9	21,898	123,235	145,133
Rhode Island	6	449,453	7	0	33,050	33,050
South Carolina	10	427,905	15	59,111	4,707	63,818
South Dakota	5	470,725	4	52	20,460	20,512
Tennessee	20	799,346	6	27,920	20,496	48,416
Texas	30	703,002	14	95,885	1,628	97,513
Vermont	5	72,590	21	4,310	11,085	15,395
Virginia	50	2,313,616	11	128,747	120,159	248,906
Washington	4	151,528	6	1,821	7,655	9,476
West Virginia	9	287,466	16	17,487	29,199	46,686
Wisconsin	36	7,696,813	20	76,979	1,430,700	1,507,679
Wyoming	3	53,891	13	2,000	5,269	7,269
Other States [a]	3	126,572	15	11,538	6,891	18,429
	802	55,928,461	10	1,420,465	4,314,570	5,735,035

[a] Includes Delaware, District of Columbia, and Utah.

Mineral waters sold in the United States in 1916 and 1917—Continued.

State.	Commercial springs.	Quantity sold.	Average price per gallon.	Value of medicinal waters.	Value of table waters.	Total value.
1917.		*Gallons.*	*Cents.*			
Alabama	13	56,270	10	$3,437	$2,072	$5,509
Arkansas	8	1,020,463	8	61,742	16,399	78,141
California	52	2,566,491	18	127,593	327,767	455,360
Colorado	12	442,815	15	25,679	39,490	65,169
Connecticut	31	1,964,096	5	3,127	100,851	103,978
Florida	7	142,030	7	5,818	4,032	9,850
Georgia	11	411,127	9	6,471	30,970	37,441
Illinois	16	1,370,461	5	1,471	64,571	66,042
Indiana	16	521,758	29	143,285	9,184	152,469
Iowa	4	99,103	12	4,375	7,750	12,125
Kansas	11	289,493	23	60,779	6,997	67,776
Kentucky	13	301,748	13	24,396	15,793	40,189
Louisiana	4	270,000	7	6,990	12,500	19,490
Maine	24	1,014,084	34	86,570	257,017	343,587
Maryland	7	1,036,045	8	1,409	85,529	86,938
Massachusetts	48	2,908,638	5	7,334	131,741	139,075
Michigan	12	1,069,164	10	500	105,141	105,641
Minnesota	17	3,004,546	4	32,528	77,436	109,964
Mississippi	12	197,555	25	49,138	648	49,786
Missouri	33	401,776	14	43,883	13,292	57,175
Montana	4	211,133	5	500	9,070	9,570
New Hampshire	7	105,181	7	158	6,817	6,975
New Jersey	14	1,283,157	9	7,751	107,437	115,188
New Mexico	3	48,325	5	40	2,290	2,330
New York	65	7,819,314	7	173,187	389,687	562,874
North Carolina	18	103,659	15	12,248	3,416	15,664
North Dakota	3	556,000	2	....	12,837	12,837
Ohio	31	3,113,093	4	6,540	130,170	136,710
Oklahoma	11	852,381	3	2,650	24,347	26,997
Oregon	5	13,741	21	579	2,263	2,842
Pennsylvania	41	1,603,090	9	18,206	128,815	147,021
Rhode Island	6	368,976	7	....	24,975	24,975
South Carolina	7	289,094	16	44,244	1,485	45,729
South Dakota	3	443,167	3	42	13,503	13,545
Tennessee	19	758,193	6	26,781	20,581	47,362
Texas	27	541,178	13	69,915	2,260	72,175
Vermont	4	94,500	19	2,000	15,705	17,705
Virginia	41	2,518,050	9	108,677	129,111	237,788
Washington	4	155,265	5	540	6,725	7,265
West Virginia	7	156,267	24	17,870	19,659	37,529
Wisconsin	36	6,296,634	22	64,140	1,298,358	1,362,498
Wyoming	4	53,726	15	2,850	5,040	7,890
Other States [a]	6	312,632	4	20	12,516	12,536
	717	46,784,419	11	1,255,463	3,676,247	4,931,710

[a] Includes Delaware, District of Columbia, Nebraska, and Nevada.

CONDITION OF TRADE.

The total production (quantity and value) in 1917 was less than that reported for the last four years, the value in 1914 excepted.

Mineral waters sold in the United States, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	838	57,867,399	$5,631,391	10
1914	829	54,358,466	4,892,328	9
1915	812	52,113,503	5,138,794	10
1916	802	55,928,461	5,735,035	10
1917	717	46,784,419	4,931,710	11

Comparative production of mineral waters, 1916 and 1917.

State.	1916			1917			Increase or decrease in number of springs.	Increase or decrease in quantity sold.		Increase or decrease in value of product.	
	Commercial springs.	Quantity sold.	Value.	Commercial springs.	Quantity sold.	Value.					
		Gallons.			Gallons.			Gallons.	Per cent.	Dollars.	Per cent.
Alabama	16	103,944	$12,174	13	56,270	$5,509	− 3	− 47,674	−46	− 6,665	−55
Arkansas	13	1,152,505	100,616	8	1,020,463	78,141	− 5	− 132,042	−11	− 22,475	−22
California	55	2,651,471	503,775	52	2,566,491	455,360	− 3	− 84,980	− 3	− 48,415	−10
Colorado	12	542,185	120,509	12	442,815	65,169	0	− 99,370	−18	− 55,340	−46
Connecticut	34	2,837,878	133,768	31	1,964,096	103,978	− 3	− 873,782	−31	− 29,790	−22
Florida	7	202,970	15,676	7	142,030	9,850	0	− 60,940	−30	− 5,826	−37
Georgia	18	618,367	45,210	11	411,127	37,441	− 7	− 207,240	−34	− 7,769	−17
Illinois	21	1,777,741	94,056	16	1,370,461	66,042	− 5	− 407,280	−23	− 28,014	−30
Indiana	17	609,544	188,645	16	521,758	152,469	− 1	− 87,786	−14	− 36,176	−19
Iowa	7	148,732	14,404	4	99,103	12,125	− 3	− 49,629	−33	− 2,279	−16
Kansas	12	237,790	58,792	11	289,493	67,776	− 1	+ 51,703	+22	+ 8,984	+15
Kentucky	11	377,246	52,305	13	301,748	40,189	+ 2	− 75,498	−20	− 12,116	−23
Louisiana	4	429,650	31,068	4	270,000	19,490	0	− 159,650	−37	− 11,578	−37
Maine	24	1,038,861	353,792	24	1,014,084	343,587	0	− 24,777	− 2	− 10,205	− 3
Maryland	9	1,312,788	99,020	7	1,036,045	86,938	− 2	− 276,743	−21	− 12,082	−12
Massachusetts	51	3,124,096	128,478	48	2,908,638	139,075	− 3	− 215,458	− 7	+ 10,597	+ 8
Michigan	18	996,875	108,867	12	1,069,164	105,641	− 6	+ 72,289	+ 7	− 3,226	− 3
Minnesota	18	4,188,434	145,582	17	3,004,546	109,964	− 1	−1,183,888	−28	− 35,618	−24
Mississippi	12	399,248	48,439	12	197,555	49,786	0	− 201,693	−51	+ 1,347	+ 3
Missouri	36	1,394,092	109,814	33	401,776	57,175	− 3	− 992,316	−71	− 52,639	−48
Montana	4	181,800	12,294	4	211,133	9,570	0	+ 29,333	+16	− 2,724	−22
Nebraska	3	8,440	946	2	(a)	(a)	− 1	(a)	(a)	(a)	(a)
Nevada	3	346,260	4,160	2	(a)	(a)	− 1	(a)	(a)	(a)	(a)
New Hampshire	6	269,860	14,935	7	105,181	6,975	+ 1	− 164,679	−61	− 7,960	−53
New Jersey	15	1,580,028	130,993	14	1,283,157	115,188	− 1	− 296,871	−19	− 15,805	−12
New Mexico	4	35,450	3,965	3	48,325	2,330	− 1	+ 12,875	+36	− 1,635	−41
New York	68	7,746,490	697,650	65	7,819,314	562,874	− 3	+ 72,824	+ 1	−134,776	−19
North Carolina	19	137,817	19,010	18	103,659	15,664	− 1	− 34,158	−25	− 3,346	−18
North Dakota	6	766,000	14,500	3	556,000	12,837	− 3	− 210,000	−27	− 1,663	−11
Ohio	37	4,102,922	161,160	31	3,113,093	136,710	− 6	− 989,829	−24	− 24,450	−15
Oklahoma	13	1,353,513	40,189	11	852,381	26,997	− 2	− 501,132	−37	− 13,192	−33
Oregon	6	30,920	7,961	5	13,741	2,842	− 1	− 17,179	−56	− 5,119	−64
Pennsylvania	42	1,671,637	145,133	41	1,603,090	147,021	− 1	− 68,547	− 4	+ 1,888	+ 1
Rhode Island	6	449,453	33,050	6	368,976	24,975	0	− 80,477	−18	− 8,075	−24
South Carolina	10	427,905	63,818	7	289,094	45,729	− 3	− 138,811	−32	− 18,089	−28
South Dakota	5	470,725	20,512	3	443,167	13,545	− 2	− 27,558	− 6	− 6,967	−34
Tennessee	20	799,346	48,416	19	758,193	47,362	− 1	− 41,153	− 5	− 1,054	− 2

a Included in "other States."

Comparative production of mineral waters, 1916 and 1917—Continued.

State.	1916			1917			Increase or decrease in number of springs.	Increase or decrease in quantity sold.		Increase or decrease in value of product.	
	Commercial springs.	Quantity sold.	Value.	Commercial springs.	Quantity sold.	Value.					
		Gallons.			*Gallons.*			*Gallons.*	*Per cent.*		*Per cent.*
Texas	30	703,002	$97,513	27	541,178	$72,175	− 3	− 161,824	−23	−$25,338	−26
Vermont	5	72,590	15,395	4	94,500	17,705	− 1	+ 21,910	+30	+ 2,310	+15
Virginia	50	2,313,616	248,906	41	2,518,050	237,788	− 9	+ 204,434	+ 9	− 11,118	− 4
Washington	4	151,528	9,476	4	155,265	7,265	0	+ 3,737	+ 2	− 2,211	−23
West Virginia	9	287,466	46,686	7	156,267	37,529	− 2	− 131,199	−46	− 9,157	−20
Wisconsin	36	7,696,813	1,507,679	36	6,296,634	2,362,498	0	−1,400,179	−18	−145,181	−10
Wyoming	3	53,891	7,269	4	53,726	7,890	+ 1	− 165	− .31	+ 621	+ 9
Other States[a]	3	126,572	18,429	6	312,632	12,536	+ 3	− 168,640	−35	− 10,999	−47
	802	55,928,461	5,735,035	721	46,784,419	4,931,710	−81	−9,144,042	−16	−803,325	−14

[a] Includes in 1916 Delaware, District of Columbia, and Utah; in 1917, Delaware, District of Columbia, Nebraska, and Nevada.

RANGE OF PRICE.

Effort has been made in compiling the following table, which gives the quantity and value of mineral water sold within certain ranges of price during 1916 and 1917, to eliminate freight and marketing charges and the value of returnable containers, and thus to give the net value of the waters at their sources.

Range of price per gallon of mineral water, 1916 and 1917.

Price per gallon (in cents).	Number of springs.	Quantity sold.	Value.	Percentage of number of springs.	Percentage of total quantity.	Percentage of total value.
1916.		*Gallons.*				
Not more than 2	44	12,507,685	$214,831	6	22.4	4
More than 2 and not more than 5	184	13,392,955	529,188	23	23.9	9
More than 5 and not more than 10	259	18,758,900	1,519,313	33	33.5	27
More than 10 and not more than 20	136	5,286,014	817,045	17	9.5	14
More than 20 and not more than 30	60	1,326,572	330,467	8	2.4	6
More than 30 and not more than 50	63	3,647,317	1,511,138	8	6.5	26
More than 50 and not more than 100	29	864,638	621,939	4	1.5	11
More than 100	9	144,380	191,114	1	.3	3
	a 784	55,928,461	5,735,035	100	100.0	100
1917.						
Not more than 2	28	3,319,063	52,350	4	7	1
More than 2 and not more than 5	163	19,354,995	674,219	23	41	14
More than 5 and not more than 10	265	14,654,374	1,230,718	38	31	25
More than 10 and not more than 20	99	4,052,103	632,423	14	9	13
More than 20 and not more than 30	53	924,773	239,648	8	2	5
More than 30 and not more than 50	59	3,605,682	1,544,024	9	8	31
More than 50 and not more than 100	23	869,240	550,061	3	2	11
More than 100	7	4,189	8,267	1	0	0
	b 697	46,784,419	4,931,710	100	100	100

a Exclusive of 18 springs whose waters are used exclusively in the manufacture of soft drinks.
b Exclusive of 20 springs whose waters are used exclusively in the manufacture of soft drinks.

Practically four-fifths of the mineral waters was sold at prices ranging from half a cent to 10 cents a gallon during 1913, 1914, 1915, 1916, and 1917. The percentage sold for more than 30 cents a gallon was 10 per cent in 1917 as compared with 8.3 per cent in 1916. The water from 456 springs was sold for 10 cents or less a gallon, and the water from 7 springs was sold for more than $1 a gallon. The average price per gallon in 1917 was 11 cents.

SOFT DRINKS.

Returns show that the quantity of mineral water used in the manufacture of soft drinks in 1917 was less than in 1916. The gross distribution of the consumption during 1917 is indicated in the following table. Wisconsin heads the list with a consumption greater than 1,000,000 gallons. In addition to Wisconsin 15 States reported consumption exceeding 100,000 gallons each, and 24 other States reported a combined consumption of 665,385 gallons. This recorded consumption does not represent the total production of soft drinks in the United States, as most of them are compounded with municipal and private supplies not classified as mineral waters.

Mineral water used in the manufacture of soft drinks, 1917.

Rank.	State.	Quantity.	Rank.	State.	Quantity.
		Gallons.			*Gallons.*
1	Wisconsin	1,014,204	11	Arkansas	250,000
2	Massachusetts	893,926	12	Ohio	248,000
3	Minnesota	506,523	13	Maryland	175,426
4	New Hampshire	477,937	14	Colorado	165,222
5	Virginia	438,166	15	Iowa	144,443
6	South Carolina	425,720	16	North Dakota	120,000
7	Pennsylvania	404,671		Other States	665,385
8	Connecticut	309,860			
9	Nebraska	280,000			6,772,321
10	New York	252,838			

EXPORTS.

Large quantities of a few domestic waters are exported, but no statistics regarding such shipments are available. The quantity and the value of these waters are included in the statistics of production for the United States.

IMPORTS.

The total imports of natural and artificial waters entered for consumption in 1917, as reported by the Bureau of Foreign and Domestic Commerce, Department of Commerce, amounted to 618,405 gallons, valued at the points of shipment at $268,665. This was a decrease of 60 per cent in quantity, according to revised figures for 1916, and of 57 per cent in value. The average price in 1917 was 43 cents, an increase of 3 cents over revised figures for 1916. The imports have decreased in quantity every year but one since 1912. A table showing general imports, by principal countries, is given on page 491, and imports of mineral waters, beginning with 1909, the first year for which statistics are available, are assembled and published in the table on page 491. This table gives historical data not otherwise obtainable without difficulty.

Mineral waters imported for consumption in the United States, 1913–1917.

Year.	Quantity.	Value.	Price per gallon.
	Gallons.		*Cents.*
1913	3,364,676	$955,788	28
1914	2,786,142	857,707	31
1915	1,528,181	551,648	36
1916	1,553,199	624,302	40
1917	618,405	268,665	43

Mineral waters imported into the United States, by countries, in 1916 and 1917.

Country.	Quantity.	Value.	Country.	Quantity.	Value.
1916.	*Gallons.*		**1917.**	*Gallons.*	
France	1,425,546	$552,626	France	580,251	$232,029
Germany	124,716	17,342	Germany	60	35
Greece	75	11	Italy	22,293	10,453
Italy	33,636	9,030	Netherlands	39	30
Netherlands	29,820	10,546	Spain	30,981	12,337
Norway	390	130	England	6,420	2,490
Spain	40,563	14,662	Canada	4,557	4,368
Sweden	12	4	Norway	180	123
England	37,788	15,512	Portugal	15	6
Ireland	228	65	Sweden	126	80
Canada	4,545	1,597	Switzerland	570	487
Mexico	504	345	Ireland	1,950	1,825
Cuba	447	327	Mexico	60	36
Colombia	141	50	Cuba	189	69
Japan	23,901	4,272	Dominican Republic	9	5
Canary Islands	1,128	278	Japan	9,045	1,666
	1,723,440	626,797		656,745	266,039

Mineral waters imported into the United States, 1909–1915.

Country.	1909		1910		1911		1912	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*		*Gallons.*	
Austria-Hungary	568,533	$159,818	495,867	$131,329	399,681	$95,816	521,823	$121,888
France	899,244	444,302	978,294	446,533	1,405,251	577,881	1,166,463	482,495
Germany	2,028,042	467,460	1,872,477	334,747	1,896,267	324,907	1,883,985	311,993
Italy	11,220	3,813	16,161	4,606	23,175	5,487	28,992	7,269
Netherlands	12,129	2,675	4,461	1,231	22,965	2,827	25,086	8,408
Spain	57,528	27,477	58,842	23,066	104,676	41,075	53,154	24,245
England	16,404	4,851	30,465	9,611	28,251	10,079	14,193	3,566
Canada	16,206	7,409	11,829	3,936	2,775	936	1,221	614
All other countries	56,931	11,009	49,221	6,627	51,279	8,494	38,874	6,443
	3,666,237	1,128,814	3,517,617	961,686	3,934,320	1,067,502	3,733,791	966,921

Country.	1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
Austria-Hungary	384,960	$88,369	314,592	$79,837	37,197	$7,531
France	1,162,878	512,415	1,304,685	528,392	899,205	375,653
Germany	1,786,839	322,350	1,029,753	196,469	511,677	111,847
Italy	35,181	8,223	70,980	20,540	31,800	9,122
Netherlands	19,155	5,634	1,125	215	9,549	3,171
Spain	72,747	29,034	72,225	30,387	51,855	19,211
England	32,568	14,220	30,423	12,229	44,178	18,624
Canada	10,077	2,107	2,475	857	4,413	1,120
All other countries	58,458	10,174	27,426	5,168	18,513	3,792
	3,562,863	992,526	2,853,684	874,094	1,608,387	550,071

"General imports" and "imports for consumption" for any period will differ to the extent that the value of entries for warehouse for the period differs from the value of withdrawals from warehouse for consumption. The term "entry for consumption" is the technical name of the import entry made at the customhouse and implies that the goods have been delivered into the custody of the importer and that the duties have been paid on the dutiable portion. Some of them may be afterward exported.

TRADE CONDITIONS IN 1917 AND 1918.

The reports of sales of mineral waters in 1918 may be expected to reflect war-time conditions. Trade disturbances due to the war were only beginning to be felt in 1917; nevertheless, as shown in preceding paragraphs, there was a decrease of nearly 10,000,000 gallons in the quantity of mineral waters sold. There are no data at hand from which to determine definitely how much of this decrease was due to the war, but it is reasonable to attribute most if not all of it to that cause. The adversities that began to appear in 1917 persisted and were even more severe in 1918. Inadequate railroad transportation, restrictions on the use of sugar in the manufacture of soft drinks, curtailment of consumption of fuel for the manufacture of glass containers, labor shortage, increased cost of materials, and scarcity of supplies all combined to render progress in the mineral-water business difficult. A comparatively minor factor opposed to these was the demand for soft drinks and for spring waters at or in the vicinity of military encampments and along routes of troop transportation. Although a stimulation of mineral-water trade on this account was no doubt observed locally, it is doubtful if the general result was more than barely appreciable.

The mineral-water trade was also probably affected in a measure by governmental regulations and restrictions on imports. The War Trade Board published on March 23, 1918, a list of restricted imports, in which overseas imports of malt liquors, wines, and other beverages, including mineral waters, were excluded except under certain very rigid conditions. On May 27 this list was amended so as to permit mineral waters to be imported from France when coming from a convenient port and loaded without delay, and on July 30 the list was further amended to permit imports of mineral waters from the United Kingdom and Italy, as well as France. On December 28, 1918, all restrictions on the importation of mineral waters were removed.

OUTLOOK FOR 1919.

With the signing of the armistice late in 1918 prospects became good for a healthy stimulation of the mineral-water trade. Important industrial and commercial improvements are now confidently expected, in which, it is reasonable to suppose, the mineral-water business will share. Among the prospects receiving attention are several spring resorts that are likely to be utilized by the War Department as convalescent or reconstruction hospitals. In addition to the established hospital at Hot Springs, Ark., new institutions are proposed for West Baden, Ind., and Hot Springs, S. Dak.

About 10 per cent of the total quantity of mineral waters handled in 1917 was used in the manufacture of soft drinks. The condition of trade in soft drinks is therefore in a measure significant to the trend of the mineral-water trade in general. Attention has been called in recent trade journals to the comparatively small number of new soft-drink firms organized and the relatively large number that have failed or desired to sell out. It is concluded that this should not be regarded as an evidence of inherent weakness in the business, but rather as an indication that the business is undergoing a process of evolution which will ultimately result not only in an improvement of soft-drink products but in a much enlarged and more profitable trade. If these expectations are realized there is likely to be an appreciable response on the part of other branches of the mineral-water business.

MINERAL-WATER TRADE BY STATES.

ALABAMA.

Returns from Alabama indicate that the mineral-water trade in 1917 was about 46 per cent less than it was in 1916. The sales amounted to 56,270 gallons, and the value of the output was $5,509, the average price per gallon decreasing from 12 cents to 10 cents. There was a considerable decrease in the value of the output of table waters, from $6,195 to $2,072. Two springs which were active in 1916 reported no sales for 1917; one which was active in 1916 was not heard from, and another, from which no report was received, was estimated. Three mineral-water bathing establishments and 5 resorts, accommodating about 500 guests, were maintained. The quantity of mineral water used in the manufacture of soft drinks decreased from 13,500 gallons to 1,227 gallons.

The following 13 springs reported sales:

Bladon Springs, Bladon Springs, Choctaw County.
Blount Springs, Blount Springs, Choctaw County.
Cooks Springs, Cooks Springs, St. Clair County.
Dixie Springs, Dixie Spring, Walker County.
Gordon Mineral Springs, Canoe, Escambia County.
Healing Springs, Healing Springs, Washington County.
Livingston Mineral Well, Livingston, Sumter County.
Luverne Mineral Spring, Luverne, Crenshaw County.
McCary Mineral Well, near Birmingham, Jefferson County.
Matchless Mineral Water Well, east of Greenville, Butler County.
Purity Spring, Spring Hill, Mobile County.
Shocco Springs, Talladega, Talladega County.
White Sulphur Wells, near Jackson, Clarke County.

ARKANSAS.

The sales of mineral water in Arkansas during 1917 were 1,020,463 gallons, as reported from eight active springs, a decrease of a little more than 11 per cent below the output in 1916. The average price of the water decreased from 9 to 8 cents, and the total value of the output amounted to $78,141, which is 22 per cent less than the total value of sales in 1916. The sales of table water showed a large falling off, from $43,993 to $16,399, and the sales of medicinal water increased slightly.

Five springs which were active in 1916 reported no sales in 1917, and one spring, from which no report was received, was estimated.

About 600 guests, exclusive of Eureka (Springs) and Hot Springs, were accommodated, in addition to which 250,000 gallons of mineral water was used in the manufacture of soft drinks, as compared with 200,000 gallons used for this purpose in 1916.

Mineral waters sold in Arkansas, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	16	1,428,869	$151,412	11
1914	18	1,314,159	115,205	9
1915	13	1,377,093	119,072	9
1916	13	1,152,505	100,6[illegible]6	9
1917	8	1,020,463	78,141	8

The 8 springs reporting sales are as follows:

Arsenic Springs, Hot Springs, Garland County.
Chewaulka Mineral Springs, Hot Springs, Garland County.
Glenaqua Mineral Spring, Hot Springs, Garland County.
Happy Hollow Springs, Hot Springs, Garland County.
Mountain Valley Springs, Mountain Valley, Garland County.
Ozarka Spring, Eureka Springs, Carroll County.
Potash Sulphur Springs, Lawrence, Garland County.
Raleigh Springs, Little Rock, Pulaski County.

CALIFORNIA.

The output of mineral water in California during 1917 showed a decrease of 3 per cent in quantity and 10 per cent in value, as compared with the output in 1916.

The total quantity sold was 2,566,491 gallons. Medicinal waters sold for $127,593 and table waters for $327,767—a total of $455,360, the average price being 18 cents.

The outputs of 7 springs from which no reports could be obtained have been estimated. The number of active springs was 52, of which 2 were idle in 1916. Mineral-water baths were maintained at 16 springs, and 20 resorts, accommodating about 4,000 guests, were operated. In the manufacture of soft drinks 67,590 gallons of mineral water was used.

Mineral waters sold in California, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	49	2,801,393	$531,925	19
1914	48	2,282,569	497,923	22
1915	50	2,789,871	532,817	19
1916	55	2,651,471	503,775	19
1917	52	2,566,491	455,360	18

The 52 springs reporting production are as follows:

Adams Springs, Adams, Lake County.
Agua Caliente Springs, Agua Caliente, Sonoma County.
Alhambra Springs, near Martinez, Contra Costa County.
Alma Spring, Alma, Santa Clara County.
Arrowhead Springs, Arrowhead Springs, San Bernardino County.
Barcal Springs, Preston, Sonoma County.
Bartlett Springs, Bartlett Springs, Lake County.
Beulah Springs, Riverside, Riverside County.
Bimini Hot Springs, Los Angeles, Los Angeles County.

Boyes Hot Springs, Boyes Springs, Sonoma County.
Busch Springs, Potter Valley, Mendocino County.
Bythinia Well, Santa Barbara, Santa Barbara County.
Calavichy Springs, Willits, Mendocino County.
Castalian Water, Keeler, Inyo County.
Castle Rock, Mineral Springs, Eubanks, Shasta County.
Cold Spring, Santa Barbara, Santa Barbara County.
Console Mineral Springs, Colton, Riverside County.
Cooks Springs, near Williams, Colusa County.
Crystal Spring, Los Angeles, Los Angeles County.
Deerlick Springs, Deer Lick Springs, Trinity County.
Elliotta Springs, Riverside, Riverside County.
Elysian Spring, Los Angeles, Los Angeles County.
Grizzly Springs, near Sulphur Creek, Lake County.
Holly Spring, Hollywood, Los Angeles County.
Iaqua Medicinal Spring, Eureka, Humboldt County.
Lepori Vichy Springs, near Napa, Napa County.
Magnesia Spring, The Geysers, Sonoma County.
Marin Mountain Spring, Sausalito, Marin County.
McGlashan Mineral Spring, near Truckee, Placer County.
Mercey Mineral Springs, Los Banos, Fresno County.
Mok-Hill Mineral Spring, Mokelumne Hill, Calaveras County.
Napa Rock Spring, Soda Valley, Napa County.
Napa Soda Springs, Napa Soda Springs, Napa County.
Nuvida Spring, La Pressa, San Diego County.
Polk Springs, Butte Meadows, Tehama County.
Pope Mineral Springs, Pope Valley, Napa County.
Radium Sulphur Springs, Colegrove, Los Angeles County.
Redwing Springs, Middletown, Lake County.
Richardsons Springs, Chico, Butte County.
Rose Spring, Los Angeles, Los Angeles County.
Samuel Soda Springs, Monticello, Napa County.
San Benito Mineral Well, near Hollister, San Benito County.
Shanghai Spring, Sausalito, Marin County.
Shasta Spring, Shasta Springs, Siskiyou County.
Tamalpais Mineral Well, San Rafael, Marin County.
Tolenas Spring, near Suisun, Solano County.
Tuscan Spring, Tuscan, Tehama County.
Upper Soda Springs, Dunsmuir, Siskiyou County.
Valley Springs, Valley Springs, Calaveras County.
Veronica Medicinal Springs, near Santa Barbara, Santa Barbara County.
Walters Springs, Pope Valley, Napa County.
Witter Medical Spring, Lake County.

COLORADO.

There has been since 1911 a constant decrease in the quantity of mineral water sold in Colorado, but the returns for 1917 do not indicate as large a decrease as was reported in 1916, the decrease in 1917 being 18 per cent, as against 37 per cent in 1916. There was a decrease of 7 cents in the average price received for the water, the price being 15 cents in 1917; and there was a decrease of 46 per cent in the total value of sales. The sales of medicinal waters increased considerably, from $6,301 in 1916 to $25,679 in 1917, but there was a large decrease in the sales of table waters.

Reports were received from 12 active springs—the same number as in 1916. Pueblo Mineral Springs is now called Lithia Spring. Four bathing establishments were maintained—the same number as in 1916—and 4 resorts, accommodating about 850 guests. In the manufacture of soft drinks 165,222 gallons of water was used.

Mineral waters sold in Colorado, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	11	1,053,429	$89,820	9
1914	12	968,260	113,413	12
1915	14	858,185	63,104	7
1916	12	542,185	120,509	22
1917	12	442,815	65,169	15

The 12 springs regarding which reports were received are as follows:

Boulder Springs, Boulder Springs, Boulder County.
Canon City Soda Springs, Canon City, Fremont County.
Clark Mineral Spring, Pueblo, Pueblo County.
Columbia Well, Denver, Denver County.
Green Mineral Well, Canon City, Fremont County.
Horn Mineral Springs, Colorado Springs, El Paso County.
Lithia Springs, Pueblo, Pueblo County.
Navajo, Shoshone, Manitou, and Cheyenne springs, Manitou, El Paso County.
Ute Chief Manitou Spring, Manitou, El Paso County.
Ute, Iron, Ouray, Geyser, and Little Chief Iron springs, Manitou, El Paso County.
Waunita Hot Springs, Waunita Hot Springs, Gunnison County.
Yampah Spring, Glenwood Springs, Garfield County.

CONNECTICUT.

The output of mineral water in Connecticut decreased 31 per cent in quantity and 22 per cent in value in 1917, the average price remaining the same, 5 cents. In 1916 an increase in the sales of table waters and a 68 per cent decrease in the sales of medicinal waters were reported, but the returns for 1917 show a very decided increase—from $1,920 in 1916 to $3,127 in 1917—in the value of medicinal waters and a decrease—from $131,848 in 1916 to $100,851 in 1917—in the value of table waters sold. The total value of sales in 1917 was $103,978.

Camp Meeting Spring, situated near Milford, reported for the first time, and Shantok Spring reported sales for the first time in three years. Thirty-one active springs reported, or three less than in 1916. No reports were received from 4 springs on the list, and estimates were made for 2 of them. No resorts or mineral-water baths were reported, but about 309,860 gallons of mineral water was used in the manufacture of soft drinks, a decrease of 172,076 gallons from the quantity used in 1916.

Mineral waters sold in Connecticut, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	43	2,458,327	$136,878	6
1914	42	2,341,082	134,478	6
1915	38	1,774,213	101,970	6
1916	34	2,837,878	133,768	5
1917	31	1,964,096	103,978	5

The 31 springs for which production was reported are as follows:

Arethusa Spring, Seymour, New Haven County.
Bailey Natural Spring, Danbury, Fairfield County.
Barcla Springs, Danbury, Fairfield County.
Beaver Spring, Ansonia, New Haven County.
Berkshire Springs, Cornwall Bridge, Litchfield County.
Camp Meeting Spring, Milford, New Haven County.
Cherry Hill Spring, Highwood, New Haven County.
Crystal Spring, near Middletown, Middlesex County.
Crystal Spring, near Derby, New Haven County.
Diamond Spring, Cheshire, New Haven County.
East Hill Spring, Derby, New Haven County.
Elco Springs, Bristol, Hartford County.
Ellis Mountain Spring, Danbury, Fairfield County.
Granite Rock Spring, Haddam, Middlesex County.
Gra-Rock Spring, Canton, Hartford County.
Hermitage and Rockledge Springs, Montowese, New Haven County.
Hillside Spring, West Meriden, New Haven County.
Hosmer Mountain Spring, Willimantic, Windham County.
Indian Spring, Huntington, Fairfield County.
Live Oak Spring, Meriden, New Haven County.
Mammanasco Spring, Ridgefield, Fairfield County.
Oak Spring, Middletown, Middlesex County.
Pequabuck Mountain Springs, Bristol, Hartford County.
Pequot Spring, Glastonbury, Hartford County.
Pequot Mineral Spring, Old Mystic, New London County.
Richardson Spring, Torrington, Litchfield County.
Rock Spring, Fairfield, Fairfield County.
Shantok Spring, Montville, New London County.
Stafford Spring, Stafford Springs, Tolland County.
Varuna Spring, North Stamford, Fairfield County.
Venture Rock Spring, Stonington, New London County.

DELAWARE.

Reports have been received from only one spring in Delaware during the last seven years, the water being used chiefly on the table by residents of Wilmington. The spring is called:

Kiamensi Springs, near Wilmington, Newcastle County.

DISTRICT OF COLUMBIA.

One spring in the District of Columbia reported sales during 1917. This spring is called:

Red Oak Spring, near Langdon.

FLORIDA.

Returns from Florida showed a decrease of 30 per cent in quantity and of 37 per cent in value of mineral water in 1917, as compared with 1916. Seven springs, the same number as reported in 1916, were active in 1917. One spring idle in 1916 was producing in 1917 and two springs active in 1916 reported no sales for 1917. Another spring from which no report was received was considered idle. Two new springs reported sales, Good Hope Mineral Spring, in Duval County, and Hampton Springs, Hampton Springs, Taylor County.

The total output was 142,030 gallons, valued at $9,850. The average price per gallon decreased from 8 cents to 7 cents.

Five bathing establishments and 3 resorts, accommodating 550 persons, were maintained.

The number of active springs is 7, as follows:

Espiritu Santo Springs, Safety Harbor, Pinellas County.
Good Hope Mineral Spring, Duval County.
Hampton Springs, Hampton Springs, Taylor County.
Magnesia Spring, near Grove Park, Alachua County.
Purity Spring, near Tampa, Hillsborough County.
Quisisana Spring, Green Cove Springs, Clay County.
Wekiwa Springs, Apopka, Orange County.

GEORGIA.

The sales of mineral water in Georgia decreased 34 per cent in quantity and 17 per cent in value during 1917, and the price per gallon increased from 7 to 9 cents. The sales were 411,127 gallons, valued at $37,441. There was a slight increase in the output of medicinal waters, but a decrease in the output of table waters. Three bathing establishments and 3 resorts, accommodating 775 guests, were maintained at springs. The number of active springs dropped from 18 to 11. Four springs active in 1916 were idle in 1917, and 3 other springs, from which no reports were received, have been considered idle.

The names and locations of the 11 springs that reported sales in 1917 are given in the appended list:

Benscot Mineral Springs, Austell, Cobb County.
Bowden Springs, Lithia Springs, Douglas County.
Catoosa Springs, Catoosa Springs, Catoosa County.
Chalybeate Springs, Chalybeate, Meriwether County.
High Point Mineral Wells, Macon, Bibb County.
High Rock Spring, near Atlanta, Fulton County.
Jay Bird Spring, near Helena, Dodge County.
Millers Mineral Spring, Milledgeville, Baldwin County.
Murrow Springs, Tifton, Tift County.
Whit Oak Mineral Wells, Macon, Bibb County.
Windsor Spring, near Augusta, Richmond County.

ILLINOIS.

The sales of mineral water in Illinois decreased 23 per cent in quantity and 30 per cent in value in 1917. The total sales were 1,370,461 gallons, valued at $66,042, of which $1,471 was received for medicinal waters and $64,571 for table waters. The number of active springs decreased from 21 to 16. Six springs active in 1916 reported no sales for 1917, and a report of sales was received from Little Nemo Spring for the first time.

The quantity of mineral water used in the manufacture of soft drinks decreased from 106,340 gallons to 44,043 gallons. Resorts for about 275 guests were maintained at 3 springs, and mineral-water bathing establishments were maintained at 5 springs.

Mineral waters sold in Illinois, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	21	1,216,442	$68,549	6
1914	21	1,760,030	81,307	5
1915	23	1,559,489	75,290	5
1916	21	1,777,741	94,056	5
1917	16	1,370,461	66,042	5

Sales were reported from the following 16 springs:

Abana Mineral Springs, Libertyville, Lake County.
Ams Well, Alton, Madison County.
Central Park Sulphur Springs, Peoria, Peoria County.
Diamond Mineral Springs, Grantfork, Madison County.
Glen Flora Mineral Springs, Waukegan, Lake County.
Gravel Springs, near Jacksonville, Morgan County.
Minerva Mineral Spring, Cary Station, McHenry County.
Montgomery Magnesia Spring, Montgomery, Kane County.
Na-mon-o-ma, Old Ironsides, and Little Nemo Springs, Dixon Springs, Pope County.
Ripley Mineral Spring, near Ripley, Brown County.
Sanicula Mineral Springs, South Ottawa, Lasalle County.
Stablers Medicinal Spring, Kewanee, Henry County.
Sulphur Lick Spring, Wedron, Lasalle County.
Woodmen Artesian Well, Rock Island, Rock Island County.

INDIANA.

Indiana produced 521,758 gallons of mineral waters in 1917—14 per cent less than in 1916—valued at $152,469. The average price per gallon was reduced from 31 cents to 29 cents. There was a decrease in the sales of both medicinal and table waters. Two springs which reported sales in 1916 failed to report for 1917. Mount Jackson Mineral Spring reported for the first time, and one spring idle in 1916, reported sales for 1917, making a total of 16 active springs in 1917. Seven bathing establishments and 6 resorts, accommodating 1,253 guests, were maintained.

The following 16 springs reported sales:

Blue Cast Well, Woodburn, Allen County.
Bronson Well, Terre Haute, Vigo County.
Carlson's Mineral Springs, Laporte, Laporte County.
Cartersburg Spring, Cartersburg, Hendricks County.
Colomagna Mineral Springs, Columbus, Bartholomew County.
Greenwood Springs, Fort Wayne, Allen County.
Holman Mineral Well, Crawfordsville, Montgomery County.
Knotts Mineral Springs, Porter, Porter County.
McCullough Springs, Oakland City, Gibson County.
Martinsville Spring, Martinsville, Morgan County.
Mount Jackson Mineral Spring, Indianapolis, Marion County.
Mudlavia Spring, Kramer, Warren County.
Paoli Lithia Springs, Paoli, Orange County.
Paynes Saline Sulphur Well, Henryville, Clark County.
Pluto, Proserpine, and Bowles springs, French Lick, Orange County.
White Crane Well, Dillsboro, Dearborn County.

IOWA.

The reported output of mineral water in Iowa during 1917 was 99,103 gallons, sold for $12,125, as compared with 148,732 gallons, sold for $14,404, in 1916. These figures correspond to a decrease in quantity and value, respectively, of 33 per cent and 16 per cent. The average price per gallon increased from 10 to 12 cents. Two springs which reported sales in 1916 were idle in 1917, and one spring, from which no report was received, was estimated. Grand Hotel Mineral Spring is now called Fry's Well, and Hygeia Spring is now known as Hawkeye Hygeia Well. More than 140,000 gallons of mineral water was used in the manufacture of soft drinks. One mineral-water bathing establishment and 1 resort were maintained.

The 4 springs reporting sales are as follows:

Fry's Well, Colfax, Jasper County.
Grand Hotel Mineral Spring, Colfax, Jasper County.
Hawkeye Hygeia Well, Sioux City, Woodbury County.
White Sulphur Spring, Linwood, Scott County.

KANSAS.

The mineral-water business in Kansas showed an increase in 1917 in both quantity and value. The total sales amounted to 289,493 gallons—22 per cent more than in 1916—valued at $67,776, or 15 per cent more than the value of the sales in 1916. The average price per gallon dropped from 25 to 23 cents. One spring active in 1916 was not heard from in 1917; thus 11 springs were active in 1917. Four mineral-water bathing establishments accommodated 104 guests at 3 resorts. More than 30,000 gallons of mineral water was used in the manufacture of soft drinks.

The following 11 springs reported sales:

Abilena Wells, Abilene, Dickinson County.
Aganippe Spring, near Independence, Montgomery County.
Blasing's Mineral Spring, near Manhattan, Riley County.
California Spring, Ottawa, Franklin County.
Crystals Springs, Coffeyville, Montgomery County.
Geuda Spring, Geuda Springs, Cowley County.
Nature's Best Spring, Conway Spring, Sumner County.
Riverview Mineral Spring, Winfield, Cowley County.
Sycamore Mineral Springs, Sabetha, Brown County.
Viola Springs, near Viola, Sedgwick County.
Waconda Springs, Waconda Springs, Mitchell County.

KENTUCKY.

The reports for 1917 show a decline in the sales of mineral water in Kentucky. There was a decrease of 20 per cent in quantity and of 23 per cent in value. The reported sales in 1917 were 301,748 gallons, as compared with 377,246 gallons in 1916, and the value of the output was $40,189, as compared with $52,305 in 1916. The average price decreased from 14 to 13 cents. One spring which marketed water in 1916 reported no sales in 1917; 2 springs active in 1916 were reported out of business in 1917; 1 spring active in 1916 could not be located in 1917; 2 springs idle in 1916 reported sales in 1917; and 4 new springs were added to the list; thus the total number of active springs was 13. Two resorts, accommodating 130 guests, exclusive of the capacity of Dawson Springs, and 2 mineral-water bathing establishments were maintained. In addition to this 76,207 gallons of mineral water was used in making soft drinks—an increase of 121 per cent over 1916. Four new wells were added to the list, as follows: Doom's Well, H. & H. Water Well, Phillip's Well, and Redden's Wells.

The 13 springs reporting production are as follows:

Anita Springs, La Grange, Oldham County.
Avon-More Well, Dry Ridge, Grant County.
Blue Rock Spring, near Fisherville, Jefferson County.
Cole's Lexington Lithia Springs, Lexington, Fayette County.
Doom's Wells, Dawsonsprings, Hopkins County.
Hamby's Well, Dawsonsprings, Hopkins County.

H. & H. Water, Dawsonsprings, Hopkins County.
Kentucky Mineral Well, Lorain, Taylor County.
Phillip's Well, Dawsonsprings, Hopkins County.
Redden's Well, Dawsonsprings, Hopkins County.
Robson Spring, Fort Thomas, Campbell County.
Royal Magnesian Spring, near La Grange, Oldham County.
St. Patricks Well, Louisville, Jefferson County.

LOUISIANA.

The sales of mineral water in Louisiana showed a total output of 270,000 gallons, valued at $19,490—a decrease of 37 per cent in both quantity and value. The sales of medicinal water increased considerably, whereas a decrease is reported in the sales of table waters. The average price per gallon remained the same, 7 cents. In addition, 18,000 gallons of mineral water was used in the manufacture of soft drinks. One spring for which no report was received was estimated. One resort for guests was maintained.

Mineral waters sold in Louisiana, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	5	700,795	$39,657	6
1914	5	576,138	31,562	6
1915	5	513,838	30,771	6
1916	4	429,650	31,068	7
1917	4	270,000	19,490	7

The four springs that made returns are as follows:

Abita Springs, Abita Springs, St. Tammany Parish.
Geyser Well, Hammond, Tangipahoa Parish.
Krotz Springs, Krotz Springs, St. Landry Parish.
Ozone Spring, Pearl River, St. Tammany Parish.

MAINE.

The output of mineral water in Maine was about the same in 1917 as in 1916, or 1,014,084 gallons, valued at $343,587; the number of active springs remained 24. The average price per gallon was 34 cents—the same as in 1916. The mineral water used in the manufacture of soft drinks in 1916 was notably more than the quantity so used in 1915, but the returns for 1917 showed a decided decrease—from 184,103 gallons in 1916 to 86,503 gallons in 1917. Three resorts for guests were maintained, but no bathing establishments using mineral water were reported. Two springs active in 1916, reported no sales in 1917; 2 springs from which no report was received were omitted; 2 springs idle in 1916 reported sales in 1917; and Boothbay Mineral and Knowlton Mineral springs reported sales for the first time.

Mineral waters sold in Maine, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	32	1,174,262	$368,436	31
1914	29	1,082,631	333,234	31
1915	24	1,115,648	338,003	30
1916	24	1,038,861	353,792	34
1917	24	1,014,084	343,587	34

The names and locations of the 24 springs from which reports of sales were received are given in the following list:

Arctic Spring, Bangor, Penobscot County.
Baker Puritan Spring, Pine Point, Cumberland County.
Boothbay Mineral Spring, East Boothbay, Lincoln County.
Forest Springs, Litchfield, Kennebec County.
Glenrock Cold Spring, Greene, Androscoggin County.
Glenwood Spring, Augusta, Kennebec County.
Hanover Spring, Hanover, Oxford County.
Highland Spring, Lewiston, Androscoggin County.
Keystone Mineral Spring, East Poland, Androscoggin County.
Knowlton Mineral Spring, Farmington, Franklin County.
Mount Desert Spring, Northeast Harbor, Hancock County.
Mount Kebo Spring, Bar Harbor, Hancock County.
Mount Zircon Spring, Milton Plantation, Oxford County.
Mystic Spring, Saco, York County.
Oak Grove Spring, Brewer, Penobscot County.
Pine Spring, Brunswick, Cumberland County.
Poland Mineral Spring, South Poland, Androscoggin County.
Purity Spring, West Scarboro, Cumberland County.
Redman Farm Spring, Belfast, Waldo County.
Rocky Hill Spring, Fairfield, Somerset County.
Skowhegan Crystal Spring, Skowhegan, Somerset County.
Thorndike Mineral Spring, near Thorndike, Waldo County.
Underwood Spring, Falmouth Foreside, Cumberland County.
Wawa Lithia Spring, Ogunquit, York County.

MARYLAND.

Reports for 1917 show a further decline, as compared with 1916, of 21 per cent in the quantity and 12 per cent in the value of mineral water produced in Maryland. There had been a decline in 1916 of 8 per cent in quantity and 6 per cent in value. The total sales in 1917 amounted to 1,036,045 gallons, valued at $86,938. The output was almost entirely table water. In addition to the quantity reported sold, 175,426 gallons was used in the manufacture of soft drinks, as compared with 138,247 gallons in 1916. Two resorts for guests were maintained, but no bathing establishments using mineral water.

Mineral waters sold in Maryland, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	12	1,390,437	$126,883	9
1914	10	1,691,776	124,403	7
1915	10	1,433,406	105,581	7
1916	9	1,312,788	99,020	8
1917	7	1,036,045	86,938	8

The 7 springs reporting sales are as follows:

Big Rock Spring, Frederick County.
Brooklandwood Springs, Brooklandville, Baltimore County.
Buena Vista Spring, Edgemont, Washington County.
Carroll Springs, Forest Glen, Montgomery County.
Caton Spring, Catonsville, Baltimore County.
Chattolanee Springs, Chattolanee, Baltimore County.
Mardela Mineral Spring, Mardela Springs, Wicomico County.

MASSACHUSETTS.

Returns from Massachusetts for 1917 indicate a decrease of 7 per cent in quantity and an increase of 8 per cent in value of mineral waters sold. The average price per gallon increased from 4 to 5 cents. The sales amounted to 2,908,638 gallons, valued at $139,075. In addition to the quantity reported as sold, 893,926 gallons were used in the manufacture of soft drinks, as compared with 1,032,815 gallons in 1916. The sales of medicinal waters decreased, but there was a slight advance in the sales of table waters. Monatiquot Spring, Braintree, Norfolk County, reported sales for the first time. Three springs active in 1916 reported no sales in 1917, and 1 spring active in 1916 was not heard from in 1917. One small resort was maintained, and 1 mineral-water bathing establishment was reported.

Mineral waters sold in Massachusetts, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	60	3,907,395	$213,802	6
1914	52	3,084,385	174,324	6
1915	48	3,872,192	184,133	5
1916	51	3,124,096	128,478	4
1917	48	2,908,638	139,075	5

The 48 reporting springs are as follows:

Abbotts Spring, Methuen, Essex County.
Avonia Spring Weymouth, Norfolk County.
Ballardvale Springs, North Andover, Essex County.
Belmont Crystal Spring, Belmont, Middlesex County.
Burnham Spring, Methuen, Essex County.
Cadwell's Crystal Spring, Woburn, Middlesex County.
Cascella Springs, Three Rivers, Hampden County.
Chapman's Crystal Spring, Stoneham, Middlesex County.
Chickatawbut Spring, Hingham, Plymouth County.
Cochato Spring, South Braintree, Norfolk County.
Crystal Spring, West Peabody, Essex County.
Deep Glen Spring, West Lynn, Essex County.
El-Azhar Spring, Tyngsboro, Middlesex County.
Goulding Spring, Whitman, Plymouth County.
Granite Rock Spring, Brockton, Plymouth County.
Great Radium Springs, Pittsfield, Berkshire County.
Holyoke Spring, West Lynn, Essex County.
King Philip Spring, Mattapoisett, Plymouth County.
Klines Spring, Lawrence, Essex County.
Massasoit Spring, West Springfield, Hampden County.
Milton Spring, Milton, Norfolk County.
Monatiquot Spring, Braintree, Norfolk County.
Mount Blue Mineral Spring, Hingham, Plymouth County.

Mount Holyoke Spring, South Hadley, Hampshire County.
Mount Pleasant Spring, Lowell, Middlesex County.
Mount Vernon Spring, Lawrence, Essex County.
New Abbott Spring, Methuen, Essex County.
Nobscot Mountain Spring, Framingham, Middlesex County.
October Spring, Lenox, Berkshire County.
Pearl Hill Spring, Fitchburg, Worcester County.
Pepperell Spring, Pepperell, Middlesex County.
Pequot Mineral Spring, North Natick, Middlesex County.
Pocahontas Spring, Lynnfield Center, Essex County.
Polar Spring, Spencer, Worcester County.
Puritan Spring, Andover, Essex County.
Purity Spring, Danvers, Essex County.
Purity Spring, Chelmsford, Middlesex County.
Robbins Springs, Arlington Heights, Middlesex County.
Sand Springs, Williamstown, Berkshire County.
Shawmut Spring, West Quincy, Norfolk County.
Simpson Spring, South Easton, Bristol County.
Sterling Spring, West Lynn, Essex County.
Stevens Spring, Lawrence, Essex County.
Twin Elm Spring, Lexington, Middlesex County.
Valpey Spring, Lawrence, Essex County.
Whitman Spring, Whitman, Plymouth County.
Wilbraham Spring, Wilbraham, Hampden County.
Ye Cape Cod Pilgrim Spring, South Wellfleet, Barnstable County.

MICHIGAN.

The total sales of mineral waters in Michigan in 1917 was 1,069,164 gallons, as compared with 996,875 gallons in 1916, an increase of 7 per cent; and the total value was $105,641, as compared with $108,867 for 1916. The sales of table waters amounted to $105,141, and medicinal waters netted only $500, a decrease of 93 per cent.

One spring idle in 1916 was active in 1917; the output of 1 spring was estimated; another spring was not reported; 7 springs active in 1916 reported no sales in 1917, and St. Louis Spring reported for the first time; thus the number of active springs decreased from 18 to 12. Four resorts accommodating 1,000 guests and 1 mineral-water bathing establishment were maintained at springs. In addition to the mineral water sold about 43,700 gallons, as compared with 25,478 gallons in 1916, was used in the manufacture of soft drinks.

Mineral waters sold in Michigan, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	20	884,893	$52,642	6
1914	22	931,343	70,310	8
1915	19	913,765	72,711	8
1916	18	996,875	108,867	11
1917	12	1,069,164	105,641	10

The 12 springs reporting sales are as follows:

Andrews Magnetic Mineral Spring, St. Louis, Gratiot County.
Arctic Spring, Grand Rapids, Kent County.
Beaver Spring, Bangor, Van Buren County.
Eastman Springs, near Benton Harbor, Berrien County.
Maple Leaf Springs, Macomb County.

Mount Clemens Well, Mount Clemens, Macomb County.
Ogemaw Spring, Maltby, Ogemaw County.
Panacea Spring, Mount Clemens, Macomb County.
Ponce de Leon Spring, Paris Township, Kent County.
St. Louis Spring, Gratiot County.
Silver Springs, Northville, Wayne County.
Victory Spring, Mount Clemens, Macomb County.

MINNESOTA.

According to reports received from 17 active springs in Minnesota, the sales of mineral waters in that State decreased 28 per cent in quantity and 24 per cent in value in 1917. The total output was 3,004,546 gallons, valued at $109,964. The sales of table water decreased from $145,027 in 1916 to $77,436 in 1917, but the sales of medicinal waters increased from $555 in 1916 to $32,528 in 1917. The average price per gallon was raised from 3 to 4 cents. All the springs that were active in 1916 reported sales in 1917 except one. One resort for guests and 1 mineral-water bathing establishment were operated at springs. In addition to the sales reported, 506,523 gallons were used in the manufacture of soft drinks, which is about the same quantity as that used in 1916.

Mineral waters sold in Minnesota, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	16	4,802,053	$183,759	4
1914	15	5,639,232	194,041	3
1915	17	3,493,887	136,259	4
1916	18	4,188,434	145,582	3
1917	17	3,004,546	109,964	4

The 17 springs for which production was reported are as follows:

Campbells Spring, Fergus Falls, Ottertail County.
Clear Spring, Excelsior, Hennepin County.
Deep Spring, Crookston, Polk County.
Glenwood-Inglewood Spring, Minneapolis, Hennepin County.
Highland Spring, St. Paul, Ramsey County.
Indian Medical Spring, Elk River, Sherburne County.
Jackson Mineral Spring, Jackson, Jackson County.
Mankato Mineral Springs, near Eagle Lake, Blue Earth County.
Ogahmah Spring, Thief River Falls, Pennington County.
Owens Spring, Glenwood, Pope County.
Pokegama Spring, near Detroit, Becker County.
Red Star Spring, Cold Spring, Stearns County.
Rock Spring, Shakopee, Scott County.
Rosendale Spring, St. James, Watonwan County.
Silver Well, Marshall, Lyon County.
Silver Spring, Ortonville, Bigstone County.
Ward Springs, Ward Springs, Todd County.

MISSISSIPPI.

The mineral-water business in Mississippi, which decreased notably in 1916, underwent a further decrease of 51 per cent in quantity, but increased 3 per cent in value in 1917, the sales reported being 197,555 gallons, practically all classed as medicinal water, valued at $49,786, as compared with 399,248 gallons, valued at $48,439 in 1916. The price per gallon increased from 12 to 25 cents. One spring idle in 1916 was producing in 1917, and 1 spring active in 1916 reported no sales in 1917. No new springs were reported to be active. Two mineral-water bathing establishments and 6 resorts, accommodating about 675 guests, were maintained at springs.

The names of the 12 springs reported active in 1917 follow:

Allison's Wells, Way, Madison County.
Arundel Spring, Meridian, Lauderdale County.
Brown's Wells, near Hazlehurst, Copiah County.
Castalian Springs, near Durant, Holmes County.
Cooper's Well, Raymond, Hinds County.
Donald Mineral Spring, Vosburg, Jasper County.
Lowes Wells, near Hazlehurst, Copiah County.
Morris Mineral Spring, Vosburg, Jasper County.
Owens Wells, Owens, Holmes County.
Red Springs, Stewart, Choctaw County.
Robinson Spring, Madison County, near Pocahontas.
Stafford Mineral Spring, Vosburg, Jasper County.

MISSOURI.

The marked increases in the sales of mineral waters in Missouri in 1915 and 1916 were followed by an appreciable decline in the output in 1917 of 71 per cent in quantity and 48 per cent in value. The total output for 1917 was 401,776 gallons, valued at $57,175. The average price per gallon increased from 8 to 14 cents. In addition to the quantity reported as sold, 35,223 gallons were used in the manufacture of soft drinks, a small increase over the quantity reported for 1916. Reports for 1917 were received from 33 active springs, as compared with 36 in 1916. Four springs active in 1916 reported no sales in 1917, and 1 spring idle in 1916 reported sales. Musick Mineral Well is now called Laxative Mineral Well. El Dorado Aperient Water Well is a new producer. Five resorts, exclusive of those at Excelsior Springs, and 5 mineral-water bathing establishments were operated.

Mineral waters sold in Missouri, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	34	697,467	$84,316	12
1914	36	583,288	74,793	13
1915	33	1,000,961	83,363	8
1916	37	1,394,092	109,814	8
1917	33	401,776	57,175	14

The following 33 springs made returns of sales:

B. B. and Fonzo springs, Bowling Green, Pike County.
Belcher Artesian Well, St. Louis, St. Louis City County.
Bokert Springs, near De Soto, Jefferson County.
Chalybeate Spring, Paris Springs, Lawerence County.
Chouteau Springs, near Boonville, Cooper County.
Crystal Mineral Springs and Saline Soda Well, Excelsior Springs, Clay County.
Cusenbery Spring, Mount Washington, Jackson County.

Eldorado Aperient Water Well, Eldorado Springs, Cedar County.
Excelsior Saline Spring, Excelsior Springs, Clay County.
Grand River Mineral Spring, near Mercer, Mercer County.
Haymaker Spring, Mercer County, near Lineville, Iowa.
Hornet Spring, Bowling Green, Pike County.
Jackson Lithia Spring, Mount Washington, Jackson County.
Kalinat and Ionian springs, Bowling Green, Pike County.
Laxative Mineral Well, Eldorado Springs, Cedar County.
Lithia No. 1 Spring, Excelsior Springs, Clay County.
Livertone Spring, Bowling Green, Pike County.
Natrona Wells, Excelsior Springs, Clay County.
Old Orchard Mineral Spring, Old Orchard, St. Louis County.
Park Spring, Eldorado Springs, Cedar County.
Ponce de Leon Well, La Grange, Lewis County.
Regent, Siloam, Soterian, and Sulpho-Saline springs, Excelsior Springs, Clay County.
Salax Spring, Excelsior Springs, Clay County.
Salt Sulphur Well, Excelsior Springs, Clay County.
Soda Saline Spring, Missouri City, Clay County.
Sweet Spring, Sweet Springs, Saline County.
White Spring, Independence, Jackson County.
Windsor Spring, Windsor Springs, St. Louis County.
Wyaconda Spring, La Grange, Lewis County.

MONTANA.

The sales from 4 springs, reporting from Montana in 1917, were 211,133 gallons, valued at $9,570. This represents a gain in quantity in 1917 of 16 per cent and a loss in value of 22 per cent. The same springs active in 1916 reported for 1917. Mineral-water bathing establishments were maintained at 2 of these springs, and 1 resort accommodating 100 guests was reported. Practically all the water was sold for table use. In addition to the quantity sold, a small quantity was used in the manufacture of soft drinks.

The 4 active springs are as follows:

Alhambra Hot Sphing, Jefferson County.
Lissner Mineral Spring, Helena, Lewis and Clark County.
Rock Creek Springs, Red Lodge, Carbon County.
White Sulphur Springs, White Sulphur Springs, Meagher County.

NEBRASKA.

Reports have been received from 2 springs in Nebraska in 1917, from one of which the water was sold entirely for medicinal purposes. The water of the other spring was used in the manufacture of soft drinks.

The names of the 2 springs reporting are as follows:

Brown Park Mineral Springs, South Omaha, Douglas County.
Curo Mineral Springs, South Omaha, Douglas County.

NEVADA.

Two springs reported sales of mineral waters in 1917 in Nevada, the entire output being sold for table use. In addition to the quantity sold, a few hundred gallons were used in the manufacture of soft drinks. One bathing establishment is reported to have been maintained.

Reports were received from the following 2 springs:

Diamond Spring, Reno, Washoe County.
Shoshone Springs, Franktown, Washoe County.

NEW HAMPSHIRE.

Returns from New Hampshire indicate a substantial decrease in both quantity and value of mineral water marketed in 1917. The total sales in 1917 were 105,181 gallons, as compared with 269,860 gallons in 1916, and the total value of the output was $6,975, as compared with $14,935 in 1916. Almost all of the output was classified as table water. The average price per gallon was 7 cents. One spring that was active in 1916 reported no sales in 1917, and 2 springs idle in 1916 reported sales in 1917. No new springs were reported. In addition to the mineral water sold, 477,937 gallons were used in the manufacture of soft drinks, as compared with 313,881 gallons in 1916.

The 7 springs reporting are as follows:

Crystal Spring, East Concord, Merrimack County.
Granite State Spring, Plaistow, Rockingham County.
Gunstock Mineral Spring, Gilford, Belknap County.
Laconia Spring, The Weirs, Belknap County.
Mount Madison Spring, Gorham, Coos County.
White Mountain Mineral Spring, Conway, Carroll County.
Wilton Mineral Spring, near Wilton, Hillsboro County.

NEW JERSEY.

The sale of mineral water in New Jersey decreased in quantity from 1,580,028 gallons in 1916 to 1,283,067 gallons in 1917, a loss of nearly 19 per cent, and in value from $130,993 to $115,188, a loss of about 12 per cent. The average price per gallon was 9 cents. Most of the output was classified as table water. In addition to the water reported as sold, 73,605 gallons was used in the manufacture of soft drinks, as compared with 91,000 in that business in 1916.

No new springs were reported; 1 spring which reported sales in 1916 failed to report for 1917; thus the number of active springs decreased from 15 to 14. No resorts or mineral-water baths were maintained.

Mineral waters sold in New Jersey, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	14	2,067,277	$188,546	9
1914	17	1,710,030	155,649	9
1915	13	1,479,479	116,226	8
1916	15	1,580,028	130,993	8
1917	14	1,283,157	115,188	9

The following 14 springs reported sales:

Alpha Spring, Springfield, Union County.
Belmar Springs, Glen Rock, Bergen County.
Cold Indian Spring, near Asbury Park, Monmouth County.
Culm Rock Spring, Pluckemin, Somerset County.
Echo Spring, Ewing (near Trenton), Mercer County.
Grey Rock Artesian Well, Trenton, Mercer County.
Indian Spring, near Rockaway, Morris County.
Kalium Spring, Collingswood, Camden County.
Kanouse-Oakland Spring, Oakland, Bergen County.

Pilgrim Spring, Ridgefield Park, Bergen County.
Red Rock Spring, Spring Valley Road, Bergen County.
Rock Spring, West Orange, Essex County.
Washington Rock Spring, Somerset County, near Plainfield.
Watchung Spring, North Plainfield, Somerset County.

NEW MEXICO.

The sale of mineral waters from 3 springs in New Mexico during 1917 was 48,325 gallons, valued at $2,330, as compared with 35,450 gallons, valued at $3,965, in 1916, an increase of 36 per cent in quantity and a decrease of 41 per cent in value. The disproportion between the gain in quantity and the loss in value is accounted for by a decline from 11 to 5 cents in the average price per gallon. Practically all this water is reported to have been sold for table use. One small resort and 1 mineral-water bathing establishment were maintained. One spring which marketed water in 1916 reported no sales for 1917. Coyote Spring is now called Perry Well.

The 3 springs for which production was reported are as follows:

Aztec Mineral Springs, Taylor Springs, Colfax County.
Perry Well, Albuquerque, Bernalillo County.
Ojo Caliente Spring, Ojo Caliente, Taos County.

NEW YORK.

The State of New York in 1917 ranked first in number of active mineral springs and in total quantity of mineral waters produced, second in total value of production and in value of table waters, first in value of medicinal waters, and tenth in consumption of mineral waters for the manufacture of soft drinks. Comparison of figures for 1917 with those of 1916 shows an increase of 1 per cent in quantity and a decrease of 19 per cent in value in 1917. The additional quantity used in the manufacture of soft drinks in 1917 was 252,838 gallons. Nearly all of the water was sold for table use. Five new springs reported. In 1917 there were 65 active springs, as against 68 in 1916. One resort besides those at Saratoga Springs, and 2 mineral-water bathing establishments were operated in 1917.

Mineral waters sold in New York, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	64	9,801,255	$871,601	9
1914	69	8,201,202	672,913	8
1915	75	8,411,616	711,697	8
1916	68	7,746,490	697,650	9
1917	65	7,819,314	562,874	7

The list of 65 commercial springs in 1917 is as follows:

Aldena Park Spring, Alden, Erie County.
Arlington Spring, Arlington, Dutchess County.
Artesian Lithia Spring, Ballston Spa, Saratoga County.
Baldwin Mineral Spring, Cayuga, Cayuga County.
Black Rock Spring, Rensselaer, Rensselaer County.

Breesport Oxygenated Mineral Spring, Breesport, Chemung County.
Briarcliff Spring, Briarcliff Manor, Westchester County.
Carrier Spring, Potsdam, St. Lawrence County.
Cascadian Spring, Nyack, Rockland County.
Chemung Spring, Chemung, Chemung County.
Chester Crest Spring, Mount Vernon, Westchester County.
Clinton Mineral Springs, Franklin Springs, Oneida County.
Coesa Spring, Saratoga Springs, Saratoga County.
Cold Spring, St. Lawrence County.
Comstock Mineral Spring, Ballston Spa, Saratoga County.
Congress No. 2 Spring, Saratoga Springs, Saratoga County.
Crystal Springs, Whitesboro, Oneida County.
Deep Rock Spring, Oswego, Oswego County.
Deer Run Spring, Sheridan, Chautauqua County.
Dietade Mineral Spring, Keeseville, Essex County.
Eagle Spring, Edgewood, Greene County.
Elixir Spring, Clintondale, Ulster County.
Elk Spring, Lancaster, Erie County.
Ferndell Spring, Saratoga Springs, Saratoga County.
Flint Spring, near West Sand Lake, Rensselaer County.
Franklin Lithia Spring, Kirkland, Oneida County.
Gardner White Sulphur Springs, Sharon Springs, Schoharie County.
Geyser Spring, Saratoga Springs, Saratoga County.
Glen Alex Spring, New Hartford, Oneida County.
Gramatan Spring, Bronxville, Westchester County.
Granite Spring, Granite Springs, Westchester County.
Great Bear Spring, near Fulton, Oswego County.
Greendale Crystal Springs, Livingston, Columbia County.
Gurn Spring, Saratoga Springs, Saratoga County.
Hathorn No. 2 Spring, Saratoga Springs, Saratoga County.
Kirkland Spring, Kirkland, Oneida County.
Lithia Polaris and Adirondack Springs, near Boonville, Oneida County.
Madrid Medicinal and Indian Mineral Springs, Madrid Springs, St. Lawrence County.
Mammoth and Ideal springs, North Greenbush, Rensselaer County.
Minnonebe Spring, Saratoga Springs, Saratoga County.
Mohawk Springs, Amsterdam, Montgomery County.
Mohican Spring, Ballston Spa, Saratoga County.
Mokobo Spring, Mount Kisco, Westchester County.
Monarch Spring, Mattewan, Dutchess County.
Plymouth Spring, North Greenbush, Rensselaer County.
Red Rock Spring, Fine View, Jefferson County.
Risley Cold Springs, New York Mills, Oneida County.
Sagamore Spring, Oyster Bay, Nassau County.
Saratoga Vichy and Victoria No. 2 springs, Saratoga Springs, Saratoga County.
Setauket Spring, Setauket, Suffolk County.
Shell Rock Spring, near Rensselaer, Rensselaer County.
Shenorock Spring, Baldwin Place, Westchester County.
Sparkling Spring, Buffalo, Erie County.
Split Rock Lithia Spring, Franklin Springs, Oneida County.
Standard Spring, Troy, Rensselaer County.
Sun Ray Spring, Ellenville, Ulster County.
Table Rock Mineral Spring, Honeoye Falls, Monroe County.
Tiffiney Spring, Chautauqua County.
Trespur Spring, McGraw, Cortland County.
Vita Spring, near Fort Edward, Washington County.
Westmoreland Mineral Spring, Westmoreland, Oneida County.
White Bear Spring, Batavia, Genesee County.
White's Spring, Norwich, Chenango County.

NORTH CAROLINA.

The sales of mineral waters in North Carolina showed a decrease in 1917 of 25 per cent in quantity and 18 per cent in value. The average price per gallon increased from 14 to 15 cents. The sales amounted to 103,659 gallons, valued at $15,664, as compared with 137,817 gallons, valued at $19,010, in 1916. In addition, 1,989 gallons was consumed in the manufacture of soft drinks. Two springs active in 1916 reported no sales in 1917, and 1 spring reported sales for the first time; thus the number of active springs in 1917 decreased from 19 to 18. Eight resorts, accommodating about 1,280 guests, and 3 establishments for bathing in mineral water were maintained at springs.

The 18 springs that reported production are as follows:

All Healing Spring, Taylorsville, Alexander County.
Barium Rock Spring, Barium Springs, Iredell County.
Bromine Arsenic Lithia Springs, Crumpler, Ashe County.
Buckhorn Lithia Spring, Bullock, Granville County.
Derita Calcic Spring, Derita, Mecklenburg County.
Haywood White Sulphur Springs, Waynesville, Haywood County.
Huckleberry Springs, Durham, Durham County.
Jackson Springs, Jackson Springs, Moore County.
Mida Spring, near Huntersville, Mecklenburg County.
Moores Springs, Moores Springs, Stokes County.
Mount Vernon Springs, Mount Vernon Springs, Chatham County.
Panacea Springs, Warren County, near Littleton.
Parks Spring, Caswell County, near Danville, Va.
Rivermont Carbonated Spring, Durham County.
Seven Springs, Sevensprings, Wayne County.
Shelby Lithia Springs, near Shelby, Cleveland County.
Smith Lithia Springs, near Oxford, Granville County.
Vade Mecum Spring, Vade Mecum, Stokes County.

NORTH DAKOTA.

Reports of sales were received from 3 active springs in North Dakota—3 less than in 1916—which showed a decrease in sales of 27 per cent in quantity and 11 per cent in value. The total output was 556,000 gallons, valued at $12,837, as compared with 766,000 gallons, valued at $14,500 in 1916. In addition to the quantity reported as sold, 120,000 gallons was used in the manufacture of soft drinks, a very considerable increase over 34,722 gallons, the quantity used in 1916.

The names and locations of the 3 springs reporting production are as follows:

Granite Spring, Minot, Ward County.
Kenmare Spring, Kenmare, Ward County.
Stony Creek Spring, Bowbells, Burke County.

OHIO.

Returns from Ohio for 1917 showed a decrease in the sales of mineral waters of 24 per cent in quantity and 15 per cent in value, owing principally to decreased sales of medicinal water. The total output was 3,113,093 gallons, valued at $136,710, as compared with 4,102,922 gallons, valued at $161,160, in 1916. The average price per gallon has been 4 cents for the last eight years. The mineral water used in the manufacture of soft drinks increased from 168,200 to 248,000 gallons. Four springs active in 1916 reported no sales in 1917, and 2 others were not heard from; thus the number of active springs in 1917 was reduced to 31. Crystal Wave Springs is now called Riblet Health Springs. Five resorts, accommodating about 650 guests, and 2 mineral-water bathing establishments were maintained.

Mineral waters sold in Ohio, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	33	3,317,639	$125,084	4
1914	35	3,558,413	145,586	4
1915	36	3,504,343	133,416	4
1916	37	4,102,922	161,100	4
1917	31	3,113,093	136,710	4

The 31 springs reporting sales are as follows:

Alba Springs, Rockport, Cuyahoga County.
Beech Rock Spring, near Zanesville, Muskingum County.
Bellmore Spring, near Signal, Columbiana County.
Belmont Spring, Bridgeport, Belmont County.
Collingwood Springs, Toledo, Lucas County.
Crystal Springs, Newark, Licking County.
Deerfield Mineral Springs, Deerfield, Portage County.
Devonian Mineral Spring, Lorain, Lorain County.
Elm Meade Spring, Youngstown, Trumbull County.
Fargo Mineral Springs, Ashtabula, Ashtabula County.
Fisher's Magnesia Spring, near Columbus, Franklin County.
Gibson Spring, Youngstown, Mahoning County.
Glenwood Mineral Spring, near Chillicothe, Ross County.
Highland Springs, Akron, Summit County.
La France Spring, Toledo, Lucas County.
Maple Grove Mineral Spring, near Chillicothe, Ross County.
Minnehaha Spring, Rockport, Cuyahoga County.
Oak Place Spring, Akron, Summit County.
Oak Ridge Mineral Springs, Sandusky County, near Greenspring.
Old Magnetic Spring, Magnetic Springs, Union County.
Partagas Natural Well, Cincinnati, Hamilton County.
Peerless and Puritas Springs, West Park, Cuyahoga County.
Pine Tree Spring, Willoughby, Lake County.
Puritas Spring, near Berea, Cuyahoga County.
Purity Spring, South Euclid, Cuyahoga County.
Riblet Health Springs, Youngstown, Mahoning County.
Rock Spring, Wickliffe, Lake County.
Sand Rock Mineral Spring, Canton, Stark County.
Sulphur Lick Springs, Chillicothe, Ross County.
Tallewanda Springs, Preble County, near College Corner.
Wheeler Mineral Springs, Youngstown, Mahoning County.

OKLAHOMA.

The output of mineral water in Oklahoma in 1917 was 852,381 gallons, valued at $26,997, as compared with 1,353,513 gallons, valued at $40,189, in 1916. These figures indicate a decrease of 37 per cent in quantity and 33 per cent in value. In addition to the quantity sold, 23,030 gallons of mineral water was consumed in the manufacture of soft drinks. Two springs active in 1916 reported no sales in 1917; thus the total number of springs active in 1917 was 11. Two resorts and 2 mineral-water bathing establishments were maintained.

The 11 springs reporting sales are as follows:

Bromide Spring, Sulphur, Murray County.
Everpure Well, Oklahoma City, Oklahoma County.
Excelsior Well, Oklahoma City, Oklahoma County.
Guthrie Mineral Springs, Guthrie, Logan County.
Kalium Well, Faxon, Comanche County.

Lewis Lithia Wells, Oklahoma City, Oklahoma County.
Shanoan Springs, Chickasha, Grady County.
Sparkling Water Well, near Shawnee, Pottawatomie County.
Standard Wells, Tulsa, Tulsa County.
White Sulphur Spring, Sapulpa, Creek County.
Works Excelsior Mineral Wells, Comanche, Stephens County.

OREGON.

Returns for 1917 show a decrease of 56 per cent in quantity and 64 per cent in the value of mineral waters sold in Oregon in 1917. The sales were 13,741 gallons, valued at $2,842, as compared with 30,920 gallons, value at $7,961, in 1916. The average price per gallon declined from 26 cents to 21 cents. One spring active in 1916 reported no sales in 1917, and another spring, from which no report was received, was estimated; thus the number of active springs was reduced from 6 to 5. Three resorts accommodating about 1,505 guests and 5 mineral-water bathing establishments were maintained. In addition to the water reported sold, 13,000 gallons was used in the manufacture of soft drinks.

The names of the 5 springs reporting productions are as follows:

Calapooya Spring, London, Lane County.
Cascade Mineral Springs, Cascadia, Linn County.
Sam-O-Spring, Baker, Baker County.
White Pelican Mineral Spring, Klamath Falls, Klamath County.
Wilhoit Spring, Wilhoit, Clackamas County.

PENNSYLVANIA.

The returns from Pennsylvania indicate a decrease of 4 per cent in quantity and an increase of 1 per cent in value of mineral water sold in 1917, as compared with reports for 1916. The price per gallon remained the same, 9 cents. The total output was 1,603,090 gallons, valued at $147,021. The sales of table water amounted to $128,815, and $18,206 was reported from sales of medicinal water. In addition, 404,671 gallons was used in the manufacture of soft drinks, an increase as compared with 1916.

Forty-one springs were active in 1917, of which 3 had been idle in 1916. Six springs which marketed water in 1916 were inactive in 1917 and 2 springs reported sales for the first time. The sales from 2 unreported springs have been estimated. Nine resorts accommodating 1,203 guests and 4 mineral-water bathing establishments were maintained.

Mineral waters sold in Pennsylvania, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	43	2,163,931	$190,459	9
1914	47	2,457,626	213,752	9
1915	47	2,136,218	174,798	8
1916	42	1,671,637	145,133	9
1917	41	1,603,090	147,021	9

The following 41 springs reported sales in 1917:

Battering Ram Spring, Beach Haven, Luzerne County.
Bedford Springs, near Bedford, Bedford County.
Carnegie Alkaline and Lithia Mineral Springs, Carnegie, Allegheny County.
Chadwick Mineral Well, Cambridge Springs, Crawford County.
Cloverdale Mineral Spring, near Newville, Cumberland County.
Cold Spring, Lotell, Lebanon County.
Dark Hollow Spring, near Oakmont, Allegheny County.
De Profundis Spring, Saegerstown, Crawford County.
Ephrata Mountain Crystal Spring, near Ephrata, Lancaster County.
Franklin Lithia Spring, Cambridge Springs, Crawford County.
Glen Summit Spring, Glen Summit, Luzerne County.
Gray Mineral Spring, Cambridge Springs, Crawford County.
Great Oak Spring, Pottstown, Chester County.
Harrison Valley Mineral Spring, Harrison Valley, Potter County.
Hurlburt Springs, Cambridge Springs, Crawford County.
Hutchinson and Rural Springs, New Castle, Lawrence County.
Jordan Mineral Spring, Carnegie, Allegheny County.
Juniata Springs, near Altoona, Blair County.
Kecksburg Artesian Mineral Springs, Kecksburg, Westmoreland County.
Keystone Spring, near Taylorsville, Bucks County.
Minnequa Spring, Canton, Bradford County.
Mount Laurel Springs, Temple, Berks County.
Original Magnesia Springs, Cambridge Springs, Crawford County.
Pavilion Spring, Wernersville, Berks County.
Petticord Spring, Cambridge Springs, Crawford County.
Plymouth Crystal Spring, Plymouth, Luzerne County.
Pocono Mineral Spring, Lilac, Luzerne County.
Polar Spring, Morrisville, Bucks County.
Puritas Spring, near Erie, Erie County.
Quaill Farm Spring, Bellevue, Allegheny County.
Ross Common Spring, Ross Common, Monroe County.
Shawmont Springs, Philadelphia, Philadelphia County.
Sizerville Magnetic Mineral Spring, Sizerville, Cameron County.
Springfield Spring, Springfield Township, Delaware County.
Summer Hill Spring, Pittsburgh, Allegheny County.
Thurstons Carbonate Springs, Meadville, Crawford County.
Tuckahoe Mineral Springs, near Northumberland, Northumberland County.
West Nanticoke Artesian Well, West Nanticoke, Luzerne County.
Whannis Lithia Springs, Franklin, Venango County.
White House Spring, Reading, Berks County.
White Star Spring, Northampton County.

RHODE ISLAND.

Rhode Island reported in 1917 sales from 6 springs amounting to 368,976 gallons, valued at $24,975. The average price per gallon remained the same, 7 cents. The water was sold exclusively for table use, and in addition 31,830 gallons was used in the manufacture of soft drinks, as against 16,500 gallons used for this purpose in 1916. The sales in 1916, at 7 cents a gallon, amounted to 449,453 gallons, valued at $33,050. Thus there was a decrease of 18 per cent in quantity and 24 per cent in value in 1917. One mineral-water resort was maintained.

The names of the 6 commercial springs are as follows:

Berry Spring, Pawtucket, Providence County.
Girard Spring, North Providence, Providence County.
Gladstone Spring, Narragansett Pier, Washington County.
Holley Mineral Spring, East Woonsocket, Providence County.
Ochee Spring, Johnston, Providence County.
Prophet Spring, Providence, Providence County.

SOUTH CAROLINA.

The sales of mineral water in South Carolina during 1917 amounted to 289,094 gallons, valued at $45,729, as compared with 427,905 gallons, valued at $63,818, in 1916. These changes are equivalent to a decrease of 32 per cent in quantity and 28 per cent in value. Ninety-seven per cent of the output is said to be sold for medicinal use. Three springs active in 1916 were idle in 1917; 1 spring active in 1916 was not heard from; the output of 1 spring unreported in 1917 was estimated; and Mertins Crystal Springs was added to the list of producers. Thus the number of active springs was reduced to 7. One resort accommodating 200 guests was maintained. In addition to the mineral water reported sold, 425,720 gallons was used in the manufacture of soft drinks.

The following 7 springs reported sales:

Buffalo Lick Spring, Carlisle, Union County.
Chick Springs, Chick Springs, Greenville County.
Glendale Mineral Spring, Bamberg, Bamberg County.
Glenn Springs, Glenn Springs, Spartanburg County.
Mansfield Mineral Springs, near Spartanburg, Spartanburg County.
Mertins Crystal Springs, Rural, Aiken County.
Shivar Spring, Shelton, Fairfield County.

SOUTH DAKOTA.

Three springs in South Dakota reported sales in 1917, which amounted to 443,167 gallons, valued at $13,545, as compared with 470,725 gallons, valued at $20,512, in 1916, a decrease of 6 per cent in quantity and 34 per cent in value. The average price per gallon dropped from 4 to 3 cents. All but 42 gallons of this water was sold for table use, and 14,000 gallons in addition was used in the manufacture of soft drinks. No resorts or bathing establishments were maintained.

The names of the 3 springs reporting are as follows:

Culbert Spring, Aberdeen, Brown County.
Milbank Well, Milbank, Grant County.
Spring Brook Spring, Sisseton, Roberts County.

TENNESSEE.

The mineral-water trade of Tennessee showed a decrease of 5 per cent in quantity and 2 per cent in value. The average price per gallon of 6 cents has remained the same for the last five years.

The total output for 1917 was 758,193 gallons, valued at $47,362, as compared with 799,346 gallons, valued at $48,416, in 1916. The sales of medicinal waters amounted to $26,781 and table waters to $20,581. One spring active in 1916 reported no sales in 1917; 2 unreported springs were considered idle; 1 spring idle in 1916 was active in 1917; and Buena Vista Springs was newly added to the list. Thus the number of active springs in 1917 was reduced to 19. Eight resorts, accommodating about 1,300 guests, and 1 mineral-water bathing establishment were operated.

Mineral waters sold in Tennessee, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	23	1,088,034	$64,905	6
1914	23	943,502	56,741	6
1915	23	703,506	39,304	6
1916	20	799,346	48,416	6
1917	19	758,193	47,362	6

The following 19 springs reported sales:

Buena Vista Springs, Nashville, Davidson County.
Bush Epsom Lithia Wells, Davidson County, near Nolensville.
Darnell Well, Clarksville, Montgomery County.
Eastbrook Springs, Eastbrook, Franklin County.
Galbraith Epsom Lithia Well, near Galbraith Springs, Hawkins County.
Hamilton Springs, near Lebanon, Wilson County.
Horn Springs, Horn Springs, Wilson County.
Larkin Spring, Madison, Davidson County.
Lockeland Spring, near Nashville, Davidson County.
Neubert Spring, near Neubert, Knox County.
Pioneer Lithia Spring, near Nashville, Davidson County.
Red and Black Boiling Springs, Red Boiling Springs, Macon County.
Rhea Springs, Rhea Springs, Rhea County.
Sunrise Spring, near Ashland City, Cheatham County.
Tate Spring, Tate Springs, Grainger County.
Thompson Spring, near Nashville, Davidson County.
Whittle Springs, near Whittle Springs, Knox County.
Willow Brook Spring, Craggie Hope, Cheatham County.
Wright's Epsom-Lithia Spring, Mooresburg, Hawkins County.

TEXAS.

There was a decrease in the sales of mineral waters in Texas in 1917 of 23 per cent in quantity and 26 per cent in value, most of the water, as in 1916, being reported as sold for medicinal use. The total sales amounted to 541,178 gallons, valued at $72,175. In addition, about 35,000 gallons of mineral water was consumed in the manufacture of soft drinks.

No new springs were reported. Two springs active in 1916 reported no sales for 1917; 4 idle in 1916 were active in 1917; the output for 1917 of 1 spring was estimated; and 5 springs active in 1916 were not heard from in 1917. Hume Sour Mineral Well is now called Dove Mineral Well. Three resorts, accommodating about 1,300 guests, and 3 mineral-water bathing establishments were reported.

The following is the list of the 27 springs reporting sales during 1917:

Austin Well, Mineral Wells, Palo Pinto County.
Beauchamp's Well, Blossom, Lamar County.
Brocks Mineral Wells, near Denton, Denton County.
Burdette Mineral Well, near Lockhart, Caldwell County.
Capps Mineral Wells, Longview, Gregg County.
Crazy and Gibson Wells, Mineral Wells, Palo Pinto County.
Dove Mineral Well, Sutherland Springs, Wilson County.
Hefner Well, Blossom, Lamar County.
High Island Mineral Well, High Island, Galveston County.
Hubbard Hot Well, Hubbard, Hill County.
Lamar Wells, Mineral Wells, Palo Pinto County.
Mangum Wells, Mangum, Eastland County.
Marlin Hot Wells, Marlin, Falls County.

Maurice Wells, Mangum, Eastland County.
Mitchell Well, Greenville, Hunt County.
Olympia Well, Mineral Wells, Palo Pinto County.
Riviere Mineral Wells, Tyler, Smith County.
Roach Mineral Well, near Mount Pleasant, Titus County.
Rock Bottom Well, Mineral Wells, Palo Pinto County.
Sour Well, Sulphur Springs, Hopkins County.
Southland Spring, Duffau, Erath County.
Texarkana Lonestar Mineral Wells, Texarkana, Bowie County.
Texas Carlsbad Wells, Mineral Wells, Palo Pinto County.
Tioga Mineral Wells, Tioga, Grayson County.
Weatherby Wells, Garrison, Nacogdoches County.
Wizard Wells, Wizard Wells, Jack County.
Wootan Wells, Wootan Wells, Robertson County.

VERMONT.

The mineral-water trade in Vermont in 1917 was 30 per cent greater in quantity and 15 per cent greater in value than in 1916. The total sales were 94,500 gallons, valued at $17,705, as compared with 72,590 gallons, valued at $15,395, in 1916. The average price per gallon dropped from 21 to 19 cents. In addition to the mineral water reported sold about 30,000 gallons was used in the manufacture of soft drinks. One resort, accommodating 400 guests, and 1 mineral-water bathing establishment were maintained.

Four springs were active, as follows:

Clarendon Nitrogen and North springs, Clarendon Springs, Rutland County.
Cold Spring, Wells, Rutland County.
Equinox Spring, Manchester, Bennington County.

VIRGINIA.

Returns from Virginia show that in 1917 the sales of mneral waters in that State increased 9 per cent in quantity and decreased about 4 per cent in value, largely on account of an increase in the sales of table water. The total output was 2,518,050 gallons, valued at $237,788, as compared with 2,313,616 gallons, valued at $248,906, in 1916. The average price fell from 11 to 9 cents per gallon. In addition to the water reported as sold 438,166 gallons was used in the manufacture of soft drinks. Eight springs active in 1916 reported no sales in 1917; 2 springs active in 1916 were not heard from in 1917; and 1 spring reported sales for the first time; thus the number of active springs was reduced from 50 in 1916 to 41 in 1917. Nine resorts, accommodating about 1,000 guests, and 4 mineral-water bathing establishments were maintained at springs.

Crystal Spring, Petersburg, Dinwiddie County, was reported in the list of active springs for the first time.

Mineral waters sold in Virginia, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	49	2,873,288	$298,473	10
1914	50	2,906,976	293,512	10
1915	50	3,027,528	237,818	8
1916	50	2,313,616	248,906	11
1917	41	2,518,050	237,788	9

The 41 springs reporting sales are as follows:

Alkaline Lithia Spring, near Staunton, Augusta County.
Alleghany Spring, Alleghany Springs, Montgomery County.
Bear Lithia Spring, near Elkton, Rockingham County.
Beaufont Spring, Chesterfield County, near Richmond.
Berry Hill Mineral Spring, Elkwood, Culpeper County.
Blue Ridge Springs, near Blue Ridge Springs, Botetourt County.
Broad Rock Mineral Spring, Chesterfield County, near Richmond.
Buckhead Springs, Buckhead Springs, Chesterfield County.
Buffalo Mineral Springs, Buffalo Lithia Springs, Mecklenburg County.
Burnett Spring, Culpeper, Culpeper County.
Carter Springs, Danville, Pittsylvania County.
Chlorinated Calcic Spring, Norfolk, Norfolk County.
Como Spring, East Richmond, Henrico County.
Crockett Arsenic Lithia Springs, Crockett Springs, Montgomery County.
Crystal Spring, Petersburg, Dinwiddie County.
Diamond Spring, near Norfolk, Princess Anne County.
Eaglewood Mineral Springs, near Danville, Pittsylvania County.
Farmvillle Lithia Springs, Cumberland County, near Farmville.
Fonticello Spring, Chesterfield County, near Richmond.
Granite Mineral Spring, Chesterfield County, near Richmond.
Harris Anti-Dyspeptic Spring, Burkeville, Nottoway County.
Healing Springs, Healing Springs, Bath County.
Kayser Springs, Staunton, Augusta County.
Landale Spring, Norfolk, Norfolk County.
Lithia Magnesia Springs, Rockymount, Franklin County.
Magee Chlorinated Lithia Springs, Clarksville, Mecklenburg County.
Massanetta Spring, near Harrisonburg, Rockingham County.
Mecklenburg Mineral Springs, Chase City, Mecklenburg County.
Mico Well, Alexandria, Alexandria County.
Mulberry Island Lithia Well, Mulberry Island, Warwick County.
Nye Lithia Springs, Wytheville, Wythe County.
Paeonian Springs, Paeonian Springs, Loudoun County.
Rockbridge Alum Springs, Rockbridge Alum Springs, Rockbridge County.
Rubino Healing Springs, Healing Springs, Bath County.
Seawright Magnesian Lithia Spring, near Staunton, Augusta County.
Stribling Springs, near Mount Solon, Augusta County.
Trepho Mineral Spring, Claremont, Surry County.
Victoria Alka-Lithia Well, Victoria, Lunenburg County.
Virginia Etna Springs, Vinton, Roanoke County.
Virginia Lithia Spring, Chesterfield, Chesterfield County.
Wyrick Mineral Spring, near Crockett, Wythe County.

WASHINGTON.

Washington's output of mineral water in 1917 was 155,265 gallons, valued at $7,265, or at 5 cents a gallon, whereas the output in 1916 was 151,528 gallons, valued at $9,476, or at 6 cents a gallon. Thus there was an increase of 2 per cent in quantity and a decrease of 23 per cent in value. No new springs were reported. One resort was maintained, but no bathing establishments were operated. About 7,515 gallons of mineral water was used in the manufacture of soft drinks, a decrease from 1916 of 92 per cent.

The names of the four active springs are:

Ahtanum Soda Springs, near Tampico, Yakima County.
Artesian Mineral Well, North Yakima, Yakima County.
Diamond Natural Mineral Spring, Auburn, King County.
Klickitat Mineral Spring, Klickitat, Klickitat County.

WEST VIRGINIA.

The output of mineral water in West Virginia in 1917 amounted to 156,267 gallons, valued at $37,529, as compared with 287,466 gallons, valued at $46,686, in 1916. This change is equivalent to a decrease of 46 per cent in quantity and 20 per cent in value. One spring active in 1916 was idle in 1917; 2 springs active in 1916 were not heard from in 1917; 1 spring idle in 1916 was active in 1917; and the output of 1 spring was estimated. Thus the number of active springs in 1917 was 7. Six resorts, accommodating 1,700 guests, and 3 mineral-water bathing establishments were operated at springs.

The following are the names of the seven commercial springs reporting in 1917:

Barilithic Spring, Webster Springs, Webster County.
Borland Mineral Springs, Borland, Pleasants County.
Manacea Irondale Spring, Independence, Preston County.
Pence Spring, Pence Springs, Summers County.
Vigora Springs, Woodsdale, Ohio County.
Webster Springs Salt Sulphur Water, Webster Springs, Webster County.
White Sulphur Springs, White Sulphur Springs, Greenbrier County.

WISCONSIN.

A decrease in the sales of mineral waters in Wisconsin is indicated by the reports for 1917. The total output was 6,296,634 gallons, valued at $1,362,498, as compared with 7,696,813 gallons, valued at $1,507,679, in 1916. These figures represent a decrease of 18 per cent in quantity and 10 per cent in value. The sales of table waters amounted to $1,298,358, and of medicinal waters to $64,140. The average price per gallon rose from 20 to 22 cents. In addition to the water reported as sold, 1,014,204 gallons was used in the manufacture of soft drinks. Two resorts accommodating 1,520 guests were maintained, but no bathing establishments were operated at springs. Three springs temporarily idle in 1916 were productive in 1917; 2 springs active in 1916 reported no sales in 1917; 2 springs from which no reports were received for 1917 were considered idle; and White Cross Springs reported sales for the first time; thus the number of active springs in 1917 was 36, the same as in 1916. Deep Rock Spring is now called Hydrox Spring.

Mineral waters sold in Wisconsin, 1913–1917.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1913	34	6,326,533	$872,518	14
1914	35	5,145,452	588,373	11
1915	36	4,861,734	1,051,405	22
1916	36	7,696,813	1,507,679	20
1917	36	6,296,634	1,362,498	22

The total number of springs reporting production was 36, as follows:

Allouez Spring, Green Bay, Brown County.
Almanaris Spring, Waukesha, Waukesha County.
Anderson Waukesha Spring, Waukesha, Waukesha County.
Arbutus Mineral Spring, Oconto, Oconto County.
Arcadian Spring, Waukesha, Waukesha County.
Bay City Springs, Ashland, Ashland County.

Bethania Spring, Osceola, Polk County.
Bethesda Mineral Spring, Waukesha, Waukesha County.
Chippewa Spring, Chippewa Falls, Chippewa County.
Clysmic Spring, Waukesha, Waukesha County.
Crystal Spring, Sheboygan, Sheboygan County.
Crystal Springs, Waupaca, Waupaca County.
Darlington Mineral Spring, Darlington, Lafayette County.
Elysian Spring, Prairie du Chien, Crawford County.
Famous Spring, Menominee Falls, Waukesha County.
Glenn Rock Spring, Waukesha, Waukesha County.
Hydrox Spring, Palmyra, Jefferson County.
High Rock Spring, Waukesha, Waukesha County.
Kusche Spring, Oshkosh, Winnebago County.
Lebenwasser Spring, Green Bay, Brown County.
Marihel Mineral Spring, Marihel, Manitowoc County.
Neeskara Spring, Wauwatosa, Milwaukee County.
Roxo Spring, Waukesha, Waukesha County.
Salvator Spring, Green Bay, Brown County.
Sheboygan Spring, Sheboygan, Sheboygan County.
Sheridan Mineral Springs, near Lake Geneva, Walworth County.
Silurian Spring, Waukesha, Waukesha County.
Silver Springs, Madison, Dane County.
Soda-Lithia Spring, Fussville, near Menominee Falls, Waukesha County.
Solon Springs, Solon Springs, Douglas County.
Sulphur Mineral Spring, Oshkosh, Winnebago County.
Waukesha AAAA Spring, Waukesha, Waukesha County.
Waukesha Fox Head Spring, Waukesha, Waukesha County.
White Cross Springs, Madison, Dane County.
White Rock Spring, Waukesha, Waukesha County.
Wilnette Spring, Cooper Station, Racine County.

WYOMING.

Sales from 4 springs in Wyoming in 1917 amounted to 53,726 gallons, valued at $7,890, or a decrease in quantity of 0.31 per cent and an increase in value of 9 per cent as compared with the output in 1916. One spring idle in 1916 reported sales in 1917, thereby increasing the number of active springs in 1917 to 4. Two small resorts and 2 mineral-water bathing establishments were operated, and about 300 gallons of mineral water also was used in the manufacture of soft drinks.

The names of the 4 reporting springs are as follows:

Big Horn Hot Springs, Thermopolis, Hot Springs County.
De Maris Spring, Cody, Park County.
Paulson Well, Saratoga, Carbon County.
Skyrok Water, Granite Canon, Laramie County.

CLAY-WORKING INDUSTRIES.[1]

By JEFFERSON MIDDLETON.

GENERAL CONDITIONS.

This report deals with the products of the clay-working industries as well as with clay mining, and the tables are made up to show the output of manufactured clay products as best expressing the production of clay.

The year 1917 was one of unusual conditions in the clay-working industries. In spite of strikes, scarcity of labor and raw materials, and unfavorable transportation conditions, which caused a marked decrease in the quantity of most clay products sold, the value of the output was much greater than in any preceding year. In the industries concerned with structural clay products the year opened with prospects of unusual activity, but the declaration of war early in April and the restriction of building to Governmental and essential war industries necessarily had the effect of reducing the demand for clay products, so that the total value of the business for the year was only a little more than in 1916. The refractory products, which were used largely in the war industries, were in great demand and showed the largest increase—$28,541,262, or 77 per cent. The adverse business conditions of the year imposed unusual hardships on the pottery industry, but nevertheless it made considerable progress. The volume of business done was not so large as in some former years, but the value of the output was the largest ever recorded, and progress was made both in the quality of ware and in the development of labor and fuel-saving devices in order to meet after-war competition.

The total value of all clay products marketed in 1917 was $248,023,368—an increase of $40,763,277, or nearly 20 per cent. In 1916 the increase over 1915 was $44,139,859, or 27 per cent. In 1917 brick and tile products, embracing structural products, engineering refractories, and miscellaneous wares—the coarser clay products—were valued at $191,860,846, or more than 77 per cent of the total, and pottery products were valued at $56,162,522, or nearly 23 per cent of the total. Brick and tile products increased in value $32,817,997, or nearly 21 per cent, and pottery products increased $7,945,280, or more than 16 per cent, compared with 1916.

The most noteworthy features of the year were (1) the large increase in the quantity and value of fire brick; (2) the decrease in the quantity and value of common brick, especially in the Hudson River region; (3) the large increase in the value of hollow building

[1] Tables of production were prepared by Miss Belle Worth Bagley and Miss K. W. Cottrell, tables of imports and exports by J. A. Dorsey, and tables of building operations by Miss Cottrell.

tile; and (4) the successful manufacture of glasshouse pots for optical glass from domestic clays.

The engineering products and refractory brick—vitrified brick, draintile, sewer pipe, fire brick, and stove lining—valued at $98,085,793, increased $30,469,293, or 45 per cent, and the clay structural materials, valued at $85,659,887, made a net increase of $1,016,635, or 1 per cent, in 1917, compared with 1916.

The increase in refractories was caused principally by the demand for these wares in the munitions industries, and especially in the erection of by-product coke ovens, which require a very high-grade refractory, though the use of refractories for other purposes is increasing rapidly with the industrial development of the country. One who is unfamiliar with the many uses of refractories finds it difficult to realize their importance. They are absolutely essential to the iron and steel industries, the basis of our modern industrial development; they are used in railroad locomotives and in steamships, in the manufacture of lead and zinc, in the manufacture of glass, in the baking of bread, in the tanning of leather, in the burning of many clay products, in kitchen stoves and ranges, and almost everywhere else that fires are used, either for the generation of power or for heat.

The large decrease in common brick was caused principally by the decrease in building operations throughout the country, but it may be attributed in part to the increased and increasing use of hollow building tile.

The imports of clay products, 97 to 98 per cent of which are pottery, which have in recent years been decreasing, in 1917 showed an increase of $876,908, or 15 per cent, compared with 1916. This increase was principally in pottery—$732,729. Owing to the unusual demand at home, however, this increase had little or no effect on the domestic production, the proportion of which to consumption was 92 per cent, the same as for 1916 and the highest recorded.

The exportation of clay products, an unimportant factor in the industries, showed another large increase in 1917 and reached the maximum value—$6,953,263, which was $1,952,368, or 39 per cent, greater than the previous maximum in 1912. Fire brick continues to be the principal clay product exported, its value constituting nearly 58 per cent of all exports. Canada is the best foreign market for clay products exported from the United States, more than one-half of our exports going to that country in 1917.

An unusual and interesting feature of the exports in 1917 was the shipment of common building brick and vitrified brick to France for use in the construction of military depots in that country.

In their statements to the Geological Survey the producers report quantities for common brick, front brick, vitrified brick or block, hollow building tile, clay fire brick, and silica fire brick, but not for fancy brick or for enameled brick. The average price per thousand for these varieties increased as follows: Common brick, $1.49; vitrified brick or block, $2.09; clay fire brick, $11.23; and silica fire brick, $20.06. These advances seem no more than reasonable, except possibly in the two kinds of fire brick, compared with the increase in the cost of labor and materials. Five varieties of brick and tile and the miscellaneous products reached their maximum value in 1917. Fire brick is the only product that reached its maximum output, so far as can be determined. Hollow building tile probably also reached its maximum output, but the Geological Survey has no means of determining this, as 1917 is the first year for which information concerning the quantity of this material was asked. The quantities of common brick, front brick, and vitrified brick or block showed large decreases.

The number of firms reporting sales continues to decrease, the number for 1917 being the smallest in the history of the industry and less than half of the maximum number reported for 1899. This decrease is caused principally by the elimination of the smaller plants, which is ascribed to the encroachment of cement or concrete and to the consolidation of plants for more efficient management. The increase in the size of the operations is shown by the average increase in the value per active operator reporting, which increased from $13,760 in 1899 to $78,439 in 1917. The number of operators does not mean the number of plants, as one operator may have more than one plant—in fact, some operators have a dozen or more. Clay products, except the highest grades, are made for local consumption, their low value preventing transportation for any considerable distances. Hence local conditions, including weather, seriously affect some branches of the clay-working industries. Imports consist chiefly of the highest grades of ware, principally pottery, and the European war, until this country entered it, had little direct effect on the brick and tile industries. Some of these wares, however, have been made from imported clays, especially from the high-grade English and German clays, and the decrease in the imports of the latter has affected the manufacture of crucibles, lead pencils, glass-house pots, etc., though domestic clays are being successfully used in the manufacture of these wares.

ACKNOWLEDGMENTS.

The writer again desires to thank the clay workers of the country for their cooperation, without which this report would be impossible. Thanks are also extended to the clay-working press for its support and appreciation, and to the officials who have supplied information concerning the building operations of the large cities of the country.

PRODUCTION.

The value of the brick and tile products as classified in this report forms a little more than three-fourths and that of the pottery products a little less than one-fourth of the total. Every State is a producer of clay wares. A small production was reported from the District of Columbia and from Porto Rico. In Nevada and Rhode Island there were not a sufficient number of producers reporting to permit the publication of State totals without disclosing confidential information, so that statistics for these States have been combined with those of contiguous States.

No returns are received from the clay workers of the Philippine Islands, but the output of clay products in the islands in 1917 is estimated by the Bureau of Insular Affairs, of the War Department, to have been valued at $450,000. This valuation is not included in the United States' production.

Value of the products of clay in the United States in 1916 and 1917, with increase or decrease.

State.	1916						1917						Increase or decrease, 1917.	
	Rank of State.	Number of firms reporting sales.	Brick and tile.	Pottery.	Total.	Percentage of total value.	Rank of State.	Number of firms reporting sales.	Brick and tile.	Pottery.	Total.	Percentage of total value.	Value.	Per cent.
Alabama	25	57	$1,497,496	$22,805	$1,520,301	0.73	19	53	$2,087,785	$18,731	$2,106,516	0.85	+ $586,215	+38.56
Arizona	45	10	106,149		106,149	.05	44	11	135,474		135,474	.05	+ 29,325	+27.63
Arkansas	33	31	521,569	(a)	a 521,569	.25	30	22	672,766	(a)	a 672,766	.27	+ 151,197	+28.99
California	10	79	3,645,629	517,797	4,163,426	2.01	11	74	4,215,456	613,151	4,828,607	1.95	+ 665,181	+15.98
Colorado	18	49	1,818,470	111,569	1,930,039	.93	15	54	2,421,174	158,093	2,579,267	1.04	+ 649,228	+33.64
Connecticut and Rhode Island	21	37	1,762,653	(b)	1,762,653	.85	23	35	1,705,013	(b)	1,705,013	.69	− 57,640	− 3.27
Delaware	42	14	187,388		187,388	.09	42	11	197,310		197,310	.08	+ 9,922	+ 5.29
District of Columbia	43	5	129,394	(a)	a 129,394	.06	43	5	154,242	6,000	160,242	.06	+ 30,848	+23.84
Florida	40	14	226,362		226,362	.11	40	16	224,606	4,800	229,406	.09	+ 3,044	+ 1.34
Georgia	15	64	2,348,781	13,201	2,361,982	1.14	17	62	2,414,368	12,303	2,426,671	.98	+ 64,689	+ 2.74
Idaho and Nevada	41	21	212,451		212,451	.10	41	19	198,606		198,606	.08	− 13,845	− 6.52
Illinois	4	225	16,507,845	1,125,506	17,633,351	8.51	4	210	17,994,158	1,571,262	19,565,420	7.89	+ 1,932,069	+10.96
Indiana	6	199	8,032,960	1,634,353	9,667,313	4.66	6	179	9,108,973	1,890,501	10,999,474	4.44	+ 1,332,161	+13.78
Iowa	9	153	7,379,289	(a)	a 7,379,289	3.56	9	137	7,535,313	4,900	7,540,213	3.04	+ 160,924	+ 2.18
Kansas	14	48	2,747,803		2,747,803	1.33	14	39	2,695,722		2,695,722	1.09	− 52,081	− 1.90
Kentucky	11	69	3,438,146	121,111	3,559,257	1.72	10	55	4,886,486	153,769	5,040,255	2.03	+ 1,480,998	+41.61
Louisiana	36	27	360,855	(a)	a 360,855	.17	35	21	440,053	7,888	447,941	.18	+ 87,086	+24.13
Maine	32	34	546,725	(a)	a 546,725	.26	34	35	531,870	(a)	a 531,870	.21	− 14,855	− 2.72
Maryland	20	43	1,548,295	277,575	1,825,870	.88	16	36	2,135,184	332,954	2,468,138	1.00	+ 642,268	+35.18
Massachusetts	19	56	1,661,737	230,821	1,892,558	.91	20	55	1,720,988	250,992	1,971,980	.80	+ 79,422	+ 4.20
Michigan	12	78	2,705,054	792,716	3,497,770	1.69	12	69	2,846,264	1,187,981	4,034,245	1.63	+ 536,475	+15.34
Minnesota	16	55	2,064,362	(a)	a 2,064,362	1.00	18	52	2,197,664	(a)	a 2,197,664	.89	+ 133,302	+ 6.46
Mississippi	34	38	508,698	11,920	520,618	.25	33	42	535,584	18,001	553,585	.22	+ 32,967	+ 6.33
Missouri	7	83	7,634,559	6,436	7,640,995	3.69	7	77	10,328,374	10,675	10,339,049	4.17	+ 2,698,054	+35.31
Montana	30	22	717,551	(a)	a 717,551	.35	31	22	663,315	500	663,815	.27	− 53,736	− 7.49
Nebraska	27	37	943,553	(a)	a 943,553	.46	27	37	1,160,508	(a)	a 1,160,508	.47	+ 216,955	+22.99
New Hampshire	35	19	473,434	(a)	a 473,434	.23	36	17	411,876	(a)	a 411,876	.17	− 61,558	−13.00
New Jersey	3	144	9,749,524	11,064,878	20,814,402	10.04	3	142	9,993,389	12,535,843	22,529,232	9.08	+ 1,714,830	+ 8.24
New Mexico	39	6	257,561		257,561	.12	39	7	257,875		257,875	.10	+ 314	+ .12
New York	5	186	8,410,340	3,344,672	11,755,012	5.67	5	167	7,351,582	4,076,817	11,428,399	4.61	− 326,613	− 2.78
North Carolina	24	125	1,541,576	9,860	1,551,436	.75	24	114	1,654,832	7,475	1,662,307	.67	+ 110,871	+ 7.15
North Dakota	38	8	264,457		264,457	.13	38	9	294,016		294,016	.12	+ 29,559	+11.18
Ohio	1	500	25,506,344	19,441,533	44,947,877	21.69	1	471	31,113,010	21,353,706	52,466,716	21.15	+ 7,518,839	+16.73
Oklahoma	26	27	1,410,657		1,410,657	.68	22	27	1,857,546		1,857,546	.75	+ 446,889	+31.68
Oregon	37	37	299,993	(a)	a 299,993	.14	37	36	331,546	(a)	a 331,546	.13	+ 31,553	+10.52
Pennsylvania	2	348	29,630,563	2,480,127	32,110,690	15.49	2	319	45,967,706	3,194,944	49,162,650	19.82	+17,051,960	+53.10

Porto Rico	48	6	5,612	(a)	a 5,612	......	48	4	a 3,374	(a)	a 3,374	......	− 2,238	−39.88
South Carolina	31	36	598,431	8,720	607,151	.29	32	34	654,613	8,188	662,801	.27	+ 55,650	+ 9.17
South Dakota	44	5	115,474	....	115,474	.06	47	4	47,213	....	47,213	.02	− 68,261	−59.11
Tennessee	17	66	1,679,319	304,638	1,983,957	.96	21	67	1,569,146	400,080	1,969,226	.79	− 14,731	− .74
Texas	13	86	2,749,780	88,180	2,837,960	1.37	13	82	3,358,913	92,893	3,451,806	1.39	+ 613,846	+21.63
Utah	29	24	885,357	(a)	a 885,357	.43	29	19	945,530	7,333	952,863	.38	+ 67,506	+ 7.62
Vermont	46	6	94,779	....	94,779	.05	46	4	98,344	....	98,344	.04	+ 3,565	+ 3.76
Virginia	22	56	1,676,723	(a)	a 1,676,723	.81	25	48	1,625,912	32,130	1,658,042	.67	− 18,681	− 1.11
Washington	23	40	1,589,574	(a)	a 1,589,574	.77	26	33	1,532,043	996	1,533,039	.62	− 56,535	− 3.56
West Virginia	8	61	1,853,468	5,780,853	7,634,321	3.68	8	57	2,364,165	7,243,900	9,608,065	3.87	+ 1,973,744	+25,85
Wisconsin	28	69	905,910	(a)	a 905,910	.44	28	64	1,114,121	8,000	1,122,121	.45	+ 216,211	+23,87
Wyoming	47	9	90,199	....	90,199	.04	45	9	106,838	....	106,838	.04	+ 16,639	+18.45
Undistributed	......	......	....	827,971	827,971	.40	......	......	....	957,716	957,716	.39	+ 129,745	+15.67
	......	3,412	159,042,849	48,217,242	207,260,091	100.00	......	3,162	191,860,846	56,162,522	248,023,368	100.00	+40,763,277	+19.67
Percentage of total	......	......	76.74	23.26	100.00	......	......	......	77.36	22.64	100.00	......	....	......

a Pottery included in "Undistributed."

b Produced by Connecticut alone and included in "Undistributed."

The total value of the clay products marketed in 1917 showed a large increase, which normally would indicate a progressive condition of the industry, but this progress was more apparent than real, as of the 48 States and Territories represented in this table only 36 showed increase in the value of clay products, whereas 43 of the 48 States showed increase in 1916. Pennsylvania, owing to the large increase in its production of refractories, showed the largest increase, both actual and proportionate—$17,051,960, or 53 per cent; Ohio also made a large gain—$7,518,839, or nearly 17 per cent. The decrease in value in 1917 was comparatively small; the total decrease for the 12 States was $740,774 and was distributed among the smaller producing States, only one of the first 13 States, New York, showing decrease. The principal product of most of these States is common brick, the decreased production of which largely accounts for the decrease in value in these States. The largest proportionate decrease in value was in South Dakota—59 per cent. Four of the five States that showed decrease in 1916 rallied and increased in 1917. New Hampshire is the only State to show decrease in both years.

Ohio has been the leading State in the value of clay products since the statistics were first compiled by the Geological Survey in 1894. The value of its output has always greatly exceeded that of the second State, Pennsylvania, but in 1917 the difference, $3,304,066, or 7 per cent, was the smallest that has been recorded by the Geological Survey. There was no change in the relative rank of the first 9 States. Kentucky was tenth, exchanging places with California, which was eleventh. Alabama rose from twenty-fifth in 1916 to nineteenth in 1917; Maryland from twentieth to sixteenth; Oklahoma from twenty-sixth to twenty-second; and Tennessee fell from seventeenth to twenty-first. The first 5 States reported wares valued at $155,152,417, or 63 per cent of the total, compared with $127,261,332, or 61 per cent of the total, in 1916. The first 10 States reported wares in 1917 valued at $198,679,473, or 80 per cent of the total. The first 10 States in 1916 reported wares valued at $163,746,676, or 79 per cent of the total.

Value of the clay products of the United States in 1916 and 1917, and increase or decrease in 1917, by products.

Product.	1916	1917	Increase or decrease in 1917.	
			Value.	Per cent.
Common brick	$49,357,411	$47,936,344	−$1,421,067	− 2.88
Vitrified brick or block	12,236,890	10,664,560	− 1,572,330	−12.85
Front brick	11,464,614	10,391,368	− 1,073,246	− 9.36
Fancy or ornamental brick	109,072	192,072	+ 83,000	+76.10
Enameled brick	827,443	889,899	+ 62,456	+ 7.55
Draintile	10,083,647	11,008,163	+ 924,516	+ 9.17
Sewer pipe	13,577,006	17,307,211	+ 3,730,205	+27.47
Architectural terra cotta	6,466,336	6,173,550	− 292,786	− 4.53
Fireproofing and hollow building tile	9,942,912	13,255,433	+ 3,312,521	+33.32
Tile, not drain	6,475,464	6,821,221	+ 345,757	+ 5.34
Stove lining	601,776	619,882	+ 18,106	+ 3.01
Fire brick	30,806,129	58,012,264	+27,206,135	+88.31
Miscellaneous	7,094,149	8,588,879	+ 1,494,730	+21.07
Total brick and tile	159,042,849	191,860,846	+32,817,997	+20.63
Total pottery	48,217,242	56,162,522	+ 7,945,280	+16.48
Grand total	207,260,091	248,023,368	+40,763,277	+19.67

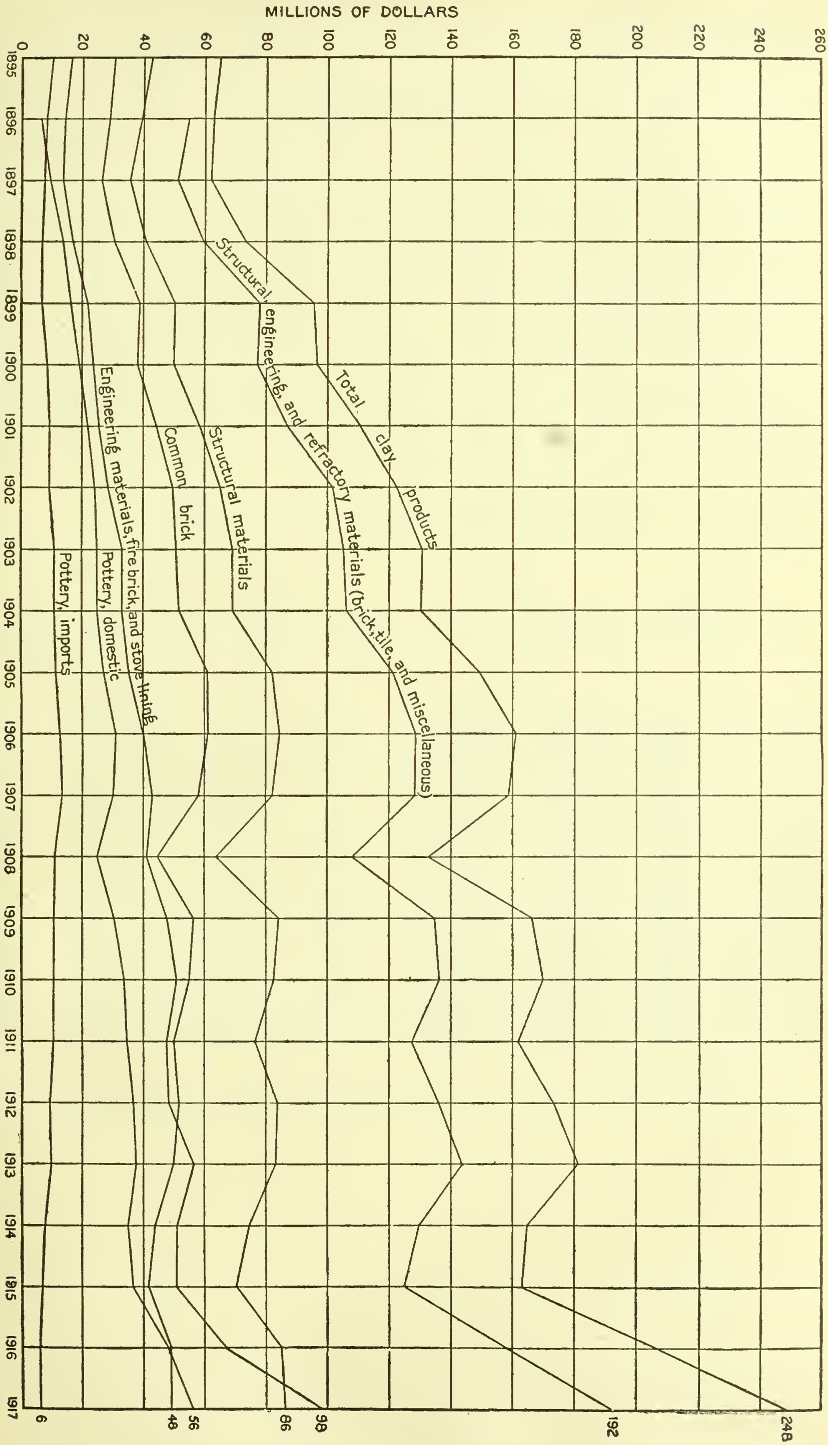

FIGURE 15.—Value of clay products sold in the United States, 1895–1917.

This table shows increase in eight brick and tile products and in miscellaneous products, and decrease in four. Fire brick, which showed large increase in 1915 and 1916 continued to grow in importance and showed a very remarkable gain, nearly doubling in value compared with 1916, and trebling compared with 1915. The increase in value of fire brick in 1917 ($27,206,135, or 88 per cent) was the largest proportionate and actual increase in any single clay product recorded by the United States Geological Survey, and was exceeded only by the total increase in value of brick and tile products in two years, 1909 and 1916. Sewer pipe and fireproofing also showed large increases. The decrease was proportionately small, except in vitrified paving brick. In 1916, 10 brick and tile products and miscellaneous increased in value, and 2 products decreased to the amount of $8,718. These products, fancy brick and enameled brick, rallied in 1917 and showed considerable increase, fancy brick increasing 76 per cent. The net increase in 1916 was: Brick and tile, $33,248,005, or 26 per cent; pottery, $10,891,854, or 29 per cent; total increase, $44,139,859, or 27 per cent.

Clay products sold in the United States, 1897–1917.

Year.	Number of firms reporting sales.	Common brick.			Vitrified brick or block.		
		Quantity (thousands).	Value.	Average price per thousand.	Quantity (thousands).	Value.	Average price per thousand.
1897	5,424	5,292,532	$26,430,207	$4.99	435,851	$3,582,037	$8.22
1898	5,971	5,867,415	30,980,704	5.28	474,419	4,016,822	8.47
1899	6,962	7,695,305	39,887,522	5.18	580,751	4,750,424	8.18
1900	6,475	7,140,622	38,621,514	5.41	546,679	4,764,124	8.71
1901	6,421	8,038,579	45,503,076	5.66	605,077	5,484,134	9.06
1902	6,046	8,475,067	48,885,869	5.77	617,192	5,744,530	9.31
1903	6,034	8,463,683	50,532,075	5.97	654,499	6,453,849	9.86
1904	6,108	8,665,171	51,768,558	5.97	735,489	7,557,425	10.28
1905	5,925	9,817,355	61,394,383	6.25	665,879	6,703,710	10.07
1906	5,857	10,027,039	61,300,696	6.11	751,974	7,857,768	10.45
1907	5,536	9,795,698	58,785,461	6.00	876,245	9,654,282	11.02
1908	5,328	7,811,046	44,765,614	5.73	978,122	10,657,475	10.90
1909	5,068	9,791,870	57,251,115	5.85	1,023,654	11,269,586	11.01
1910	4,915	9,221,517	55,219,551	5.99	968,000	11,004,666	11.37
1911	4,628	8,475,277	49,885,262	5.89	948,758	11,115,742	11.72
1912	4,284	8,555,238	51,796,266	6.05	911,869	10,921,575	11.98
1913	4,065	8,088,790	50,134,757	6.20	958,680	12,138,221	12.66
1914	3,860	7,146,571	43,769,524	6.12	931,324	12,500,866	13.42
1915	3,636	6,851,099	42,145,292	6.15	953,335	12,230,899	12.83
1916	3,412	7,394,202	49,357,411	6.68	941,553	12,236,890	13.00
1917	3,162	5,864,909	47,936,344	8.17	706,934	10,664,560	15.09

Clay products sold in the United States, 1897–1917—Continued.

Year.	Front brick. Quantity (thousands).	Front brick. Value.	Front brick. Average price per thousand.	Fancy or ornamental brick (value).	Enameled brick (value).	Fire brick (value).	Stove lining (value).	Draintile (value).
1897....	310,918	$3,855,033	$12.40	$685,048	(a)	$4,094,704	(b)	$2,623,305
1898....	295,833	3,572,385	12.08	358,372	$279,993	6,093,071	(b)	3,115,318
1899....	438,817	4,767,343	10.86	476,191	329,969	8,641,882	$416,235	3,682,394
1900....	344,516	3,864,670	11.09	289,698	323,630	9,830,517	462,541	2,976,281
1901....	415,343	4,709,737	11.34	372,131	463,709	9,870,421	423,371	3,143,001
1902....	458,391	5,318,008	11.60	335,290	471,163	11,970,511	630,924	3,506,787
1903....	433,016	5,402,861	12.48	328,387	569,689	[b]14,062,369	(b)	4,639,214
1904....	434,351	5,560,131	12.80	300,233	545,397	11,167,972	(b)	5,348,555
1905....	541,590	7,108,092	13.12	293,907	636,279	12,735,404	645,432	5,850,210
1906....	617,469	7,895,323	12.79	207,119	773,104	14,296,868	743,414	6,543,289
1907....	585,943	7,329,360	12.51	361,243	918,173	14,946,045	627,647	6,864,162
1908....	584,482	6,935,600	11.87	259,556	660,862	10,696,216	529,976	8,661,476
1909....	816,164	9,712,219	11.90	174,073	993,902	16,620,695	423,583	9,799,158
1910....	697,857	8,590,057	12.31	179,505	832,225	18,111,474	503,806	10,389,822
1911....	724,911	8,648,877	11.93	177,015	1,038,865	16,074,686	614,116	8,826,314
1912....	814,007	9,455,297	11.62	225,367	1,027,314	17,877,629	516,874	8,010,250
1913....	827,665	9,614,138	11.62	109,703	1,225,708	20,627,122	535,667	8,558,320
1914....	810,395	9,289,623	11.46	124,459	1,075,026	16,427,547	520,585	8,522,039
1915....	855,668	9,535,536	11.14	109,425	835,808	18,839,931	459,341	8,879,264
1916....	1,002,762	11,464,614	11.43	109,072	827,443	30,806,129	601,776	10,083,647
1917....	757,618	10,391,368	13.72	192,072	889,899	58,012,264	619,882	11,008,163

Year.	Sewer pipe (value).	Architectural terra cotta (value).	Hollow building tile and fireproofing (value).	Tile, not drain (value).	Miscellaneous (value).	Total brick and tile (value).	Pottery.	Total.
1897.....	$4,069,534	$1,841,422	$1,979,259	$1,476,638	$1,413,595	$52,050,782	$10,309,209	$62,359,991
1898.....	3,791,057	2,043,325	1,900,642	1,746,024	2,000,743	59,898,456	14,589,224	74,487,680
1899.....	4,560,334	2,027,532	1,665,066	1,276,300	6,065,928	78,547,120	17,250,250	95,797,370
1900.....	5,842,562	2,372,568	1,820,214	2,349,420	2,896,036	76,413,775	19,798,570	96,212,345
1901.....	6,736,969	3,367,982	1,860,269	2,867,659	2,945,268	87,747,727	22,463,860	110,211,587
1902.....	7,174,892	3,526,906	3,175,593	3,622,863	3,678,742	98,042,078	24,127,453	122,169,531
1903.....	8,525,369	4,672,028	3,861,343	3,505,329	3,073,856	105,626,369	25,436,052	131,062,421
1904.....	9,187,423	4,107,473	3,629,101	3,023,428	3,669,282	105,864,978	25,158,270	131,023,248
1905.....	10,097,089	5,003,158	4,098,793	3,647,726	3,564,111	121,778,294	27,918,894	149,697,188
1906.....	11,114,967	5,739,460	4,586,538	4,634,898	3,988,394	129,591,838	31,440,884	161,032,722
1907.....	11,482,845	6,026,977	4,250,618	4,551,881	3,000,201	128,798,895	30,143,474	158,942,369
1908.....	11,003,731	4,577,367	3,168,037	3,877,780	2,268,517	108,062,207	25,135,555	133,197,762
1909.....	10,322,324	6,251,625	4,466,708	5,291,963	2,694,821	135,271,772	31,049,441	166,321,213
1910.....	11,428,696	6,976,771	5,110,597	5,240,644	2,743,482	136,331,296	33,784,678	170,115,974
1911.....	11,454,616	6,017,801	5,660,172	5,356,184	2,847,971	127,717,621	34,518,560	162,236,181
1912.....	12,147,677	8,580,436	7,174,148	5,809,495	2,764,783	136,307,111	36,504,164	172,811,275
1913.....	14,872,103	7,733,306	8,620,216	6,109,180	3,018,316	143,296,757	37,992,375	181,289,132
1914.....	14,014,767	6,087,652	8,385,337	5,705,583	3,165,814	129,588,822	35,398,161	164,986,983
1915.....	11,259,349	4,796,062	7,800,938	5,186,055	3,716,944	125,794,844	37,325,388	163,120,232
1916.....	13,577,006	6,466,336	9,942,912	6,475,464	7,094,149	159,042,849	48,217,242	207,260,091
1917.....	17,307,211	6,173,550	13,255,433	6,821,221	8,588,879	191,860,846	56,162,522	248,023,368

[a] Enameled brick not separately classified prior to 1898.
[b] Stove lining, not separately classified prior to 1899, is included in fire brick in 1903; in miscellaneous in 1904.

The growth of the clay-working industries in the United States during the last 21 years is shown in this table. The total value of the products ranged from $62,359,991 in 1897, to $248,023,368 in 1917, an increase of $185,663,377, or 298 per cent. This value in 1917 was the greatest ever recorded; it was greater by $66,734,236, or 37 per cent, than that of 1913, the year of greatest value next to 1916 and the last year of normal conditions.

The maximum quantity of common brick was reached in 1906, and the maximum value in 1905. The number in 1917 was less than the maximum by 4,162,130,000 brick, or 42 per cent, and the value was less by $13,458,039, or 22 per cent. The average price per thousand ranged from $4.99 in 1897, to $8.17 in 1917. The price in 1917 was $1.49 higher than the previous maximum, and $3.18 higher than the minimum in the period covered by the table.

Vitrified brick or block reached its maximum quantity in 1909 and its maximum value in 1914. The output in 1917 was less than the maximum by 316,720,000 brick or block, or 31 per cent, and the value was less by $1,836,306, or 15 per cent. The average price per thousand in 1917 was the highest recorded; it was $1.67 higher than the previous highest price—in 1914, and $6.91 higher than the lowest price—in 1899.

Front or face brick reached maximum quantity and value in 1916, and, like common building brick, showed a considerable decrease in 1917 in both output and value. The output of front brick decreased 245,144,000 brick, or 24 per cent.

Fancy or ornamental brick, which has, on the whole, been declining in value in recent years, showed a considerable increase in value in 1917, but remained far below the maximum of the period covered by the table—it was $685,048 in 1897.

Enameled brick also showed a reversal of tendency and made a considerable increase in value over 1916.

Fire brick made the largest gain in value and reached its maximum in 1917; it has increased fourteenfold in the last 20 years.

Draintile was one of the five products to reach its maximum value in 1917, which was greater than the previous maximum in 1910 by $618,341, or 6 per cent. The value of draintile has increased fourfold in the last 20 years.

Sewer pipe reached its maximum value in 1917—which was greater by $2,435,108, or 16 per cent, than in 1913, the preceding year of greatest value. The value of sewer pipe has increased more than fourfold during the period covered by the table.

Architectural terra cotta reached its maximum value in 1912. In 1917 its value was less by $2,406,886, or 28 per cent, than the maximum.

Hollow building tile and fireproofing made a large gain and reached its maximum in 1917. It increased in value more than sevenfold in the period covered by the table.

Tile, not drain, reached its maximum value in 1917—approximately five times its value in 1897.

Brick and tile products ranged in value from $52,050,782 in 1897, to $191,860,846 in 1917, an increase of $139,810,064, or 269 per cent. Pottery also made wonderful strides; it ranged from $10,309,209 in 1897 to $56,162,522 in 1917, an increase of $45,853,313, or 445 per cent.

The following table shows the value of the clay products of the United States by varieties of ware. These classifications are not all exact, but they are as definite as it is possible to make them from the data at hand. For instance, under "fire brick" are included all material reported as such by the producers and all grades of fire brick, from those of the highest refractoriness to those which sell at a low price and can have but little value as refractory material. On the other hand, the item "cooking ware nonrefractory," possibly does not include all the ware used for that purpose. The table is interesting in that it shows in a general way and on broad lines the value of refractory and nonrefractory wares. The details of this table, where they differ from the tables showing the value of the brick and tile and pottery products, are derived from the miscellaneous columns of those tables. Only values are given, because for many products no data of quantity are available. In fact, for some wares, notably pottery, there is no satisfactory unit of quantity. Therefore increases shown during the last year or two owing to the increased cost of production do not necessarily represent proportionate increases in output. In fact, as shown by other tables in this report, the quantity of some wares decreased in greater proportion than the value on account of the higher prices received.

It is not possible to draw a hard and fast line between refractory and nonrefractory wares, but the classification is based on the generally accepted use of those terms. The rapid rise in the value of refractory wares, especially fire brick, glass-house refractories, and chemical pottery, may be ascribed to the war, as those materials are used, either directly or indirectly, in the manufacture of munitions or in the field and in the naval establishment. The most striking developments indicated in the nonrefractory wares are the great increase in the value of fireproofing, hollow building tile or block, and porcelain electrical supplies and the decrease in common building brick.

An inspection of this table shows that, compared with 1913, the latest year of normal conditions, the value of clay products decreased in 1914, owing to the unsettled conditons brought about by the war. Of this decrease, however, less than one-fourth was in the refractory wares. In 1915 the nonrefractories continued to decrease, not having yet recovered from the demoralization caused by the outbreak of the war, but the refractories, owing to large contracts placed by foreign powers in this country, made a considerable increase—more than 17 per cent. In 1916, when the United States was in a highly prosperous condition, having recovered from the first shock of the war, nearly all branches of the industries showed great progress, refractory wares increasing in value $15,127,107, or more than 68 per cent, and the nonrefractory wares increasing $29,012,752, or nearly 21 per cent. In 1917, with our own Nation at war and the maximum demand for munitions, refractory wares made an enormous increase, $28,541,262, or 77 per cent. The nonrefractory products during the same year increased in value only $12,222,015, or 7 per cent. To show further the increasing importance of the refractory products, it should be noted that the percentage of their value to the total value increased from 12.4 per cent in 1913 and 11.4 per cent in 1914, to 26.5 per cent in 1917.

Value of refractory and nonrefractory clay products of the United States, 1913–1917.

Class.	1913	1914	1915	1916	1917
Refractory:					
Fire brick, including refractory block or tile, boiler and locomotive tile and tank blocks, and similar refractory products	$16,811,316	$13,476,022	$15,800,062	$24,436,873	$42,501,669
Other fire brick, including some special shapes	134,635	115,144	121,747	311,052	473,713
Silica brick, including clay-bond and lime-bond brick	3,815,806	2,951,525	3,039,869	6,369,256	15,510,595
Stove lining	535,667	520,585	459,341	601,776	619,882
Zinc retorts	(a)	576,655	823,545	1,553,691	1,514,027
Glass melting pots and other glasshouse refractories. (Special effort to collect statistics of these products from the consumer manufacturing for his own use was not made prior to 1915.)	568,603	498,096	719,889	989,754	3,179,336
Gas retorts	65,846	41,372	23,835	35,821	(b)
Charcoal furnaces (portable)	37,217	36,243	32,865	27,280	40,568
Muffles, scorifiers, assay supplies, and crucibles. (Other crucibles are included with chemical porcelain and chemical stoneware)	63,869	67,367	98,105	364,563	178,941
Saggers. (Prior to 1917 statistics for saggers were not collected from the sagger consumer manufacturing for his own use)	(b)	(b)	(b)	34,476	122,000
Chemical porcelain and chemical stoneware	c 224,894	c 246,918	c 620,401	1,054,061	1,099,432
Mantle, rings, and special ware for gas lighting and heating, including magnesia ware and refractory porcelain for electric ranges and heaters	(b)	(b)	172,261	220,849	247,997
Potters' supplies. (Pins, stilts, and spurs)	125,987	130,740	126,780	188,643	224,343
Undistributed	148,116	132,031	22,288	....	16,854
	22,531,956	18,792,698	22,060,988	37,188,095	65,729,357
Nonrefractory:					
Common brick	50,134,757	43,769,524	42,145,292	49,357,411	47,936,344
Vitrified brick or block	12,138,221	12,500,866	12,230,899	12,236,890	10,664,560
Front brick	9,614,138	9,289,623	9,535,536	11,464,614	10,391,368
Fancy or ornamental brick	109,703	124,459	109,425	109,072	192,072
Enameled brick	1,225,708	1,075,026	835,808	827,443	889,899
Drain tile	8,558,320	8,522,039	8,879,264	10,083,647	11,008,163
Sewer pipe	14,872,103	14,014,767	11,259,349	13,577,006	17,307,211
Architectural terra cotta	7,733,306	6,087,652	4,796,062	6,466,336	6,173,550
Fireproofing and hollow building tile or block	8,620,216	8,385,337	7,800,938	9,942,912	13,255,433
Silo tile or block	138,263	(d)	(d)	(d)	(d)
Conduits	(e)	(e)	(e)	(e)	1,227,668
Roofing tile	1,130,286	1,043,020	891,150	914,240	871,872
Floor tile	2,483,082	881,362	912,180	1,438,231	1,325,516
Ceramic mosiac tile	(f)	1,520,739	1,185,787	1,308,861	1,481,505
Faience tile	731,820	675,615	635,073	814,077	1,007,005
Wall tile	1,763,992	1,584,847	1,561,865	2,000,055	2,135,323
Zinc condensers	(g)	176,591	260,436	512,453	496,691
Red earthenware	1,000,529	1,059,904	1,072,061	1,156,351	1,065,185
Stoneware and yellow and Rockingham ware	3,683,567	3,349,301	3,575,603	3,696,288	3,865,825
White ware, including C. C. ware, white granite, semiporcelain ware, and semivitreous porcelain ware	15,066,811	14,968,079	15,324,242	18,191,390	20,920,469
China, bone china, delft and belleek ware	2,424,060	2,384,686	2,330,156	3,478,372	4,805,906
Sanitary ware	8,214,838	7,874,269	7,993,216	11,111,417	12,636,217
Porcelain electrical supplies	5,737,741	4,130,270	4,671,202	7,034,420	9,431,586
Turpentine cups	(h)	(h)	(h)	284,218	(e)
Art pottery	400,244	374,113	446,457	619,558	870,229
Tobacco pipes	62,490	30,247	35,248	44,921	72,827

a Reported by one producer only for 1913, and included with "Undistributed" refractory products. Statistics for zinc retorts were not collected prior to 1914.
b Reported by less than 3 producers. Included in "Undistributed refractory products."
c Chemical porcelain and chemical stoneware not separately collected prior to 1916, were probably partly reported under stoneware and yellow and Rockingham ware in 1913, 1914, and 1915.
d All silo tile and block was reported under fireproofing in 1914, 1915, 1916, and 1917.
e Included in "Miscellaneous."
f Not separately classified in 1913.
g Reported by one producer only for 1913 and included under "Miscellaneous." Statistics for zinc condensers were not collected prior to 1914.
h Reported by less than 3 producers. Included in "Miscellaneous."

Value of refractory and nonrefractory clay products of the United States, 1913–1917—Cont.

Class.	1913	1914	1915	1916	1917
Nonrefractory—Continued.					
Hardware supplies and trimmings and door knobs	$86,064	$69,959	$59,297	$78,168	$43,275
Toy marbles	57,000	66,325	63,948	75,304	77,243
Cooking ware, including porcelain cooking utensils (other cooking ware probably is included under stoneware)	(a)	(a)	376,532	478,805	316,991
Miscellaneous. (Mostly nonrefractory)[b]	2,769,917	2,235,665	2,072,218	2,769,536	1,804,078
	158,757,176	146,194,285	141,059,244	170,071,996	182,294,011
Grand total	181,289,132	164,986,983	163,120,232	207,260,091	248,023,368

a Reported by less than 3 producers. Included in "Miscellaneous."

b Including adobes, aquarium ornaments, arch brick for foundations, bitumenized block, burnt-clay ballast, chemical brick pipes, rings, and tiling for acid towers, chimney pots, pipes, crocks, tops, and thimbles, chuck (broken ware), clay pigeons, crushed tile for roofing, porcelain filter tubes, water filters and filter stones, flue lining, garden pottery, gas logs, grave and lot markers, interlocking sewer blocks, jardinieres, Holland splits, lead corroding pots, lidded pipe, porcelain interiors for refrigerators, porcelain shuttle eyes and thread guides, radial chimney brick and block, radial sewer brick, ruffled brick, rustic stumps, segment block, sewer brick and block, souvenirs, stone sewer trap covers, sun dials, tunnel brick umbrella stands, and wall and chimney coping.

BRICK AND TILE.

PRODUCTION.

PRODUCTION BY STATES.

The following tables show the output and value of the building brick and other structural products of clay, and of the fire brick, paving brick, and other clay products used in engineering work, the rank of the State in these products, and the percentage of the total value of each State in 1916 and 1917:

Brick and tile products in the United States in 1916.

Rank.	State.	Common brick.			Vitrified brick or block.		
		Quantity (thousands).	Value.	Average price per thousand.	Quantity (thousands).	Value.	Average price per thousand.
25	Alabama	85,655	$497,446	$5.81	(a)	(a)	$12.38
45	Arizona	11,039	93,649	8.48			
33	Arkansas	65,419	418,034	6.39			
9	California	168,826	1,107,940	6.56	6,240	$126,168	20.22
17	Colorado	50,281	340,846	6.78	1,869	21,653	11.59
18	Connecticut and Rhode Island	184,098	1,640,349	8.91	(a)	(a)	18.53
42	Delaware	20,321	177,588	8.74			
43	District of Columbia	12,900	86,260	6.69			
40	Florida	31,029	188,357	6.07			
14	Georgia	208,781	1,050,473	5.03	15,652	173,505	11.09
41	Idaho and Nevada	19,725	168,076	8.52			
3	Illinois	1,182,473	6,738,152	5.70	175,989	2,465,179	14.01
6	Indiana	166,954	963,932	5.77	55,490	758,943	13.68
8	Iowa	132,676	947,247	7.14	24,265	393,038	16.20
12	Kansas	114,880	596,271	5.19	48,704	628,638	12.91
10	Kentucky	70,610	464,775	6.58	(a)	(a)	11.70
36	Louisiana	59,695	333,573	5.59			
32	Maine	35,431	289,171	8.16	(a)	(a)	25.34
23	Maryland	119,650	871,866	7.29	(a)	(a)	14.55
21	Massachusetts	140,420	1,207,777	8.60			
13	Michigan	279,175	1,856,587	6.65	5,539	80,915	14.61
15	Minnesota	118,090	772,696	6.54	(a)	(a)	8.87
34	Mississippi	70,123	453,185	6.46			
7	Missouri	126,658	896,201	7.08	(a)	(a)	13.83
30	Montana	44,498	481,546	10.82	(a)	(a)	24.03
27	Nebraska	102,729	699,837	6.81	(a)	(a)	12.68
35	New Hampshire	51,852	473,434	9.13			
4	New Jersey	328,419	2,366,614	7.21			
39	New Mexico	12,375	96,612	7.81	(a)	(a)	12.00
5	New York	977,085	6,433,266	6.58	18,788	248,932	13.25
24	North Carolina	193,264	1,234,926	6.39			
38	North Dakota	19,155	174,289	9.10			
2	Ohio	437,334	3,082,099	7.05	295,048	3,522,695	11.94
26	Oklahoma	106,378	594,082	5.58	(a)	(a)	11.32
37	Oregon	15,792	128,289	8.12	(a)	(a)	9.04
1	Pennsylvania	688,096	5,200,910	7.56	118,664	1,495,645	12.60
48	Porto Rico	616	5,612	9.11			
31	South Carolina	100,349	589,016	5.87			
44	South Dakota	10,701	103,474	9.67			
19	Tennessee	161,761	1,004,234	6.21	(a)	(a)	15.23
11	Texas	203,013	1,224,919	6.03	(a)	(a)	11.82
29	Utah	40,269	324,966	8.07	(a)	(a)	16.62
46	Vermont	9,651	64,779	6.71			
20	Virginia	204,808	1,397,436	6.82			
22	Washington	45,163	309,130	6.84	20,218	322,182	15.94
16	West Virginia	59,993	420,955	7.02	46,416	579,679	12.49
28	Wisconsin	98,060	699,819	7.14			
47	Wyoming	7,932	86,716	10.93			
	Undistributed [b]				108,671	1,419,718	
		7,394,202	49,357,411	6.68	[c] 941,553	[c] 12,236,890	13.00
	Percentage of brick and tile products		31.03			7.69	
	Percentage of total clay products		23.82			5.90	

[a] Included in "Undistributed."

[b] Includes all products made by less than 3 producers in 1 State.

[c] In the total quantity and total value of vitrified brick are included, respectively, 760,672,000 vitrified brick or block sold for paving, valued at $10,614,797, and 180,881,000 vitrified brick or block sold for other uses, valued at $1,622,093.

Brick and tile products in the United States in 1916—Continued.

Rank.	State.	Front brick. Quantity (thousands).	Front brick. Value.	Front brick. Average price per thousand.	Fancy or ornamental brick (value).	Draintile (value).	Sewer pipe (value).	Architectural terra cotta (value).	Fireproofing (value).
25	Alabama	6,968	$77,470	$11.12	...	(a)	(a)	...	$80,523
45	Arizona	(a)	(a)	25.00	...	...	...	...	...
33	Arkansas	1,880	24,980	13.29	...	(a)	...	...	...
9	California	9,035	208,255	23.05	...	$44,292	$772,295	$341,671	165,098
17	Colorado	16,314	195,976	12.01	(a)	70,015	(a)	(a)	33,840
18	Connecticut and Rhode Island	(a)	(a)	16.03	(a)	...	...	...	(a)
42	Delaware	...	...	...	...	(a)	...	...	...
43	District of Columbia	...	...	...	...	(a)	(a)	...	(a)
40	Florida	...	...	...	...	(a)	...	...	(a)
14	Georgia	10,670	105,130	9.85	...	7,758	691,628	(a)	44,350
41	Idaho and Nevada	(a)	(a)	14.78	...	...	...	...	(a)
3	Illinois	74,652	810,440	10.86	(a)	1,200,465	768,410	1,980,781	769,929
6	Indiana	116,860	1,192,076	10.20	...	1,452,719	666,792	(a)	799,260
8	Iowa	22,112	283,559	12.82	...	3,996,163	491,428	...	1,141,291
12	Kansas	40,433	380,332	9.41	(a)	84,224	(a)	(a)	183,109
10	Kentucky	2,181	22,342	10.24	...	70,661	(a)	...	57,753
36	Louisiana	(a)	(a)	10.90	...	(a)	...	...	(a)
32	Maine	(a)	(a)	9.50	...	(a)	(a)	...	...
23	Maryland	(a)	(a)	16.08	(a)	2,040	...	(a)	42,629
21	Massachusetts	(a)	(a)	24.00	...	...	...	...	(a)
13	Michigan	...	...	...	(a)	548,795	(a)	...	2,492
15	Minnesota	19,014	243,246	12.79	...	422,809	(a)	...	153,486
34	Mississippi	1,090	13,702	12.57	...	38,771	...	...	...
7	Missouri	37,325	481,406	12.90	(a)	197,150	1,308,977	(a)	153,596
30	Montana	3,700	60,261	16.29	...	...	(a)	...	28,439
27	Nebraska	4,655	78,390	16.84	...	16,172	...	...	124,411
35	New Hampshire	...	...	...	...	...	...	...	...
4	New Jersey	23,174	462,490	19.96	(a)	30,542	(a)	1,818,052	1,830,949
39	New Mexico	7,642	98,267	12.86	(a)	(a)	...	...	(a)
5	New York	5,857	64,004	10.93	...	63,756	(a)	714,041	174,786
24	North Carolina	(a)	(a)	10.28	...	18,000	(a)	...	(a)
38	North Dakota	(a)	(a)	16.08	(a)	...	...	...	(a)
2	Ohio	209,584	2,161,719	10.31	$19,049	1,470,054	5,132,810	...	2,816,535
26	Oklahoma	4,397	40,881	9.30	...	...	...	...	...
37	Oregon	3,446	57,826	16.78	...	53,041	(a)	...	50,741
1	Pennsylvania	277,612	3,076,024	11.08	18,562	13,002	1,207,016	473,634	664,293
48	Porto Rico	...	...	...	...	...	...	...	...
31	South Carolina	(a)	(a)	14.31	...	(a)	...	...	...
44	South Dakota	(a)	(a)	15.00	...	...	...	...	...
19	Tennessee	6,716	87,253	12.99	13,884	45,162	(a)	...	16,424
11	Texas	28,481	358,355	12.58	...	13,024	(a)	...	253,529
29	Utah	13,883	170,003	12.25	...	(a)	(a)	...	77,512
46	Vermont	...	...	...	...	...	...	...	...
20	Virginia	18,441	232,135	12.59	(a)	7,125	(a)	...	...
22	Washington	4,425	70,509	15.93	(a)	37,138	347,388	275,693	125,033
16	West Virginia	4,194	44,397	10.59	...	7,285	...	...	(a)
28	Wisconsin	12,482	133,445	10.69	...	69,404	...	...	(a)
47	Wyoming	(a)	(a)	14.88	...	...	...	...	...
	Undistributed [b]	15,539	229,741	...	57,577	104,080	2,187,262	862,464	152,904
		1,002,762	11,464,614	11.43	[c]936,515	10,083,647	13,577,006	6,466,336	9,942,902
	Percentage of brick and tile products	...	7.21	...	.59	6.34	8.54	4.07	6.25
	Percentage of total clay products	...	5.53	...	.45	4.87	6.55	3.12	4.80

[a] Included in "Undistributed."
[b] Includes all products made by less than 3 producers in 1 State.
[c] Includes enameled brick valued at $827,443, made in California, Colorado, Illinois, Maryland, Missouri, New Jersey, and Utah.

Brick and tile products in the United States in 1916—Continued.

Rank.	State.	Tile, not drain (value).	Stove lining (value).	Fire brick. Quantity (thousands).	Fire brick. Value.	Fire brick. Average price per thousand.	Miscellaneous [a] (value).	Total value.	Percentage of total value.
25	Alabama	......	(b)	13,379	$278,749	$20.83	$803	$1,497,496	0.94
45	Arizona	......	......	......	......	......	......	106,149	.07
33	Arkansas	......	......	1,435	19,281	13.44	58,356	521,569	.33
9	California	$197,779	(b)	20,327	508,900	25.04	103,887	3,645,629	2.29
17	Colorado	16,735	......	18,602	412,511	22.18	227,145	1,818,470	1.14
18	Connecticut and Rhode Island	(b)	(b)	(b)	(b)	27.00	......	1,762,653	1.11
42	Delaware	......	......	......	......	......	......	187,388	.12
43	District of Columbia	......	......	......	......	......	4,268	129,394	.08
40	Florida	......	......	......	......	......	......	226,362	.14
14	Georgia	......	$14,833	(b)	(b)	14.65	12,909	2,348,781	1.48
41	Idaho and Nevada	......	......	(b)	(b)	22.16	......	212,451	.13
3	Illinois	(b)	(b)	26,880	523,442	10.47	451,150	16,507,845	10.38
6	Indiana	680,820	......	9,350	153,572	16.42	611,200	8,032,960	5.05
8	Iowa	(b)	......	......	......	......	69,052	7,379,289	4.64
12	Kansas	(b)	(b)	(b)	(b)	35.00	563,789	2,747,803	1.73
10	Kentucky	295,815	......	114,945	2,323,606	20.21	15,315	3,438,146	2.16
36	Louisiana	......	......	......	......	......	13,350	360,855	.23
32	Maine	......	......	(b)	(b)	39.13	......	546,725	.34
23	Maryland	......	22,158	17,724	412,832	23.29	8,750	1,548,295	.97
21	Massachusetts	158,387	180,482	2,014	80,168	39.81	450	1,661,737	1.04
13	Michigan	(b)	......	......	......	......	77,620	2,705,054	1.70
15	Minnesota	......	......	(b)	(b)	45.00	97,901	2,064,362	1.30
34	Mississippi	......	......	(b)	(b)	20.00	2,940	508,698	.32
7	Missouri	(b)	(b)	126,257	3,006,841	23.82	349,522	7,634,559	4.80
30	Montana	......	......	866	36,768	42.46	21,121	717,551	.45
27	Nebraska	......	......	......	......	......	19,200	943,553	.59
35	New Hampshire	......	......	......	......	......	......	473,434	.30
4	New Jersey	1,298,392	(b)	37,891	1,162,794	30.69	335,253	9,749,524	6.13
39	New Mexico	......	......	3,115	42,452	13.63	......	257,561	.16
5	New York	86,112	80,605	9,955	417,805	41.97	75,533	8,410,340	5.29
24	North Carolina	......	......	......	......	......	(b)	1,541,576	.97
38	North Dakota	......	......	(b)	(b)	26.69	......	264,457	.17
2	Ohio	2,615,854	(b)	185,557	3,337,470	17.99	1,106,928	25,506,344	16.04
26	Oklahoma	......	......	(b)	(b)	93.36	593,589	1,410,657	.89
37	Oregon	......	......	(b)	(b)	27.74	39	299,993	.19
1	Pennsylvania	506,805	108,344	515,530	11,009,646	21.36	1,665,974	29,630,563	18.63
48	Porto Rico	......	......	......	......	......	......	5,612	......
31	South Carolina	......	......	......	......	......	......	598,431	.38
44	South Dakota	......	......	......	......	......	......	115,474	.07
19	Tennessee	(b)	......	(b)	(b)	14.00	(b)	1,679,319	1.06
11	Texas	......	(b)	3,371	53,135	15.76	227,700	2,749,780	1.73
29	Utah	......	......	(b)	(b)	32.22	6,864	885,357	.56
46	Vermont	......	(b)	......	......	......	......	94,779	.06
20	Virginia	......	......	(b)	(b)	16.83	......	1,676,723	1.05
22	Washington	......	(b)	4,009	94,992	23.69	5,357	1,589,574	1.00
16	West Virginia	239,601	......	18,266	209,625	11.48	308,401	1,853,468	1.16
28	Wisconsin	......	(b)	......	......	......	112	905,910	.57
47	Wyoming	......	......	......	......	......	......	90,199	.06
	Undistributed [c]	379,164	195,354	14,777	352,284	......	59,671	(d)	......
		[e]6,475,464	601,776	[f]1,376,923	[f]30,806,129	22.37	7,094,149	159,042,849	100.00
	Percentage of brick and tile products	4.07	.38	......	19.37	......	4.46	100.00	......
	Percentage of total clay products	3.13	.29	......	14.86	......	3.42	76.74	......

[a] Including adobes, assay supplies, bituminized blocks, burnt-clay ballast, charcoal furnaces, chemical brick and tile, chimney crocks, pipe and tops, clay pigeons, condensers, conduits, crucibles, floral terra cotta, flue lining, flux bricks, gas logs, glasshouse pots and glasshouse supplies, grave and lot markers, ironing furnaces, muffles, radial brick and block, retorts, scorifiers, segment blocks, sewer blocks, and wall coping.

[b] Included in "Undistributed."

[c] Includes all products made by less than 3 producers in 1 State.

[d] The total of "Undistributed" is distributed among the States to which it belongs, in order that they may be fully represented in the totals.

[e] Including the following values: Roofing tile, $914,240; floor tile, $1,438,231; ceramic mosaic tile, $1,308,861; faience tile, $814,077; wall tile, $2,000,055.

[f] In the total quantity and total value of fire brick are included, respectively, 232,673,000 silica brick, valued at $6,369,256, of which 166,291,000 brick, valued at $4,190,708, were produced by Pennsylvania, and the remainder, 66,382,000 brick, valued at $2,178,548, by Alabama, Colorado, Illinois, Indiana, Missouri, Montana, New Jersey, Ohio, Utah, and Virginia.

Brick and tile products in the United States in 1917.

Rank.	State.	Common brick.			Vitrified brick or block.		
		Quantity (thousands).	Value.	Average price per thousand.	Quantity (thousands).	Value.	Average price per thousand.
19	Alabama	81,574	$557,920	$6.84	21,319	$316,914	$14.87
44	Arizona	12,964	121,974	9.41			
30	Arkansas	68,711	484,273	7.05			
10	California	169,045	1,207,765	7.14	5,839	101,909	17.45
14	Colorado	50,239	389,394	7.75	1,311	16,506	12.59
22	Connecticut and Rhode Island	142,106	1,458,386	10.26	(a)	(a)	19.06
42	Delaware	14,597	194,276	13.31			
43	District of Columbia	(a)	(a)	8.30			
40	Florida	28,457	216,989	7.63			
15	Georgia	179,598	1,200,790	6.69	(a)	(a)	12.57
41	Idaho and Nevada	15,611	151,694	9.72			
3	Illinois	738,963	5,138,822	6.95	171,067	2,530,046	14.79
6	Indiana	106,855	821,617	7.69	48,330	776,218	16.06
7	Iowa	119,984	1,045,790	8.72	5,927	83,310	14.06
13	Kansas	103,232	698,452	6.77	42,774	597,241	13.96
9	Kentucky	63,410	492,098	7.76	(a)	(b)	14.43
35	Louisiana	60,970	390,718	6.41			
34	Maine	25,457	235,530	9.25	(a)	(a)	43.00
18	Maryland	93,237	856,412	9.19	(a)	(a)	21.37
21	Massachusetts	98,644	1,031,427	10.46			
12	Michigan	236,612	1,882,042	7.95	(a)	(a)	17.76
17	Minnesota	86,606	656,247	7.58	(a)	(a)	14.00
33	Mississippi	67,936	493,022	7.26			
4	Missouri	116,887	951,324	8.14	32,770	493,114	15.05
31	Montana	35,644	397,675	11.16	(a)	(a)	24.00
27	Nebraska	98,731	822,932	8.34	(a)	(a)	26.31
36	New Hampshire	34,558	411,876	11.92			
5	New Jersey	205,794	1,843,246	8.96			
39	New Mexico	11,918	110,400	9.26	(a)	(a)	14.00
8	New York	656,508	5,068,028	7.72	16,451	293,831	17.86
23	North Carolina	172,842	1,346,211	7.79			
38	North Dakota	12,640	115,633	9.15			
2	Ohio	408,203	3,895,164	9.54	186,364	2,757,766	14.80
20	Oklahoma	121,803	800,234	6.57	13,834	189,584	13.70
37	Oregon	12,549	108,914	8.68			
1	Pennsylvania	586,632	5,704,680	9.72	75,995	1,202,216	15.82
48	Porto Rico	390	3,374	8.65			
32	South Carolina	77,115	557,500	7.23			
47	South Dakota	3,999	42,442	10.61			
25	Tennessee	120,845	907,876	7.51	(a)	(a)	15.52
11	Texas	202,285	1,444,026	7.14	(a)	(a)	12.33
29	Utah	38,923	360,114	9.25	(a)	(a)	21.27
46	Vermont	5,499	53,344	9.70			
24	Virginia	155,383	1,306,524	8.41			
26	Washington	43,487	367,906	8.46	(a)	(a)	20.40
16	West Virginia	61,519	582,185	9.46	33,044	474,772	14.37
28	Wisconsin	95,787	817,110	8.53			
45	Wyoming	9,461	103,140	10.90			
	Undistributed[b]	10,699	88,848		51,909	831,133	16.01
		5,864,909	47,936,344	8.17	[c] 706,934	[c] 10,664,560	15.09
	Percentage of brick and tile products		24.98			5.56	
	Percentage of total clay products		19.32			4.30	

[a] Included in "Undistributed."
[b] Includes all products made by less than 3 producers in 1 State.
[c] In the total quantity and total value of vitrified brick are included, respectively, 562,234,000 vitrified brick or block sold for paving, valued at $9,076,655, and 144,700,000 vitrified brick or block sold for other purposes, valued at $1,587,905.

Brick and tile products in the United States in 1917—Continued.

Rank.	State.	Front brick.			Fancy or ornamental brick.	Draintile.	Sewer pipe.	Architectural terra cotta.
		Quantity (thousands).	Value.	Average price per thousand.	Value.	Value.	Value.	Value.
19	Alabama	(a)	(a)	$12.17	....	$17,261	(a)	....
44	Arizona	(a)	(a)	25.00	....	....	....	....
30	Arkansas	4,610	$56,409	12.24	....	(a)	....	....
10	California	8,933	197,773	22.14	(a)	60,337	$794,617	$537,972
14	Colorado	13,330	174,631	13.10	(a)	105,926	(a)	(a)
22	Connecticut and Rhode Island	(a)	(a)	19.20	(a)	....	....	....
42	Delaware	(a)	(a)	25.00	....	(a)	....	....
43	District of Columbia	....	....	....	....	(a)	(a)	....
40	Florida	....	....	....	....	(a)	....	....
15	Georgia	8,325	112,734	13.54	....	7,152	674,188	(a)
41	Idaho and Nevada	(a)	(a)	20.17	....	....	....	....
3	Illinois	63,074	785,056	12.45	(a)	1,314,006	997,419	2,060,954
6	Indiana	74,279	880,219	11.85	....	1,564,542	766,665	(a)
7	Iowa	18,425	282,840	15.35	(a)	4,004,989	455,561	....
13	Kansas	37,579	388,355	10.33	(a)	76,222	(a)	(a)
9	Kentucky	1,844	21,844	11.85	....	74,501	(a)	....
35	Louisiana	(a)	(a)	10.38	....	....	....	....
34	Maine	....	....	....	....	....	(a)	....
18	Maryland	(a)	(a)	15.18	....	1,495	....	(a)
21	Massachusetts	(a)	(a)	11.26	....	....	....	....
12	Michigan	(a)	(a)	18.00	....	734,042	(a)	....
17	Minnesota	13,600	194,800	14.32	....	579,461	(a)	....
33	Mississippi	(a)	(a)	13.70	....	34,843	....	....
4	Missouri	36,739	484,524	13.19	(a)	211,845	1,620,569	(a)
31	Montana	3,428	69,464	20.26	....	(a)	....	....
27	Nebraska	2,179	48,010	22.03	....	(a)	....	....
36	New Hampshire	....	....	....	....	....	....	....
5	New Jersey	20,505	358,280	17.47	(a)	31,300	(a)	1,322,202
39	New Mexico	(a)	(a)	16.34	....	(a)	....	....
8	New York	3,675	50,938	13.86	(a)	94,831	(a)	813,112
23	North Carolina	(a)	(a)	10.98	....	(a)	(a)	....
38	North Dakota	(a)	(a)	20.10	(a)	....	....	....
2	Ohio	130,476	1,742,680	13.36	$12,964	1,696,763	6,897,255	....
20	Oklahoma	5,788	65,819	11.37	....	....	....	....
37	Oregon	2,610	53,045	20.32	(a)	79,718	6,939	....
1	Pennsylvania	199,357	2,745,031	13.77	28,979	12,595	1,970,996	373,671
48	Porto Rico	....	....	....	....	....	....	....
32	South Carolina	(a)	(a)	15.57	....	(a)	....	....
47	South Dakota	(a)	(a)	19.71	....	....	....	....
25	Tennessee	8,892	128,709	14.47	(a)	88,571	(a)	....
11	Texas	24,428	398,433	16.31	....	7,719	(a)	....
29	Utah	9,570	147,881	15.45	....	35,041	(a)	(a)
46	Vermont	....	....	....	....	....	....	....
24	Virginia	15,809	226,890	14.35	(a)	10,440	(a)	....
26	Washington	3,565	60,404	16.94	....	30,755	340,621	190,468
16	West Virginia	3,524	45,325	12.86	....	5,708	(a)	....
28	Wisconsin	12,643	187,371	14.82	....	102,047	....	....
45	Wyoming	(a)	(a)	17.93	(a)	(a)	....	....
	Undistributed [b]	30,431	483,903	....	150,129	26,053	2,782,381	875,171
		757,618	10,391,368	13.72	[c]1,081,971	11,008,163	17,307,211	6,173,550
	Percentage of brick and tile products	....	5.42	....	0.56	5.74	9.02	3.22
	Percentage of total clay products	....	4.19	....	.43	4.44	6.98	2.49

[a] Included in "Undistributed."
[b] Includes all products made by less than 3 producers in 1 State.
[c] Includes enameled brick valued at $889,899 madei n California, Colorado, Illinois, Maryland, Missouri, New Jersey, Tennessee, and Utah.

Brick and tile products in the United States in 1917—Continued.

Rank.	State.	Hollow building tile and fireproofing.			Tile, not drain.	Stove lining.
		Quantity (short tons).	Value.	Average price per ton.	Value.	Value.
19	Alabama	21,148	$106,700	$5.05		(a)
44	Arizona	(a)	(a)	4.00		
30	Arkansas					
10	California	39,701	258,917	6.52	$273,420	(a)
14	Colorado	9,658	68,971	7.14	(a)	
	Connecticut and Rhode Island					(a)
42	Delaware					
43	District of Columbia	(a)	(a)	7.30		
40	Florida	(a)	(a)	12.90		
15	Georgia	(a)	(a)	5.88		
41	Idaho and Nevada	(a)	(a)	6.15		
3	Illinois	238,326	1,136,975	4.77	(a)	(a)
6	Indiana	185,719	992,132	5.34	(a)	
7	Iowa	261,488	1,542,884	5.90	(a)	(a)
13	Kansas	58,426	275,215	4.71	(a)	
9	Kentucky	10,415	49,402	4.74	343,769	
35	Louisiana	(a)	(a)	2.65		
34	Maine					
18	Maryland	(a)	(a)	5.82		(a)
21	Massachusetts	(a)	(a)	8.05	184,578	$213,322
12	Michigan	971	4,621	4.76	(a)	
17	Minnesota	45,914	233,851	5.09		(a)
33	Mississippi					
4	Missouri	41,856	294,041	7.03	(a)	(a)
31	Montana	6,985	58,477	8.37		
27	Nebraska	44,981	264,241	5.87		
36	New Hampshire					
5	New Jersey	302,648	2,167,296	7.16	1,301,960	(a)
39	New Mexico	(a)	(a)	5.33		
8	New York	24,184	140,464	5.81	72,117	108,793
23	North Carolina	(a)	(a)	6.67		(a)
38	North Dakota	8,726	49,936	5.72		
2	Ohio	908,624	3,529,003	3.88	2,642,638	60,251
20	Oklahoma	(a)	(a)	3.71		
37	Oregon	16,490	81,680	4.95		
1	Pennsylvania	189,015	903,787	4.78	495,838	112,519
48	Porto Rico					
32	South Carolina	(a)	(a)	5.15		
47	South Dakota					
25	Tennessee	2,973	18,821	6.33	(a)	
11	Texas	66,018	412,055	6.24		
29	Utah	8,408	64,159	7.63		(a)
46	Vermont					(a)
24	Virginia					
26	Washington	27,352	183,812	6.72		(a)
16	West Virginia	12,620	64,476	5.11	295,116	
28	Wisconsin	(a)	(a)	3.84		
45	Wyoming					
	Undistributed [b]	57,382	353,517		1,211,785	124,997
		2,590,028	13,255,433	5.12	[c] 6,821,221	619,882
	Percentage of brick and tile products		6.91		3.55	0.32
	Percentage of total clay products		5.34		2.75	.27

[a] Included in "Undistributed."
[b] Includes all products made by less than 3 producers in 1 State.
[c] Including the following values: Roofing tile, $871,872; floor tile, $1,325,516; ceramic mosaic tile, $1,481,505; faience tile, $1,007,005; wall tile, $2,135,323.

Brick and tile products in the United States in 1917—Continued.

Rank.	State.	Fire brick. Quantity (thousands).	Fire brick. Value.	Fire brick. Average price per thousand.	Miscellaneous.[a] Value.	Total value.	Percentage of total value.
19	Alabama	17,815	$502,936	$28.23	$10,440	$2,087,785	1.09
44	Arizona					135,474	.07
30	Arkansas	(b)	(b)	27.91	83,679	672,766	.35
10	California	22,537	626,102	27.78	62,762	4,215,456	2.20
14	Colorado	24,636	623,593	25.32	253,307	2,421,174	1.26
22	Connecticut and Rhode Island	(b)	(b)	77.03		1,705,013	.89
42	Delaware					197,310	.10
43	District of Columbia				4,250	154,242	.08
40	Florida					224,606	.12
15	Georgia	7,132	129,514	18.16	8,590	2,414,368	1.26
41	Idaho and Nevada	(b)	(b)	23.11		198,606	.10
3	Illinois	30,956	936,260	30.24	546,374	17,994,158	9.38
6	Indiana	18,749	378,317	20.18	776,678	9,108,973	4.75
7	Iowa	190	4,000	21.05	68,145	7,535,313	3.93
13	Kansas	(b)	(b)	25.71	272,917	2,695,722	1.41
9	Kentucky	115,226	3,659,437	31.76	4,300	4,886,486	2.55
35	Louisiana	(b)	(b)	46.00	25,000	440,053	.23
34	Maine	(b)	(b)	57.25	19,213	531,870	.28
18	Maryland	19,816	908,348	45.84	15,000	2,135,184	1.11
21	Massachusetts	2,165	97,207	44.90	509	1,720,988	.90
12	Michigan				79,996	2,846,264	1.48
17	Minnesota	(b)	(b)	41.82	66,923	2,197,664	1.15
33	Mississippi				2,500	535,584	.28
4	Missouri	147,874	4,977,590	33.66	433,863	10,328,374	5.38
31	Montana	1,263	51,370	40.67		663,315	.35
27	Nebraska				14,311	1,160,508	.60
36	New Hampshire					411,876	.21
5	New Jersey	42,065	2,290,899	54.46	344,846	9,993,389	5.21
39	New Mexico	1,160	29,587	25.51	4,708	257,875	.13
8	New York	8,924	584,536	65.50	66,195	7,351,582	3.83
23	North Carolina	(b)	(b)	20,00	12,000	1,654,832	.86
38	North Dakota	(b)	(b)	26.01		294,016	.15
2	Ohio	221,918	5,716,839	25.76	1,652,014	31,113,010	16.22
20	Oklahoma	(b)	(b)	45.33	795,883	1,857,546	.97
37	Oregon	(b)	(b)	28.57		331,546	.17
1	Pennsylvania	553,420	19,382,304	35.02	2,615,545	45,967,706	23.96
48	Porto Rico					3,374	
32	South Carolina	(b)	(b)	19,00		654,613	.34
47	South Dakota					47,213	.02
25	Tennessee	2,154	47,455	22.03	(b)	1,569,146	.82
11	Texas	12,681	264,825	20.88	31,106	3,358,913	1.75
29	Utah	(b)	(b)	30.28	200	945,530	.49
46	Vermont					98,344	.05
24	Virginia	(b)	(b)	38.32		1,625,912	.85
26	Washington	5,146	143,696	27.92	11,858	1,532,043	.80
16	West Virginia	36,505	624,278	17.10	271,363	2,364,165	1.23
28	Wisconsin				1,873	1,114,121	.58
45	Wyoming					106,838	.06
	Undistributed[c]	11,954	522,576		32,540	(d)	
		[e]1,631,316	[e]58,012,264	35.56	8,588,879	191,860,846	100.00
	Percentage of brick and tile products		30.24		4.48	100.00	
	Percentage of total clay products		23.39		3.46	77.36	

[a] Including adobes, assay supplies, bituminized blocks, burnt-clay ballast, charcoal furnaces, chemical brick and tile, chimney pipe, blocks, and tile, clay pigeons, condensers, conduits, flue crocks, flue lining, flux blocks, gas logs, gas and zinc retorts, glasshouse pots and glasshouse supplies, grave and lot markers, muffles, radial brick and block, scorifiers, segment blocks, sewer blocks, and wall coping.
[b] Included in "Undistributed."
[c] Includes all products made by less than 3 producers in 1 State.
[d] The total of "Undistributed" is distributed among the States to which it belongs, in order that they may be fully represented in the totals.
[e] In the total quantity and total value of fire brick are included, respectively, 327,030,000 silica brick valued at $15,510,595, of which 223,043,000 brick, valued at $10,419,545, were produced by Pennsylvania, and the remainder, 103,987,000 brick, valued at $5,091,050, by Alabama, Cailfornia, Colorado, Illinois, Indiana, and Kentucky, Missouri, Montana, Ohio, and Utah.

Brick and tile products, as classified in this report, were reported from every State, the District of Columbia, and Porto Rico. Three States, California, Illinois, and Missouri, reported every variety of wares classified as brick and tile and two, Colorado and Pennsylvania, reported all but one.

The increase in the value of brick and tile in 1917 compared with 1916 was $32,817,997, or 20.6 per cent. Pennsylvania was the leading State in 1917, Ohio second, and Illinois third. There was an increase of $16,337,143, or 55 per cent, in the value of Pennsylvania's brick and tile products in 1917; of $5,606,666, or 22 per cent, in those of Ohio; and of $1,486,313, or 9 per cent, in those of Illinois. Missouri was fourth, rising from seventh in 1916, with an increase of $2,693,815, or 35 per cent. New Jersey was fifth, with an increase of $243,865, or 2.5 per cent. Indiana was sixth, Iowa seventh, New York eighth, Kentucky ninth, and California tenth.

The only clay product reported from every State and the District of Columbia and Porto Rico is common brick. This product, the value of which constituted over 19 per cent of the value of all clay products and 25 per cent of the brick and tile products in 1917, decreased 1,529,293,000 brick, or 21 per cent, compared with 1916. In 1916 there was an increase of 543,103,000 brick, or 8 per cent, compared with 1915. Seven States, Arizona, Arkansas, California, Louisiana, Oklahoma, West Virginia, and Wyoming reported increase in quantity and value of common brick, compared with 1916. Twenty States reported decrease in quantity and value, and 21 States reported decrease in quantity but increase in value. Fourteen States reported common brick marketed to the value of $1,000,000, or more.

Illinois, as for several years, was the largest producer of common brick, followed by New York, Pennsylvania, Ohio, Michigan, and New Jersey in the order named. In 1916 New Jersey was fifth and Michigan sixth. Of the output of Illinois, 497,235,000, or 67 per cent, was from Cook County, and of the output of New York, 467,044,000, or 71 per cent, was from the Hudson River region. The average price per thousand in 1917, which ranged from $6.41 in Louisiana to $13.31 in Delaware, decreased in only Porto Rico and Wyoming. The largest increase was in Delaware—$4.57. There was an increase of $1 or more per thousand in 1916 in 9 States; in 1917 the average price increased more than $1 in 32 States, and in 6 States, Delaware, New Hampshire, Ohio, Pennsylvania, Vermont, and West Virginia, it increased more than $2. The average price per thousand for the entire country increased $1.49.

Vitrified brick or block, the sixth brick and tile product in value in 1917, was reported from 27 States, a decrease of 1—Oregon. Ohio, as for many years, was the leading State, and reported 26 per cent of the total quantity and value. Illinois ranked second, reporting 24 per cent of the output and value; Pennsylvania was third, with 11 per cent of the output and value; Indiana was fourth, with 7 per cent of the output and value; and Kansas, fifth with 6 per cent. These relative ranks have been maintained for several years. These five States reported about three-fourths of the output and value. Of the output marketed in 1917, 562,234,000 vitrified brick or block, or 80 per cent, was sold for paving and 144,700,000, or 20 per cent, was sold for other purposes. This was a decrease of 198,438,000 brick or block, or 26 per cent, in the output sold for paving and of 36,181,000 brick or block, or 20 per cent, in the output sold for other purposes, compared with 1916. The average price per thousand for vitrified brick or block sold for paving was $16.14; sold for other purposes, $10.97—an increase of $2.19 and $2, respectively. The quantity of vitrified brick or block marketed in 1917 was 706,934,000 a decrease of 234,619,000, or 25 per cent. The average price per thousand ranged in the more important States from $12.33 in Texas to $21.37 in Maryland.

The manufacture of front brick is the most widely distributed branch of the clay-working industries, except that of common brick, and in 1917 it was reported from 42 States, an increase of 1—Delaware and Michigan entering the list of producers and Maine dropping out. Pennsylvania in 1917, as for many years, was the leading front brick producing State and reported 26 per cent of the total quantity and value. Ohio ranked second, Indiana third, and Illinois fourth in quantity and value, as in 1916. Kansas was fifth in quantity and seventh in value, and Missouri was sixth in quantity and fifth in value. The first five States reported two-thirds of the quantity marketed in 1917. The average price per thousand ranged from $10.33 in Kansas to $25.00 in Arizona and Delaware. There was a decrease in the quantity of front brick reported in 1917 of 245,144,000 brick, or 24 per cent, compared with 1916.

Draintile was fifth in value among the brick and tile products in 1917 and was reported from 36 States, the same number as in 1916. Montana and Wyoming, which reported none for 1916, reported draintile in 1917, and Louisiana and Maine reported none. The Central West continues to be the largest producer and user of draintile. Iowa, Ohio, Indiana, Illinois, Michigan, and Minnesota were the leading States in the order named. These six States, together, reported draintile valued at $9,893,803, or 90 per cent of the total. This was an increase of $802,798, or 9 per cent, over 1916. All of these leading States, except Iowa, showed large increase over 1916.

Sewer pipe, the third brick and tile product in value in 1917, was reported from 26 States, the same number as in 1916. West Virginia, which reported none for 1916, reentered the list of producers and Montana dropped out. Ohio was the leading producer and reported 40 per cent of the total. Its output was valued at $6,897,255—an increase of $1,764,445, or 34 per cent, over 1916. Pennsylvania ranked second, displacing Missouri, which became third; Illinois was fourth, and California fifth. These five States reported 71 per cent of the total for 1917, and all except California showed large increase over 1916.

Architectural terra cotta was reported from 13 States in 1917, an increase of 1—Utah. Illinois was the leading State, and reported one-third of the total. New Jersey was second, and New York third. These three States reported 68 per cent of the total for 1917.

For the first time, at the request of those interested, an effort was made to obtain statistics of the quantity as well as of the value of hollow building tile or block including partition, load-bearing, back-up, floor, arch blocks, silo tile, and fireproofing. The results show that there were 2,590,028 short tons of the hollow building tile marketed in 1917 at an average price of $5.12 per ton. It was reported from 37 States, an increase of two—Arizona, Oklahoma. South Carolina, which reported none in 1916, marketed this product in 1917, and Connecticut reported none. Ohio was the leading State, reporting 35 per cent of the output and 27 per cent of the total value. This was an increase in value of $712,468, or 25 per cent, over 1916. New Jersey was second with 12 per cent of the output and 16 per cent of the value, an increase in value of $336,347, or 18 per cent, over 1916. Iowa was third with 10 per cent of the output and 12 per cent of the value, an increase of $401,593, or 35 per cent, over 1916. Illinois was fourth with 9 per cent of the output and value, an increase of $367,046, or 48 per cent over 1916. Pennsylvania was fifth in output and sixth in value, and Indiana was sixth in output and fifth in value. These six States reported 81 per cent of the total output and 77 per cent of the total value in 1917.

Tile, not drain, includes roofing, floor, wall, ceramic mosaic, and faience tile. These products were reported from 16 States—a decrease of 1, Rhode Island. Ohio continues to be the leading State, reporting 39 per cent of the total; New Jersey was second, and Indiana third. These three States produced more than two-thirds of the total for 1917.

Fire brick, owing to its large increase in value in 1917, ranked first in value among clay products, displacing common brick, and was reported from 35 States—an increase of 3 compared with 1916. Iowa, Louisiana, North Carolina, and South Carolina reentered the list of producers, and Mississippi dropped out.

The quantity of 9-inch equivalent fire brick reported (1,631,316,000) increased 254,393,000 brick, or 18 per cent, and the value increased $27,206,135, or 88 per cent. The average price per thousand in 1917 for all fire brick was $35.56—an increase of $13.19. The total number of clay 9-inch equivalent fire brick was 1,304,286,000, valued at $42,501,669, or $32.59 per thousand—an increase of 160,036,000 brick, or 14 per cent, and of $18,064,796, or 74 per cent. Pennsylvania continued to be the leading producer of both clay and silica fire brick, reporting 42 per cent of the quantity and 46 per cent of the value of clay fire brick, and 68 per cent of the quantity and 67 per cent of the value of silica fire brick in 1917.

If clay and silica fire brick be considered together, Pennsylvania's marketed output was 776,463,000 9-inch equivalent brick, valued at $29,801,849, or 48 per cent of the quantity and 51 per cent of the total value reported for 1917. Ohio was second in output and value, Missouri third, Kentucky fourth, and New Jersey fifth, as for several years. These five States reported 83 per cent of the output and 85 per cent of the value of clay fire brick in 1917.

The production of silica fire brick in 1917 was 327,030,000 9-inch equivalent brick, valued at $15,510,595, or $47.43 per thousand, an increase of 94,357,000 brick, or 41 per cent, and of $9,141,339, or 143 per cent. The average price per thousand increased $20.06 or to $47.73 in 1917, compared with 1916.

TILE, NOT DRAIN.

Under the head "Tile, not drain," are embraced the varieties of higher grades of tile used almost exclusively in structural work. There are numerous subdivisions and trade names for these varieties, but, owing to the small number of producers of some of them, it has been thought best to classify them as roofing, floor, ceramic mosaic, faïence, and wall tile.

Tile, not drain, of domestic production, sold in the United States, 1914–1917.

Variety.	1914		1915		1916		1917	
	Value.	Number of firms reporting sales.	Value.	Number of firms reporting sales.	Value.	Number of firms reporting sales.	Value.	Number of firms reporting sales.
Roofing	$1,043,020	26	$891,150	23	$914,240	21	$871,872	18
Floor	881,362	41	912,180	44	1,438,231	49	1,325,516	35
Ceramic mosaic	1,520,739	18	1,185,787	19	1,308,861	19	1,481,505	19
Faïence	675,615	23	635,073	23	814,077	24	1,007,005	24
Wall	1,584,847	19	1,561,865	19	2,000,055	16	2,135,323	17
	5,705,583	....	5,186,055	....	6,475,464	....	6,821,221	....

Wall tile is the variety of greatest value; it constituted 31 per cent of the total in 1917 and increased $135,268, or 7 per cent, over 1916. If, however, floor tile and ceramic mosaics, which are used almost exclusively as floor material, are considered together, tile used for flooring was valued at $2,807,021, or 41 per cent of the total, and increased $59,929, or 2 per cent. In 1916 there was an increase of $649,125, or 31 per cent, over 1915, in the total value of these tiles.

Floor tile showed a decrease of $112,715, and ceramic mosaics increased $172,644 compared with 1916. Floor tile was reported from nine States, California, Indiana, Massachusetts, New Jersey, New York, Ohio, Pennsylvania, Tennessee, and West Virginia, and by 35 producers—a decrease of four States, Illinois, Iowa, Kentucky and Rhode Island, and of 14 producers. Ohio was the leading State with sales valued at $650,044, or 49 per cent of the total, an increase of $64,352, or 11 per cent. Of this output $504,143, or 78 per cent, was from Muskingum County. New Jersey was second and West Virginia third. These three States reported 83 per cent of the entire output of this variety of tile.

Ceramic mosaics were reported from six States, Indiana, Kentucky, Massachusetts, New Jersey, Ohio, and Pennsylvania, a decrease of two—Colorado and New York. Ohio was the leading State, having wares valued at $488,065, or 33 per cent of the total—an increase of $20,442. New Jersey was second, with an output valued at $374,779. These two States reported 58 per cent of the total for this variety of ware.

Wall tile was reported from seven States, California, Indiana, Kentucky, New Jersey, Ohio, Pennsylvania, and West Virginia. Ohio was the leading State, and reported an output valued at $826,910, or 39 per cent of the total, an increase of $19,847, or 2 per cent, over 1916. New Jersey was second, with an output valued at $480,981, or 23 per cent of the total, a decrease of $37,222, or 7 per cent, from 1916.

Roofing tile, constituting 13 per cent of the total and showing a decrease of $42,368, or 5 per cent, from 1916, was reported from 10 States in 1917, California, Colorado, Illinois, Iowa, Kansas, Kentucky, Missouri, Ohio, Pennsylvania, and West Virginia. Ohio was the leading State; Kansas was second and California third.

Faïence tile, constituting 15 per cent of the total, was reported from 10 States in 1917, California, Colorado, Indiana, Kentucky, Massachusetts, Michigan, New Jersey, Ohio, Pennsylvania, and West Virginia. Ohio was the leading State and reported an output valued at $391,328, or 39 per cent of the total, an increase of $34,946, or 10 per cent, over 1916. New Jersey was second, with $165,316, an increase of $56,093, or 51 per cent.

HUDSON RIVER REGION.

The Hudson River region has always held an interesting and unique place in the clay-working industries. This region, so far as the brick-making industry is concerned, is located on both sides of Hudson River and extends from New York City to Cohoes. It is bountifully supplied with excellent clay for making common brick and is favorably located for water transportation, in many places the the plants being on the water's edge. For many years this region has been the chief source of supply of common building brick for New York City. In recent years, however, the Raritan River region in Middlesex County, N. J., has sent a considerable proportion of its output of common brick to the New York market. Hence it, together with Bergen County, N. J., has been included in the table of production of common brick along the Hudson River. The year 1917 in this region was one of comparative inaction. The large decrease in the building operations in New York was naturally reflected in the decline of the output of brick along Hudson River. When prices for common brick are high in New York City, as they were in 1917, Connecticut usually sends a supply of brick to the metropolis. But the great falling off in the building operations in New York in 1917 and the high prices received at home served to check the movement of Connecticut brick to New York, and it is believed that few, if any, brick from that State found a market in New York in 1917.

Common brick produced and sold in the Hudson River district, 1901–1917.

Year.	Number of firms reporting sales.	Quantity (thousands).	Value.	Average price per thousand.
1901	127	830,154	$3,880,215	$4.67
1902	127	833,065	3,683,379	4.42
1903	115	844,500	3,973,316	4.70
1904	119	987,644	5,810,114	5.88
1905	129	1,297,389	9,063,753	6.99
1906	135	1,274,372	7,672,639	6.02
1907	132	1,064,892	5,515,585	5.18
1908	123	875,979	4,107,382	4.69
1909	127	1,313,760	6,438,642	4.90
1910	135	1,142,284	5,544,600	4.85
1911	125	926,072	4,717,633	5.09
1912 [a]	136	1,233,187	7,133,177	5.78
1913 [a]	132	1,025,308	5,636,061	5.50
1914 [a]	129	888,266	4,350,832	4.90
1915 [a]	120	960,527	5,009,065	5.21
1916 [a]	113	893,552	5,915,254	6.62
1917 [a]	99	584,184	4,427,934	7.58

[a] Includes Raritan district, N. J.

The number of brick marketed in this region in 1917 decreased 309,368,000 brick, or 35 per cent, and was the smallest output recorded by the Geological Survey. The value of the output decreased $1,487,320, or 25 per cent. The average price per thousand brick for the region increased 96 cents, compared with 1916, and was the highest recorded, and was 59 cents more than the next highest price, which was $6.99 in 1905. The number of operators reporting sales continues to decline and in 1917 was the smallest recorded.

In the New York and Bergen County, N. J., portion of the region the output was 505,535,000 brick—a decrease of 239,443,000 brick, valued at $3,719,430—a decrease of $1,134,516. The number of operators (93) in this portion of the region in 1917 decreased 12 as compared with 1916.

Common brick marketed in the Hudson River district (from Cohoes to New York City) and in the Raritan district, N. J., in 1916 and 1917.

County.	1916				1917			
	Number of firms reporting sales.	Common brick.			Number of firms reporting sales.	Common brick.		
		Quantity (thousands).	Value.	Average price per thousand.		Quantity (thousands).	Value.	Average price per thousand.
Albany	13	71,183	$442,640	$6.22	12	43,763	$323,298	$7.39
Columbia	[a] 8	[a] 70,526	[a] 417,713	5.92	[a] 7	[a] 39,629	[a] 314,453	7.93
Dutchess	14	87,779	552,271	6.29	11	56,740	411,681	7.26
Greene	6	29,683	182,524	6.15	5	23,861	138,197	5.79
Orange	7	80,450	577,829	7.18	5	61,083	441,790	7.23
Rensselaer	([a])	([a])	([a])	([a])	([a])	([a])	([a])	([a])
Rockland	20	121,967	809,019	6.63	19	89,227	668,197	7.49
Ulster	22	222,651	1,444,275	6.49	20	142,768	1,040,535	7.29
Westchester	6	18,357	126,197	6.87	5	9,973	85,422	8.57
Total for New York portion of district	96	702,596	4,552,468	6.48	84	467,044	3,423,573	7.33
Bergen County, N. J	9	42,382	301,478	7.11	9	38,491	295,857	7.69
Raritan district (Middlesex County), N. J	8	148,574	1,061,308	7.14	6	78,649	708,504	9.01
Grand total	113	893,552	5,915,254	6.62	99	584,184	4,427,934	7.58

[a] Columbia and Rensselaer counties are combined.

The New York portion of the region by reason of its greater number of operators has always been by far the larger producer. For 1917 it reported 80 per cent of the output and 77 per cent of the value for the entire region. The quantity of brick sold in this portion of the region in 1917 decreased 235,552,000 brick, or 34 per cent, and the value decreased $1,128,895, or 25 per cent, compared with 1916. The average price per thousand in this portion of the region increased 85 cents.

Of the counties included in the New York portion, Ulster, as for many years, was first in output and value, its 20 operators reporting about 30 per cent of the output and value in 1917. There was a decrease of 79,883,000 brick, or 36 per cent, and of $403,740, or 28 per cent, in value in this county, compared with 1916. The average price per thousand in Ulster County increased 80 cents. Rockland County was second, as in 1916; its output decreased 32,740,000, or 27 per cent, and its value decreased $140,822, or 17 per cent. The average price per thousand increased 86 cents in this county. Orange County was third in 1917, displacing Dutchess County. The decrease in output in Orange County was 19,367,000 brick, or 24 per cent, and in value $136,039, or 24 per cent. Every one of the other six counties in this portion of the region showed decrease in both output and value, compared with 1916. Every county except Greene showed an increase in average price per thousand compared with 1916. The largest increase was in Columbia—$2.01.

The New Jersey portion of the production of this region was comparatively small—117,140,000 brick, valued at $1,004,361—but owing to the higher average price obtained in 1917 its proportionate value was somewhat larger, the proportions being 20 per cent of the output and 23 per cent of the value of the entire region. Both counties in this portion of the region showed decrease in output and value. The output in Bergen County decreased 3,891,000 brick, or 9 per cent, and the value decreased $5,621, or 2 per cent, compared with 1916. The decrease in Middlesex County was very much larger, being 69,925,000 brick, or 47 per cent, and $352,804, or 33 per cent. The total decrease in the New Jersey portion of the region was 73,816,000 brick, or 39 per cent, and $358,425, or 26 per cent, compared with 1916. The average price per thousand brick in this portion of the region was $8.57 in 1917, $7.14 in 1916, and $5.78 in 1915.

The number of operators reporting sales decreased 14, of whom 12 were in the New York portion of the region.

POTTERY.

GENERAL STATEMENT.

The pottery industry of the United States in 1917 experienced an unusual year. The imports of pottery were necessarily small, whereas the demand was fully equal to the largest domestic supply that would have been produced under normal conditions; owing, however, to the handicaps caused by shortage of fuel and of raw materials, by labor strikes, by the withdrawal of laborers from the industry, by the draft and other war demands, and by freight embargoes affecting alike the receipts of raw materials and the shipment of the finished product, the American potters found it impossible to supply the demand. Though the value of the output was the largest yet recorded, the volume of the product was probably not so large as in some other years. Few plants, if any, ran to capacity, and many of them did not market more than three-fourths of their normal output. The increased cost of labor and raw materials made it necessary to fix higher prices for the wares than those that have prevailed in the last few years. The imports showed an increase over those of 1916 but were much below normal imports before the war. This increase was due chiefly to greater imports from Japan, whose wares are now finding a larger market in the United States.

Notwithstanding the handicaps which the pottery industry endured in 1917, greater efforts were made to place the industry on a firmer foundation than ever. Realizing that after the war he will have the keenest competition and knowing that in order to hold his present trade he must not only make ware of superior quality but must be able to undersell foreign competitors, the American potter has begun to study how to improve the quality of his ware and how to devise labor-saving machines and improved kilns. The report of the United States Potters' Association shows that a number of devices that give promise of lowering the cost of labor and fuel were introduced in 1917 or were being successfully developed. Among these devices are sagger-making machines, a conveyor type of stove, a casting process that makes large production possible by unskilled labor, and down-draft and tunnel kilns that insure a large saving of fuel.

The effort to establish in the Southern States a pottery for the manufacture of high-grade ware has, after many years, at last been successful. In 1917, for the first time, white ware was manufactured in the South. The Southern Potteries (Inc.) began to operate at Erwin, Tenn., a 10-kiln plant for the manufacture of semivitreous porcelain tableware, using domestic clays exclusively.

Another milestone in the pottery industry in this country in 1917 was the establishment at East Liverpool, Ohio, by Ernst Reinhardt, of the Bisc Novelty Co.'s pottery for making bisque doll heads. Since the imports of toys from Germany have been cut off efforts have been made, with more or less success, to produce dolls and doll heads of various materials, but it remained for Mr. Reinhardt, formerly connected with the doll-head making industry in Germany, to produce bisque doll heads on a commercial scale in the United States. Mr. Reinhardt started his work in a small way in Philadelphia soon after the war began, and in 1917 he removed to East Liverpool, Ohio, where, if his plans are carried out, bisque doll heads will be made in large quantity.

Another important development in the pottery industry of the United States is the production of high-grade chemical porcelain, the manufacture of which in this country was considered impossible before the war. Several operators are now making chemical porcelain which satisfactorily meets the exacting requirements of the laboratory.

PRODUCTION.

The value of all domestic pottery marketed in 1917 was $56,162,522—an increase of $7,945,280, or more than 16 per cent, over 1916, and the greatest value attained by the pottery industry of the United States. It was $18,170,147, or 48 per cent, greater than that of 1913. Pottery imports also increased, but the ratio of production to consumption, 92 per cent, was the same as for 1916.

Every variety of ware as classified in this report, except the lowest grade, red earthenware, increased in value compared with 1916, and all except red earthenware and stoneware reached their maximum value. White ware showed the largest increase, $2,729,079, or 15 per cent; porcelain electrical supplies increased $2,417,166, or 34 per cent; and china, the highest grade of pottery, increased $1,327,534, or 38 per cent. Red earthenware showed a small decrease, $91,166, or nearly 8 per cent.

The value of white ware and china, which comprise the general household wares and constitute nearly one-half of all pottery products, was $25,726,375 in 1917, an increase of $4,056,613, or 19 per cent. If to this sum is added the value of sanitary ware and porcelain electrical supplies, the total value of 1917 was $47,814,178, or $7,998,579 more than in 1916.

Value of pottery products in the United States, 1908–1917.

Year.	Number of firms reporting sales.	Red earthenware.	Stoneware and yellow and Rockingham ware.	Chemical stoneware and porcelain.	White ware, including C. C. ware, etc.
1908	497	$757,900	$3,518,841	(a)	$11,474,147
1909	466	805,906	3,993,859	(a)	13,728,316
1910	463	854,196	3,796,688	(a)	14,780,980
1911	449	893,678	4,120,608	(a)	14,366,251
1912	434	958,270	3,919,778	(a)	14,829,431
1913	426	1,000,529	3,683,567	(a)	15,066,811
1914	412	1,059,904	3,349,301	(a)	14,968,079
1915	416	1,072,061	3,575,603	(a)	15,324,242
1916	393	1,156,351	3,696,288	$1,054,061	18,191,390
1917	394	1,065,185	3,865,825	1,099,432	20,920,469

Year.	China, bone china, delft, and belleek ware.	Sanitary ware.	Porcelain electrical supplies.	Miscellaneous.	Total.
1908	$1,581,020	$4,373,590	$2,009,005	$1,421,052	$25,135,555
1909	[b] 1,766,766	5,989,295	3,047,499	[b] 1,717,800	31,049,441
1910	1,962,126	6,758,996	3,794,153	1,837,539	33,784,678
1911	2,057,985	7,031,458	4,232,101	1,816,479	34,518,560
1912	2,177,305	7,902,255	4,927,316	1,789,809	36,504,164
1913	2,424,060	8,214,838	5,737,741	1,864,829	37,992,375
1914	2,384,686	7,874,269	4,130,270	1,631,652	35,398,161
1915	2,330,156	7,993,216	4,671,202	2,358,908	37,325,388
1916	3,478,372	11,111,417	7,034,420	2,494,943	48,217,242
1917	4,805,906	12,636,217	9,451,586	2,317,902	56,162,522

[a] Chemical stoneware and chemical porcelain were not separately classified prior to 1916.
[b] China, bone china, delft, and belleek ware for Ohio is included in miscellaneous.

Value of pottery products in 1916.

Rank.	State.	Number of firms reporting sales.	Red earthenware.	Stoneware and yellow and Rockingham ware.	Chemical stoneware and porcelain.	White ware, including C. C. ware white granite, semiporcelain ware, and semivitreous porcelain ware.	China, bone china, delft, and belleek ware.
16	Alabama	9	$4,121	$9,254			
	Arkansas		(a)	(a)			
9	California	13	32,350	(a)	(a)		
14	Colorado	5	(a)	(a)	(a)		
	Connecticut		(a)				
	District of Columbia		(a)				
17	Georgia	16	7,493	5,708			
7	Illinois	18	46,843	548,633		(a)	
6	Indiana	11	(a)	41,001		(a)	
	Iowa		(a)				
13	Kentucky	7	49,703	71,468			
	Louisiana		(a)				
	Maine			(a)			
11	Maryland	6	(a)			(a)	
12	Massachusetts	9	(a)	(a)	(a)	(a)	
8	Michigan	7	123,734		(a)	(a)	
	Minnesota		(a)	(a)			
18	Mississippi	6	860	11,060			
21	Missouri	3	(a)	(a)			
	Montana		(a)				
	Nebraska		(a)				
	New Hampshire						
2	New Jersey	51	37,529	(a)	(a)	$811,391	$1,407,930
4	New York	18	(a)	(a)	(a)	(a)	1,254,374
19	North Carolina	18	1,290	7,805			
1	Ohio	98	323,777	1,938,726	$486,171	11,834,913	
	Oregon		(a)	(a)			
5	Pennsylvania	25	215,115	218,624	(a)	(a)	(a)
	Porto Rico		(a)				
20	South Carolina	6	7,030	1,690			
10	Tennessee	8	(a)	24,850			
15	Texas	18	13,831	74,099			
	Utah		(a)	(a)			
	Virginia						
	Washington		(a)				
3	West Virginia	15				3,576,510	(a)
	Wisconsin		(a)				
	Undistributed [b]	26	292,675	743,430	567,890	1,968,576	816,068
		393	1,156,351	3,696,288	1,054,061	18,191,390	3,478,372
	Percentage of pottery products		2.40	7.67	2.19	37.73	7.21
	Percentage of total clay products		.56	1.78	.51	8.78	1.68
	Number of firms reporting each variety		136	126	13	54	17

[a] Included in "Undistributed." [b] Includes all products made by less than 3 producers in 1 State.

Value of pottery products in 1916—Continued.

Rank.	State.	Sanitary ware.	Porcelain electrical supplies.	Miscellaneous.[a]	Total.	Percentage of total.
16	Alabama			(b)	$22,805	0.05
	Arkansas			(b)	(b)	
9	California	$393,867		$19,093	517,797	1.07
14	Colorado			20,067	111,569	.23
	Connecticut		(b)		(b)	
	District of Columbia				(b)	
17	Georgia				13,201	.03
7	Illinois	(b)	(b)	42,565	1,125,506	2.33
6	Indiana	1,140,455	(b)		1,634,353	3.39
	Iowa			(b)	(b)	
13	Kentucky				121,111	.25
	Louisiana			(b)	(b)	
	Maine				(b)	
11	Maryland	(b)	(b)	(b)	277,575	.58
12	Massachusetts			31,714	230,821	.48
8	Michigan	(b)	(b)	(b)	792,716	1.64
	Minnesota				(b)	
18	Mississippi				11,920	.03
21	Missouri				6,436	.01
	Montana				(b)	
	Nebraska				(b)	
	New Hampshire			(b)	(b)	
2	New Jersey	6,458,356	$1,674,093	177,218	11,064,878	22.95
4	New York	(b)	1,623,433	40,763	3,344,672	6.94
19	North Carolina			(b)	9,860	.02
1	Ohio	941,643	2,181,026	1,735,277	19,441,533	40.32
	Oregon				(b)	
5	Pennsylvania	(b)	(b)	(b)	2,480,127	5.14
	Porto Rico				(b)	
20	South Carolina				8,720	.02
10	Tennessee			(b)	304,638	.63
15	Texas			(b)	88,180	.18
	Utah				(b)	
	Virginia	(b)		(b)	(b)	
	Washington				(b)	
3	West Virginia	1,310,949	(b)	86,469	5,780,853	11.99
	Wisconsin				(b)	
	Undistributed[c]	866,147	1,555,868	341,777	[d] 827,971	1.72
		11,111,417	7,034,420	2,494,943	48,217,242	100.00
	Percentage of pottery products	23.04	14.59	5.17	100.00	
	Percentage of total clay products	5.36	3.40	1.20	23.27	
	Number of firms reporting each variety	46	42	66		

[a] Including aquarium ornaments, art pottery, cracqule porcelain, filter stones, gas and electric lighting appliances, jardinieres, porcelain door knobs, shuttle eyes and thread guides, porcelain hardware trimmings, Guernsey earthenware, Niloak, Omar Khayyam, Pewabic, Rookwood, and Teco pottery, Oxfordware, pins, stilts, and spurs for potters' use, refrigerator linings, saggers, tobacco pipes, toy marbles, turpentine cups, umbrella stands, and vases.

[b] Included in "Undistributed."

[c] Includes all products made by less than 3 producers in 1 State.

[d] Made up of State totals of Arkansas, Connecticut, District of Columbia, Iowa, Louisiana, Maine, Minnesota, Montana, Nebraska, New Hampshire, Oregon, Porto Rico, Utah, Virginia, Washington, and Wisconsin.

Value of pottery products in 1917.

Rank.	State.	Number of firms reporting sales.	Red earthenware.	Stoneware and yellow and Rockingham ware.	Chemical stoneware and porcelain.	White ware, including C. C. ware, white granite, semi-porcelain ware, and semi-vitreous porcelain ware.	China, bone china, delft, and belleek ware (value).
17	Alabama	11	$6,060	$12,671			
	Arkansas			(a)			
9	California	12	27,110	65,581			
13	Colorado	5	(a)	(a)	(a)		
	Connecticut		(a)				
26	District of Columbia		6,000				
28	Florida						
19	Georgia	14	5,693	6,610			
7	Illinois	18	51,787	796,194		(a)	
6	Indiana	9	(a)	58,387	(a)	(a)	
27	Iowa	3	(a)				
14	Kentucky	6	49,669	104,100			
23	Louisiana						
	Maine			(a)			
11	Maryland	6	(a)			(a)	
12	Massachusetts	10	(a)		(a)	(a)	
8	Michigan	8	(a)		(a)	(a)	
	Minnesota		(a)	(a)			
18	Mississippi	9	2,200	15,771			
20	Missouri	3	(a)	(a)			
30	Montana		500				
	Nebraska		(a)				
	New Hampshire						
2	New Jersey	55	36,045	(a)	$472,681	$1,040,697	$1,632,622
4	New York	18	(a)		(a)	(a)	1,574,962
24	North Carolina	16	1,269	5,756			
1	Ohio	101	280,874	1,761,468	429,449	13,222,826	(a)
	Oregon		(a)	(a)			
5	Pennsylvania	20	238,456	231,431	(a)	(a)	840,043
	Porto Rico		(a)				
21	South Carolina	6	6,142	2,046			
10	Tennessee	8	(a)	53,750		(a)	
15	Texas	16	9,981	82,912			
25	Utah		(a)				
16	Virginia	3					
29	Washington		996				
3	West Virginia	16				4,421,017	(a)
22	Wisconsin	3	8,000				
	Undistributed [b]	18	334,403	669,148	197,302	2,235,929	758,279
		394	1,065,185	3,865,825	1,099,432	20,920,469	4,805,906
	Percentage of pottery products		1.89	6.88	1.96	37.25	8.56
	Percentage of total clay products		.43	1.56	.44	8.44	1.94
	Number of firms reporting each variety		121	113	19	64	18

a Included in "Undistributed." b Includes all products made by less than 3 producers in 1 State.

Value of pottery products in 1917—Continued.

Rank.	State.	Sanitary ware.	Porcelain electrical supplies.	Miscellaneous.[a]	Total.	Percentage of total.
17	Alabama				$18,731	0.03
	Arkansas			(b)	(b)	
9	California	$518,084		$2,376	613,151	1.09
13	Colorado			17,910	158,093	.28
	Connecticut		(b)		(b)	
26	District of Columbia				6,000	.01
28	Florida			4,800	4,800	.01
19	Georgia				12,303	.02
7	Illinois	(b)	(b)	36,421	1,571,262	2.80
6	Indiana	1,297,343	(b)		1,890,501	3.37
27	Iowa			(b)	4,900	.01
14	Kentucky				153,769	.27
23	Louisiana			7,888	7,888	.01
	Maine				(b)	
11	Maryland	(b)	(b)	6,821	332,954	.59
12	Massachusetts			43,266	250,992	.45
8	Michigan	(b)	(b)	13,722	1,187,981	2.12
	Minnesota				(b)	
18	Mississippi			30	18,001	.03
20	Missouri				10,675	.02
30	Montana				500	
	Nebraska				(b)	
	New Hampshire			(b)	(b)	
2	New Jersey	7,202,671	$1,893,382	250,195	12,535,843	22.32
4	New York	(b)	2,018,363	80,614	4,076,817	7.26
24	North Carolina			(b)	7,475	.01
1	Ohio	1,004,726	3,096,162	1,504,734	21,353,706	38.02
	Oregon			(b)	(b)	
5	Pennsylvania	(b)	(b)	25,869	3,194,944	5.69
	Porto Rico				(b)	
21	South Carolina				8,188	.02
10	Tennessee			(b)	400,080	.71
15	Texas				92,893	.17
25	Utah			(b)	7,333	.01
16	Virginia	(b)		(b)	32,130	.06
29	Washington				996	
3	West Virginia	1,342,970	(b)	115,660	7,243,900	12.90
22	Wisconsin				8,000	.01
	Undistributed[c]	1,270,423	2,443,679	207,596	[d] 957,716	1.71
		12,636,217	9,451,586	2,317,902	56,162,522	100.00
	Percentage of pottery products	22.50	16.83	4.13	100.00	
	Percentage of total clay products	5.09	3.81	.93	22.64	
	Number of firms reporting each variety	47	44	79		

[a] Including aquarium ornaments, art pottery, bisque doll heads, chimney tubes, cracqule porcelain, filter stones, gas and electric lighting and heating appliances, Guernsey and Oxford ware, Niloak, Omar Khayyam, Pewabic, Rhead and Rookwood pottery, pins, stilts, and spurs for potters' use, porcelain door knobs and filter tubes, porcelain hardware trimmings and supplies, porcelain guides for use on textile machinery, saggers, shooting gallery pipes, shuttle eyes and thread guides, stems for laboratories and supply houses, tobacco pipes, toy marbles, turpentine cups, and vases.
[b] Included in "Undistributed."
[c] Includes all products made by less than 3 producers in 1 State.
[d] Made up of State totals of Arkansas, Connecticut, Maine, Minnesota, Nebraska, New Hampshire, Oregon, and Porto Rico.

The number of States reporting ware classed in this report as pottery was 38, an increase of—Florida. There are, however, but few States reporting the higher grades of ware. Only three States, New Jersey, Ohio, and Pennsylvania reported all kinds of ware, and New York reported all but one.

Ohio, the leading pottery-producing State, reported in 1917 wares valued at $21,353,706, or 38 per cent of the total, an increase of $1,912,173, or nearly 10 per cent, over 1916. Ohio's principal pottery product is white ware, valued at $13,222,826. White ware constituted 62 per cent of the value of the entire pottery output of the State in 1917. Ohio's second product in importance in 1917 was porcelain electrical supplies, valued at $3,096,162—an increase of $915,136, or 42 per cent, over 1916. New Jersey is the second largest pottery-producing State. For 1917 it reported wares valued at $12,535,843, or more than 22 per cent of the total—an increase of $1,470,965, or 13 per cent. Sanitary ware was New Jersey's principal pottery product, valued at $7,202,671, and constituted 57 per cent of the State's total in 1917. West Virginia ranks third among the pottery producing States and reported nearly 13 per cent of the total for 1917. Its pottery products increased in value $1,463,047, or 25 per cent. West Virginia's principal pottery product is white ware, valued at $4,421,017, which constituted 61 per cent of its total in 1917. It is also a large producer of sanitary ware. New York was fourth and Pennsylvania fifth, as for many years. Indiana, Illinois, and Michigan maintained their relative ranks of sixth, seventh, and eighth, respectively. The value of pottery output in all these States increased very considerably in 1917. The first five States, Ohio, New Jersey, West Virginia, New York, and Pennsylvania, reported wares valued at $48,405,210, or 86 per cent of the total for 1917.

In considering the rank of States it should be borne in mind that the small number of producers in many of them in 1917, which makes it impossible to publish State totals without disclosing individual returns, makes the rank of all but the first few the relative and not the actual rank.

Red earthenware, which consists principally of flowerpots, the commonest of pottery products, was reported from 31 States, a decrease of 2—Arkansas and Louisiana. Ohio was the leading State, as for many years, and showed a decrease of $42,903, or 13 per cent, compared with 1916. Pennsylvania was second, and Massachusetts third. These three States reported nearly two-thirds of the total for 1917. The number of producers reporting this ware decreased by 15 in 1917, compared with 1916.

Stoneware, including yellow and Rockingham ware, was reported from 20 States in 1917—a decrease of three States—Massachusetts, New York, and Utah. Ohio, the leading State, reported nearly one-half of the entire output.

Chemical pottery—that is, chemical porcelain and chemical stoneware—was reported from eight States, the same number as for 1916, but California reported none for 1917 and Indiana entered the list of producers. New Jersey was the leading State, displacing Ohio. These two States reported 82 per cent of the total. Nineteen operators reported chemical pottery—an increase of three.

The pottery products of the United States having the largest total value are grouped under the head of white ware. These include the various household wares and constituted in 1917 more than 37 per cent of the total value of all pottery products. White-ware products were reported by 64 operators in 11 States—an increase of one State (Tennessee) and of 10 operators over 1916. As there were less than three producers in each of eight States, totals for only three States are published in order to avoid disclosing confidential information. Ohio was the leading State in the production of these wares in 1917, as for many years, and reported 63 per cent of the total value—an increase of $1,387,913, or 12 per cent, over 1916. Of the 64 operators reporting white ware in 1917, 39 were located in Ohio. West Virginia ranked second and showed an increase in value of $844,507, or 24 per cent.

China was reported from five States, an increase of one—Ohio. New Jersey was the leading State, reporting wares valued at $1,632,622, or 34 per cent of the total, its production increasing $224,692, or 16 per cent, over 1916. New York was second, its production being valued at $1,574,962, an increase of $320,588, or 26 per cent. These two States reported two-thirds of the output. One more operator reported china in 1917 than in 1916.

Sanitary ware was reported from 11 States, the same as in 1916. New Jersey was the leading State, and reported 57 per cent of the entire output. West Virginia was second and Indiana third. These relative ranks have been maintained for many years. These three States produced nearly 78 per cent of the total output. All of them reported increases, New Jersey $744,315, or 12 per cent, West Virginia $32,021, or 2 per cent, and Indiana $156,888, or 14 per cent.

Porcelain electrical supplies were reported by 10 States, the same as in 1916. Ohio, New York and New Jersey were the leading States, in the order named, and reported nearly 75 per cent of the output in 1917. These three States showed large increase in value of output. The number of operators reporting porcelain electrical supplies in 1917 was 44, an increase of 2.

CONSUMPTION.

The value of the pottery imported into the United States in 1917, added to that of the pottery produced and sold, amounted to a total of $62,495,836. After deducting from this sum the value of the exports of domestic ware, approximately $1,551,983, and of the reexports of foreign ware, $25,926, the value of the apparent net consumption was $60,917,927, of which the domestic production was 92 per cent, the same as in 1916, and the highest proportion yet reached. In 1915 this percentage was 86; in 1914 it was 82; in 1913 it was 80; and in 1912 it was 81.

IMPORTS.

The total value of imports of all clay products increased $876,908, or 15 per cent, compared with 1916. In 1916 there was a decrease of $1,034,222, or 15 per cent. The total value of imports for 1917 was, with the exception of 1916, the lowest for many years, and was less than that of 1907, the year of maximum value, by $7,168,359, or 52 per cent. Of the imports for 1917, 95 per cent was pottery and 5 per cent brick and tile. The value of imports of pottery in 1917 increased $732,729, or 13 per cent, compared with 1916, and with the exception of 1915 and 1916, was the smallest in many years, and was considerably less than one-half of the value of the pottery imported in 1907, and $3,883,774, or 38 per cent, less than that of 1913, the last year of normal conditions. Every kind of pottery imported, except tobacco pipes and plain china, showed an increase over 1916. Earthenware showed the largest increase—$290,438, or 17 per cent; plain china decreased $131,561, or 45 per cent. In 1917 the imports of the higher grades of pottery constituted 92 per cent of the total. Brick and tile imports increased $144,179, or 87 per cent, in 1917, compared with 1916.

Value of clay products imported and entered for consumption in the United States, 1908–1917.

Year.	Pottery.								Brick, fire brick, tile, etc.	Grand total.
	Brown earthen and common stone ware.[a]	Tobacco pipes and pipe bowls of clay.	Earthenware and crockery composed of a nonvitrified absorbent body.		China and porcelain.		Sanitary earthenware, decorated and not decorated.	Total.		
			Not decorated.	Decorated.	Not decorated.	Decorated.				
1908	$70,629				$1,142,444	$9,309,718		$10,522,791	$162,341	$10,685,132
1909	98,716				1,245,479	9,263,017		10,607,212	189,536	10,796,748
1910	154,614	$52,077			1,293,986	9,682,558		11,183,235	222,183	11,405,418
1911	164,871	61,244			1,221,756	9,251,989		10,699,860	208,966	10,908,826
1912	152,166	66,292			1,094,152	8,309,212		9,621,822	215,379	9,837,201
1913	238,611	31,806	[b]$81,978	[b]$523,803	[c]1,067,209	[c]8,273,681		10,217,088	276,677	10,493,765
1914	312,934	40,548	438,460	1,968,561	727,725	4,910,365		8,398,593	207,644	8,606,237
1915	227,017	15,155	272,795	1,538,732	458,302	4,116,085		6,628,086	171,801	6,799,887
1916	264,715	10,378	173,192	1,669,712	289,219	3,177,998	$15,371	5,600,585	165,080	5,765,665
1917	518,965	8,209	235,104	1,960,150	157,658	3,409,527	43,701	6,333,314	309,259	6,642,573

[a] Including Rockingham ware and miscellaneous pottery products.
[b] Figures cover period from Oct. 4 to Dec. 31.
[c] Including wares classified under the act of 1913 as china and porcelain wares composed of a vitrified nonabsorbent body: Not decorated, $244,933, decorated, $2,204,851. After 1913 only wares composed of a vitrified nonabsorbent body are included.

EXPORTS.

The value of exports of domestic clay products in 1917 increased $2,097,733, or 43 per cent, over 1916 and reached its maximum. Of the exports in 1917, 67 per cent was brick and tile, 22 per cent pottery, and 11 per cent unclassified. The value in 1917 was greater by $1,952,368, or 39 per cent, than that of 1912, the year of maximum value prior to 1917.

Each of the kinds of ware exported increased in 1917 compared with 1916; the unclassified or "all other" wares, however, showed a slight decrease, which means, perhaps, that the wares were better classified in 1917 than in 1916. Brick and tile, valued at $4,658,175, showed the largest increase, $1,659,139, or 55 per cent; pottery exports, valued at $1,551,983, increased $475,411, or 44 per cent; and "all other" clay products decreased $36,817, or 5 per cent. Exports of fire brick and china reached their maximum value in 1917.

Value of clay products of domestic manufacture exported from the United States, 1907–1917.

Year.	Building brick.	Fire brick.	Tile (except drain).	Earthen and stone ware.	China.	Sanitary earthenware.	All other.	Total.
1907	$185,192	$631,779		$1,022,730	$108,911			$1,948,612
1908		[a]550,243		906,266	77,494		$113,243	1,647,246
1909		[a]1,002,270		776,842	86,853		147,622	2,013,587
1910		[b]634,775		928,475	113,214		968,138	2,644,602
1911		1,057,725		1,278,892	122,474		1,206,629	3,665,720
1912	[b]448,939	1,117,161	[b]$539,116	1,037,637	140,147		1,717,895	5,000,895
1913	689,515	1,121,590	851,463	410,050	149,281		1,566,340	4,788,239
1914	524,239	734,134	658,695	390,693	136,209		1,134,035	3,578,005
1915	279,336	975,089	276,785	297,127	160,710	[b]$105,615	610,578	2,705,240
1916	189,668	2,406,184	403,184	600,377	262,119	214,076	779,922	4,855,530
1917	196,207	4,011,546	450,422	805,784	422,641	323,558	743,105	6,953,263

[a] Includes all brick other than building brick. [b] Figures cover period from July 1 to Dec. 31.

Value of clay products of domestic manufacture exported from the United States in 1916 and 1917.

	Building brick.	Fire brick.	Tile (except drain).	Earthen and stone ware.	Sanitary earthen-ware.	China.	All other.	Total.
1916.								
Europe	12,114	494,144	13,574	7,247	5,104	24,853	78,563	635,599
Central America and West Indies	35,483	272,165	155,878	95,674	105,630	78,546	247,786	991,162
Canada	122,519	1,349,994	149,907	425,758	42,593	91,408	317,774	2,499,953
Mexico	16,467	65,455	11,889	18,618	7,676	17,492	25,134	162,731
Newfoundland	15	18,647	1,663	1,197	2,624	1,200	1,297	26,643
South America	3,014	171,857	58,975	29,518	37,687	40,877	82,627	424,555
Asia	....	18,291	2,873	14,544	6,704	3,856	9,449	55,717
Oceania	56	15,048	8,408	7,018	5,884	3,318	12,151	51,883
Africa	....	583	17	803	174	569	5,141	7,287
	189,668	2,406,184	403,184	600,377	214,076	262,119	779,922	4,855,530
1917.								
Europe	33,151	430,965	2,829	22,044	9,139	5,375	28,213	531,716
Central America and West Indies	35,371	431,327	217,827	238,002	136,268	100,747	157,396	1,316,938
Canada	104,945	2,491,174	116,832	385,041	72,961	115,590	409,518	3,696,061
Mexico	22,491	221,210	16,472	64,390	26,104	61,519	34,931	447,117
Newfoundland	....	1,997	1,057	870	1,623	3,886	478	9,911
South America	189	328,833	82,816	74,736	52,765	109,299	50,786	699,424
Asia	....	93,746	8,940	11,833	10,830	16,687	53,117	195,153
Oceania	44	12,294	2,746	8,489	13,868	8,782	8,350	54,573
Africa	16	....	903	379	....	756	316	2,370
	196,207	4,011,546	450,422	805,784	323,558	422,641	743,105	6,953,263

Canada continues to afford the greatest foreign market for clay products exported from the United States, more than 53 per cent of such wares going to that country in 1917, an increase of $1,196,108, or 48 per cent, over 1916. Central America and the West Indies are the next largest consumers of American clay products, these countries taking wares valued at $1,316,938, or 19 per cent of the total in 1917, an increase of $325,776, or 33 per cent. South America was third, and took wares, mostly fire brick, valued at $699,424, or 10 per cent of the total, and increase of $274,869, or 65 per cent, over 1916.

CLAY.

GENERAL CONDITIONS.

Clay available for the manufacture of clay products is one of the most widely distributed minerals. Hence there are clay-working plants in every State in the Union. Miners of the lower-grade clays are usually also the manufacturers, but as the higher grades of ware are reached, the rule is that fewer and fewer manufacturers are also miners, until in the highest grades of ware nearly every manufacturer buys the clays he uses. The figures given in the following tables represent clay that is mined and not burned into clay products by the miner, but is sold as clay. The clay thus sold is small in quantity compared with the total production and includes mainly clay used for high-grade pottery and tile, for paper making, and for refractory products.

The conditions in the clay-mining industry in 1917, as in other industries, were most unusual. The industry suffered from shortage and high cost of labor and from adverse transportation conditions, but in spite of these handicaps it showed considerable progress, both in increased output and in a wider use of domestic clay. Some embarrassment had been caused manufacturers of high-grade wares, who had depended more or less on imported clay, especially manufacturers of such refractory and other wares as require high-grade clays, for example, glasshouse refractories, crucibles, lead pencils, abrasive wheels, enamel ware, paint, oilcloth, and high-grade pottery; but this embarrassment was felt less keenly during 1917, because the use of domestic clay as a substitute was becoming more general. This happy condition was largely the result of the cooperative work of the Bureau of Standards, the Bureau of Mines, the State and the United States geological surveys, and other Federal agencies in the location of clays and in the study of their adaptability to certain uses. It has been shown by the Bureau of Standards that the Klingenberg clay, which found its most extensive use in the manufacture of crucibles, the Gross-Almerode clay, used in glass-pot manufacture, and the Vallendar clay, used in the enameling industry, are no longer necessary for these uses but can be replaced by American clays or combinations of clays. The largely specialized use of these clays formerly imported is shown by the fact that the greatest quantity ever entered for consumption, which was in 1913, was less than 25,000 tons. The domestic clays that have thus far been reported as being suitable for these purposes are located in Arkansas, Delaware, Illinois, Kentucky, Mississippi, Missouri, Ohio, Pennsylvania, and Tennessee.

A further important use of domestic clay is in the manufacture of chemical and electrical porcelain. In a canvass of the manufacture of these wares, it was found that one of the chief obstacles to the wider uses therein of domestic clays is the lack of proper and uniform preparation. The imported kaolins are, on the other hand, said to be uniform and reliable in chemical and physical characteristics, not only as to each individual shipment, but from month to month and from year to year. Nevertheless, a study of the reports of producers to the Geological Survey reveals the fact that a large proportion—nearly one-half of the makers of porcelain electrical supplies state that they are using no foreign clays in the body of their ware. This includes standard and special porcelains, spark plugs, pole-line and small-line insulators, floor and wall tubes, and porcelain knob tops. One operator has reported the successful manufacture of high-tension transmission-line insulators entirely from American clays, and one maker of tableware reports the production of a semivitreous porcelain body entirely from domestic clays.

One of the most urgent needs of the country at the outbreak of the war was that of optical glass, little or none of which had been made in this country, and one of the chief problems that confronted the glassmakers was to obtain glass pots free from injurious impurities that would be imparted to the glass in the process of melting. The most objectionable of these impurities is iron. To obtain pots free from this impurity, the Bureau of Standards and the Geophysical Laboratory of the Carnegie Institution made an exhaustive study of this subject and evolved a formula, using domestic clays and the defective bisque pieces of white ware potteries, from which satisfactory pots for the manufacture of optical glass are being made.

The principal developments in the clay-mining industry in 1917 were the large increase in the output of fire clays; the increasing employment of the plastic refractory clays of southern Illinois in uses that require the highest qualities; the development of a field of high-grade fire clay in northern Mississippi that gives promise of being an important factor in the ability of domestic clays to displace foreign clays; and the discovery of deposits of high-grade kaolin in Nevada. Considerable demand for clay high in alumina has been manifest within the last few years. Besides the well-known deposits of bauxite of the Southern States, clays containing more than 37 per cent of alumina are found in a number of States, notably in Arkansas, California, Georgia, Indiana, Kentucky, Missouri, New Jersey, Ohio, and Pennsylvania. One of the most promising fields for this material is Missouri.

The imports of clay decreased in quantity and value compared with 1916, and were the smallest since 1909, with the exception of 1915, and were about a third less than those of 1914, the year of maximum quantity and value. Under kaolin in the imports are included clays used in the paper, pottery, and other industries. In the tables of domestic production the kaolin and paper clay are separately classified. Therefore, to make a fair comparison between imported "kaolin" and domestic output, these varieties should be added together. For 1917 they amounted to 206,334 tons, valued at $1,263,799, compared with 241,029 tons of imported kaolin, valued at $1,315,769, at the port of shipment.

PRODUCTION.

The clay sold as such in 1917 amounted to 3,113,844 short tons, an increase of 181,254 tons, or 6 per cent. This clay was valued at $8,042,546, or $2.58 per ton, an increase of $2,290,772, or 40 per cent, and of 62 cents in the average price. Paper, slip, ball, and fire clay showed increase in output. Paper clay, ball clay, and fire clay reached their maximum output and value, and slip clay reached its maximum value in 1917. Kaolin showed a decrease in both output and value. Fire clay made the largest gain in production, 290,158 tons, or 14 per cent; paper clay increased 21,015 tons, or nearly 14 per cent; ball clay, 17,645 tons, or 20 per cent; and slip clay 2,908 tons, or 21 per cent. Fire clay also showed the largest increase in value, $1,917,086, or 52 per cent; paper clay increased $193,510, or 25 per cent; ball clay $178,088, or 46 per cent; slip clay $22,566, or 47 per cent; and brick clay $17,849, or 23 per cent. Kaolin decreased 15,838 tons, or 33 per cent in quantity, and $5,441, or 2 per cent, in value; stoneware clay decreased 54,606 tons, or 40 per cent, and $23,940, or 17 per cent, in value. Fire clay is the chief kind, judged by production, and constituted 75 per cent of the output and 70 per cent of the value of the domestic clay marketed in 1917. Paper clay ranked second in value of output and ball clay third. The average price per ton for each kind of clay was considerably higher in 1917 than in 1916. The greatest increase was in kaolin, $3.02, or to $9.45; ball clay increased in average price 94 cents, or to $5.30; and slip clay 74 cents, or to $4.15.

The maximum, both in quantity and value, of clay marketed in the period covered by this table was attained in 1917. The previous year of greatest output and value was 1916. Kaolin reached its maximum production and value in 1906, the output of 1917 being less than that of 1906 by 20,052 tons, but its value was less by $68,074.

Clay marketed in the United States, 1908–1917.

Year.	Kaolin.		Paper clay.		Slip clay.		Ball clay.		Fire clay.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1908	28,649	$216,243	64,510	$310,943	10,087	$22,370	40,838	$133,770	1,101,579	$1,486,139
1909	31,227	241,060	81,586	386,764	18,010	30,527	49,074	214,194	1,463,919	2,082,193
1910	34,221	255,873	85,949	420,476	17,696	29,962	70,637	257,265	1,638,931	2,157,720
1911	27,400	221,045	99,265	454,435	8,393	16,770	65,072	220,710	1,526,921	2,112,827
1912	25,852	220,747	119,857	522,924	16,339	27,573	64,939	227,545	1,695,337	2,363,357
1913	28,834	235,457	126,377	567,977	10,902	24,505	67,134	237,672	1,820,379	2,592,591
1914	34,191	284,817	116,328	558,334	8,237	17,731	67,927	255,767	1,409,467	2,147,277
1915	28,031	241,520	113,033	539,622	7,646	18,774	75,348	301,910	1,570,481	2,361,482
1916	47,723	306,819	153,434	768,911	14,064	47,939	89,761	391,152	2,057,814	3,708,009
1917	31,885	301,378	174,449	962,421	16,972	70,505	107,406	569,240	2,347,972	5,625,095

Year.	Stoneware clay.		Brick clay.		Miscellaneous clay.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1908	124,192	$102,390	210,556	$154,575	143,490	$173,556	1,723,901	$2,599,986
1909	130,757	137,264	222,686	171,183	162,388	186,522	2,159,647	3,449,707
1910	152,942	153,044	173,625	128,039	215,228	223,106	2,389,229	3,625,485
1911	151,384	165,751	142,020	123,900	162,243	165,325	2,182,698	3,480,763
1912	124,409	115,522	229,306	204,504	254,226	263,848	2,530,265	3,946,020
1913	153,353	143,587	158,890	137,976	282,120	240,694	2,647,989	4,180,459
1914	130,383	116,610	199,154	161,852	241,173	214,180	2,209,860	3,756,568
1915	134,297	126,429	101,968	93,863	332,150	288,341	2,362,954	3,971,941
1916	135,958	137,779	97,164	76,854	336,672	314,311	2,932,590	5,751,774
1917	81,352	113,839	93,779	94,703	260,029	305,365	3,113,844	8,042,546

Slip clay reached its maximum quantity in 1905 and its maximum value in 1917. Brick clay reached its maximum quantity and value in 1912, since which time it has been decreasing until 1917, when it reached its minimum quantity, but its value in that year showed a considerable increase.

Forty-one States reported sales of clay in 1917—an increase of two, Arizona, Nevada, and South Dakota appearing as producers, and Arkansas dropping out. The leading six States, in the order of quantity marketed, were Pennsylvania, Missouri, Ohio, New Jersey, Illinois, and Georgia. In value of output, however, their rank was: Missouri, Pennsylvania, New Jersey, Illinois, Georgia, and Ohio. These States reported 2,168,878 tons, valued at $5,745,546, or nearly 70 per cent of the total quantity and 71 per cent of the value of clay marketed in 1917. The same States in 1916 reported 2,104,860 tons of clay marketed, valued at $4,008,765, or 72 per cent of the total quantity and 70 per cent of the total value of clay marketed in that year. In all these States, except Georgia, fire clay is the principal variety, and the large increase in its price was the cause of the increase in the value of clay in these States. In Pennsylvania it constituted 86 per cent of the output and 82 per cent of the value of the clay marketed; in Missouri it was nearly 99 per cent of the output and 94 per cent of the value; in Ohio 88 per cent of the output was fire clay; and in New Jersey and Illinois 74 and 77 per cent of the output, respectively, was fire clay. In Georgia the principal clay marketed is the well-known "plastic kaolin" or paper clay of the central part of the State, 58 per cent of the output and 96 per cent of the value of the State's total being of that variety.

Fire clay.—In 1917 Missouri was the leading State in the production and value of fire clay, displacing Pennsylvania. Its output of fire clay was 491,674 tons, or nearly 21 per cent of the total, valued at $1,306,721—an increase of 56,054 tons, or 13 per cent, in quantity and of $366,412, or 39 per cent, in value. Of this production, 406,248 tons, valued at $1,173,662, came from St. Louis City and St. Louis County. Pennsylvania was second in output and value. Pennsylvania's output was 441,344 tons, or nearly 19 per cent of the total, valued at $1,118,343—a decrease of 70,960 tons, or nearly 14 per cent, but an increase of $227,426, or nearly 26 per cent, in value. Ohio was third in output and fifth in value. Its output was 15 per cent of the total and was 349,526 tons—an increase of 117,004 tons, or 50 per cent. The value of the fire clay mined in Ohio in 1917 was $529,840, an increase of $277,567, or 110 per cent. New Jersey was fourth in output and third in value, the State reporting 281,098 tons or 12 per cent of the total output, valued at $815,507, which was an increase of 17,065 tons, or 6 per cent, and of $230,277, or 39 per cent. Middlesex County is the great fire clay producing center of the State, 240,672 tons, or nearly 86 per cent of the State's total, being reported from that county. The average price per ton of fire clay in 1917 in these States was: Illinois, $4.89; Missouri, $2.66; New Jersey, $2.90; Ohio, $1.52; and Pennsylvania, $2.53. In 1916 the corresponding prices were: Illinois, $2.49; Missouri, $2.16· New Jersey, $2.22; Ohio, $1.08; and Pennsylvania, $1.74.

Kaolin.—Kaolin, the purest form of clay and in some respects the most valuable, was reported from 10 States—an increase of two—Colorado and Nevada. On account of the small number of producers in all of these States except Missouri, it is impossible to publish figures of production without disclosing confidential information. The principal source of domestic kaolin is the Southern States, which reported seven-eighths of the output. North Carolina reported more than one-half of the output and value.

Paper clay.—Paper clay, the second kind in output, value, and average price per ton, whose principal use is indicated by its name, was reported from four States. Georgia was the leading producer of this kind of clay and reported 62 per cent of the output and 60 per cent of the value, an increase of 16,551 tons and of $156,313 over 1916. Other States in the South also supply large quantities of paper clay, the total from that region being more than 85 per cent of the marketed product. Considerable quantities of this clay, especially from Georgia and South Carolina, are also used in the manufacture of paint, tile, and pottery.

Ball clay.—Ball clay was reported from six States—an increase of one—Alabama. The Southern States produce nearly the entire output of ball clay, 95 per cent of the output coming from that region. Tennessee was the leading State and reported 38 per cent of the output and 29 per cent of its value—an increase of 7,052 tons and $55,833 over 1916.

Clay marketed in the United States in 1916.

State.	Kaolin.		Paper clay.		Slip clay.		Ball clay.		Fire clay.		Stoneware clay.		Brick clay.		Miscellaneous clay.[a]		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama									40,235	$50,618					1,244	$435	41,479	$51,053
Arkansas									(b)	(b)							(b)	(b)
California	366	$4,103	(c)	(c)	(b)	(b)	(b)	(b)	80,218	96,598	(b)	(b)	(b)	(b)	c17,123	c16,415	106,330	133,950
Colorado									31,738	48,150			45,198	$29,480	50	200	76,986	77,830
Connecticut													(b)	(b)			(b)	(b)
Delaware	8,888	85,560							(b)	(b)							12,844	101,384
Florida							(b)	(b)									(b)	(b)
Georgia			92,671	$417,394					10,370	6,703	(b)	(b)			90,150	18,300	193,791	443,147
Idaho									(b)	(b)							(b)	(b)
Illinois									131,658	327,666	25,615	$24,970			40,428	25,804	197,701	378,440
Indiana	(b)	(b)			(b)	(b)			56,534	50,564	(b)	(b)	(b)	(b)	3,778	6,304	69,748	65,537
Iowa															21,829	2,427	21,829	2,427
Kentucky							15,282	$50,831	44,070	116,287	(b)	(b)	(b)	(b)	10	200	62,247	170,984
Maryland	(b)	(b)							28,753	59,831			(b)	(b)	1,462	1,950	45,975	82,667
Massachusetts									(b)	(b)			(b)	(b)			892	1,296
Michigan					2,810	$10,509							(b)	(b)			3,454	11,153
Minnesota															(b)	(b)	(b)	(b)
Mississippi									(b)	(b)							(b)	(b)
Missouri	(b)	(b)							435,620	940,309	(b)	(b)	(b)	(b)	(b)	(b)	439,583	988,884
Montana									(b)	(b)							(b)	(b)
Nebraska									(b)	(b)	(b)	(b)			(b)	(b)	(b)	(b)
New Jersey							6,318	26,397	264,033	585,230	8,288	22,388	22,074	17,880	71,203	138,901	371,916	790,796
New Mexico									3,602	9,511							3,602	9,511
New York					(b)	(b)			(b)	(b)			(b)	(b)	1,826	1,341	11,158	36,413
North Carolina	(b)	(b)									70	35	(b)	(b)			17,562	151,823
North Dakota									(b)	(b)							(b)	(b)
Ohio					(b)	(b)			232,522	252,273	65,107	42,246	(b)	(b)	22,619	9,667	324,722	309,369
Oregon									(b)	(b)	(b)	(b)					(b)	(b)
Pennsylvania			28,207	183,397					512,304	890,917	(b)	(b)	8,584	5,534	25,178	14,739	577,147	1,098,129
South Carolina			32,556	168,120					(b)	(b)							32,881	170,070
Tennessee							33,230	110,756	42,634	63,696	22,306	33,497	(b)	(b)			101,617	209,951
Texas									2,156	9,498	(b)	(b)	(b)	(b)	53	116	2,936	10,531
Utah									(b)	(b)							(b)	(b)
Vermont	(b)	(b)							(b)	(b)					(b)	(b)	5,397	40,684
Virginia	(b)	(b)							(b)	(b)					(b)	(b)	(b)	(b)
Washington					(b)	(b)			630	3,934	(b)	(b)					1,840	6,251
West Virginia									121,931	125,363			(b)	(b)			122,944	126,283
Wisconsin									(b)	(b)			(b)	(b)			(b)	(b)

Wyoming	....	....	....	....	....	....	....	....	(b)	(b)	....	....	....	....	(b)	(b)	(b)	(b
Undistributed d	38,469	217,156	....	....	11,254	37,430	34,931	203,168	18,806	70,861	14,572	14,643	21,308	23,960	39,719	77,512	e 86,009	e 283,211
	47,723	306,819	153,434	768,911	14,064	47,939	89,761	391,152	2,057,814	3,708,009	135,958	137,779	97,164	76,854	336,672	314,311	2,932,590	5,751,774
Average price per ton	....	6.43	....	5.01	....	3.41	....	4.36	....	1.80	....	1.01	....	0.79	....	0.93	....	1.96

a Including bentonite, modeling clay, sewer-pipe clay, terra-cotta clay, and clay for medicinal use.
b Included in "Undistributed."
c Paper clay for California is included in "California miscellaneous."
d Includes all clay reported by less than 3 producers in 1 State.
e Made up of State totals of Arkansas, Connecticut, Florida, Idaho, Minnesota, Mississippi, Montana, Nebraska, North Dakota, Oregon, Utah, Virginia, Wisconsin, and Wyoming.

Clay marketed in the United States in 1917.

State.	Kaolin.		Paper clay.		Slip clay.		Ball clay.		Fire clay.		Stoneware clay.		Brick clay.		Miscellaneous clay.[a]		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity. (short tons).	Value.
Alabama							(b)	(b)	41,951	$67,674			(b)	(b)			58,667	$84,763
Arizona									(b)	(b)							(b)	(b)
California	(b)	(b)					(b)	(b)	91,589	95,346	7,372	$8,155	(b)	(b)	23,508	$21,808	137,892	151,348
Colorado	(b)	(b)			(b)	(b)			97,393	95,375	(b)	(b)	7,873	$6,451			106,775	103,376
Connecticut													(b)	(b)			(b)	(b)
Delaware	(b)	(b)							(b)	(b)							11,243	85,330
Florida							(b)	(b)									(b)	(b)
Georgia			109,222	$573,707	(b)	(b)			1,727	5,652	(b)	(b)			(b)	(b)	187,355	599,359
Idaho									(b)	(b)							(b)	(b)
Illinois			(b)	(b)					150,655	736,568	32,327	35,752			(b)	(b)	195,693	789,589
Indiana	(b)	(b)							71,564	72,605			(b)	(b)	250	1,750	73,863	78,463
Iowa									(b)	(b)					5,426	2,764	5,488	3,012
Kentucky					(b)	(b)	17,858	$98,736	70,276	213,819	(b)	(b)			3	50	91,727	320,365
Maryland	(b)	(b)							37,274	107,557			(b)	(b)	1,000	200	42,364	114,027
Massachusetts									(b)	(b)			532	401	15	28	847	1,329
Michigan					2,153	$8,824							(b)	(b)			5.746	13,627
Minnesota															(b)	(b)	(b)	(b)
Mississippi									(b)	(b)							(b)	(b)
Missouri	573	$3,992							491,674	1,306,721	(b)	(b)			(b)	(b)	497,267	1,386,338
Montana									7,083	26,710							7,083	26,710
Nebraska									(b)	(b)	(b)	(b)			(b)	(b)	1,980	4,412
Nevada	(b)	(b)															(b)	(b)
New Jersey					(b)	(b)	5,118	28,264	281,098	815,507	12,041	39,326	38,563	46,204	43,475	106,125	380,362	1,035,703
New Mexico									2,269	8,931							2,269	8,931
New York					(b)	(b)			(b)	(b)					1,714	1,955	11,894	51,505
North Carolina	(b)	(b)									(b)	(b)	(b)	(b)			17,426	182,176
North Dakota									(b)	(b)							(b)	(b)
Ohio					2,675	4,840			349,526	529,840	20,464	18,886	(b)	(b)	19,663	9,758	396,796	568,687
Oregon									(b)	(b)	(b)	(b)					(b)	(b)
Pennsylvania			25,014	217,008					441,344	1,118,343	(b)	(b)	8,143	4,602	34,382	21,859	511,405	1,365,870
South Carolina			40,173	171,506					(b)	(b)							40,448	173,706
South Dakota															(b)	(b)	(b)	(b)
Tennessee							40,282	166,589	58,153	107,347	(b)	(b)			8,000	6,000	106,535	280,136
Texas									4,059	22,257	(b)	(b)			87	175	4,446	22,477
Utah									4,079	8,298							4,079	8,298
Vermont	(b)	(b)							(b)	(b)					32	140	2,766	27,032
Virginia	(b)	(b)							(b)	(b)			(b)	(b)			3,724	6,263
Washington					(b)	(b)			779	7,159	(b)	(b)					1,613	9.248

West Virginia	....	....	....	....	....	....	....	....	127,024	189,672	....	....	....	....	....	....	127,024	189,672
Wisconsin	....	....	....	....	....	....	....	....	....	....	....	....	(b)	(b)	....	....	(b)	(b)
Wyoming	....	....	....	....	....	....	....	....	....	....	....	....	....	....	(b)	(b)	(b)	(b)
Undistributed c	31,312	297,386	40	200	12,144	56,841	44,148	275,651	18,455	89,714	9,148	11,720	38,668	37,045	122,474	132,753	d 79,067	d 350,794
	31,885	301,378	174,449	962,421	16,972	70,505	107,406	569,240	2,347,972	5,625,095	81,352	113,839	93,779	94,703	260,029	305,365	3,113,844	8,042,546
Average price per ton	....	9.45	....	5.52	....	4.15	....	5.30	....	2.40	....	1.40	....	1.01	....	1.17	....	2.58

a Including bentonite, modeling clay, sewer-pipe clay, and terra-cotta clay.
b Included in "Undistributed."
c Includes all clay reported by less than 3 producers in 1 State.
d Made up of State totals of Arizona, Connecticut, Florida, Idaho, Minnesota, Mississippi, Nevada, North Dakota, Oregon, South Dakota, Wisconsin, and Wyoming.

IMPORTS.

Clay imported and entered for consumption in the United States, 1908–1917.

Year.	Kaolin or china clay.			Common blue and Gross-Almerode glass-pot clay.		All other clays. Unwrought.		All other clays. Wrought.		Total.	
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity short tons).	Value.
1908...	176,895	$1,129,847	$6.39	4,872	$37,053	27,730	$129,411	1,372	$22,990	219,869	$1,319,301
1909...	246,381	1,505,779	6.11	12,346	104,401	30,147	134,978	1,906	50,632	290,780	1,795,790
1910...	257,902	1,593,472	6.18	21,176	181,334	27,890	113,352	1,496	26,205	308,464	1,914,363
1911...	255,107	1,461,068	5.73	17,193	124,278	26,086	100,540	1,032	10,436	299,418	1,696,322
1912...	278,276	1,629,105	5.85	23,112	184,018	32,473	127,004	794	12,109	334,655	1,952,236
1913...	268,666	1,623,993	6.04	24,986	204,911	42,582	155,693	1,889	22,178	338,123	2,006,775
1914...	328,038	1,927,425	5.88	16,761	122,325	50,069	195,956	3,232	41,712	398,100	2,287,418
1915...	209,132	1,152,778	5.51	8,864	62,569	23,718	90,367	1,343	12,433	243,057	1,318,147
1916...	253,707	1,326,684	5.22	2,501	12,134	42,478	163,421	180	1,994	298,866	1,504,233
1917...	241,029	1,315,769	5.46	88	709	26,581	123,439	338	2,142	268,036	1,442,059

The imports of clay are unimportant, except kaolin or china clay and the "common blue" and Gross Almerode, which include high-grade fire clay imported principally from Germany. The imports of these fire clays in 1917 were practically nothing, only 88 tons, valued at $709, being entered for consumption, compared with 24,986 tons, valued at $204,911, imported in 1913. The imports of kaolin or china clay, which come principally from England, also decreased, but naturally not so much as those from Germany. The imports of kaolin—241,029 short tons, valued at $1,315,769, or $5.46 per ton—decreased 12,678 tons, or 5 per cent, and $10,915, or less than 1 per cent, in value. The average price per ton of imported kaolin was 24 cents higher than in 1916. Compared with 1914, the year of maximum imports, the decrease in 1917 was 87,009 tons, or nearly 27 per cent, and $611,656, or nearly 32 per cent, in value. The total quantity of clay imported decreased 30,830 tons, or 10 per cent, and $62,174, or 4 per cent, in value, compared with 1916. The total imports in 1917 compared with 1914 showed a decrease of 130,064 tons, or 33 per cent, and of $845,359, or 37 per cent.

Kaolin is the most important of the clays imported, 90 per cent of the quantity of imports and 91 per cent of the value in 1917 being of this kind.

BUILDING OPERATIONS.

The following tables show the building operations of some of the larger cities of the country in 1917. Efforts were made to obtain detailed information from 150 cities. Sufficient detail was received from 129 cities to permit them to be included in a table showing classes of buildings; from 16 cities only totals for permits or buildings and cost of buildings could be obtained; and from 5 cities no satisfactory data were obtained.

Statistics on building operations have been collected by the United States Geological Survey only from cities that had a population of 35,000 or more at the last Federal census and do not cover the smaller cities or rural communities, from which, so far as known, no effort has ever been made to collect statistics of building. The absence of building regulations in the smaller cities and towns and in rural communities makes it impracticable to collect statistics from them.

The table on page 568 makes a comparison between 1916 and 1917 in 60 cities, Greater New York being considered one city. The figures show that on the whole the building industry was far less active in 1917 than in 1916. The most noteworthy features of the building industry in 1917 were the very large decrease in the cost of building operations in most of these cities, and the general decrease in the cost per operation. Twelve of the cities, however, showed increase in 1917 compared with 1916.

Various causes are assigned for the changes. The principal reasons for the decrease in building activities were the scarcity and high cost of both labor and materials in the centers of population, conditions caused by the draft and by large Governmental operations in places outside the jurisdiction of the cities considered in this report. In some cities unusually large operations begun in 1916 made those for 1917 seem comparatively small, and in a few cities the stringency of money is given as the determining cause of the decline. The causes of the few increases were largely local. In New Haven, for example, the beginning of a large building for Yale University in 1917, and in some other cities the erection of munitions factories and dwellings to accommodate war workers caused the increase.

Of the 60 cities given in the first table 48 showed decrease and 12 showed increase in the total cost of building operations. Nine of these cities, Akron, Chester, Denver, Hartford, Los Angeles, Omaha, Sioux City, Waterbury, and Youngstown showed increase in both 1916 and 1917; and three, Atlanta, El Paso, and New Haven, which showed decrease in 1916, rallied and in spite of the general tendency to decrease in building operation showed increase in 1917. Forty cities that showed increase in 1916 showed decrease in 1917, and six cities showed decrease in both years, namely, Bridgeport, Cincinnati, Jersey City, Louisville, Pittsburgh, and St. Paul. The boroughs of Manhattan and Richmond, of Greater New York, showed increase in 1916 and decrease in 1917, and the boroughs of the Bronx and Brooklyn showed decrease in both years. Two cities, Nashville and Toledo, were not included in the table for 1916.

The net decrease was $315,491,134, or 35 per cent. The largest decrease was in Greater New York—$109,010,819, or 55 per cent. The largest proportional decrease was in Nashville—72 per cent. The largest gain was in Waterbury—$2,292,930, or 54 per cent. This was also the largest proportional gain.

The cost of building operations in these cities in 1917 ranged from $1,036,676 in Nashville to $90,221,357 in Greater New York, and the average for these 60 cities was $9,736,556, compared with $14,994,742 in 1916.

In 1917 the number of permits issued or buildings erected was 70,044 less than in 1916. The number ranged from 364 in Jersey City to 20,691 in Greater New York. The average cost per operation in these 60 cities was $2,925 in 1917 and $3,335 in 1916. In Greater New York the average cost was $4,360 in 1917 and $7,494 in 1916; in the Borough of the Bronx, $3,334 in 1917 and $4,997 in 1916; in Brooklyn, $2,741 in 1917 and $2,563 in 1916; in Manhattan, $11,379 in 1917 and $30,143 in 1916; and in the Borough of Richmond it was $2,293 and $2,281. In Chicago, the second city in cost of building operations, the average cost was $10,163 in 1917 and

$10,979 in 1916; in Detroit, the third city, it was $3,276 in 1917 and $3,097 in 1916; in Philadelphia, the fourth city, it was $4,375 in 1917 and $3,598 in 1916; in Cleveland, the fifth city, it was $2,551 in 1917 and $2,361 in 1916.

Building operations in larger cities of the United States in 1916 and 1917.

City.	1916		1917		Increase or decrease in 1917.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Cost.	Percentage.
Akron, Ohio	4,658	$12,824,536	5,039	$14,166,818	+ $1,342,282	+10.47
Atlanta, Ga	2,419	3,685,663	2,274	4,967,676	+ 1,282,013	+34.78
Baltimore, Md	10,682	10,647,893	1,424	6,299,643	− 4,348,250	−40.84
Boston, Mass	9,045	49,201,122	4,679	23,294,161	− 25,906,961	−52.66
Bridgeport, Conn	2,091	7,064,564	1,491	4,497,983	− 2,566,581	−36.33
Buffalo, N. Y	4,749	13,737,000	4,068	10,501,000	− 3,236,000	−23.56
Cambridge, Mass	667	4,033,115	561	3,146,367	− 886,748	−21.99
Camden, N. J	1,032	3,628,760	794	2,305,483	− 1,323,277	−36.47
Canton, Ohio	1,348	3,869,655	970	2,647,280	− 1,222,375	−31.59
Chester, Pa	656	3,122,750	693	3,678,735	+ 555,985	+17.80
Chicago, Ill	10,277	112,835,150	4,838	49,167,990	− 63,667,160	−56.42
Cincinnati, Ohio	15,987	10,842,895	4,262	9,151,925	− 1,690,970	−15.60
Cleveland, Ohio	14,022	33,108,260	11,952	30,483,750	− 2,624,510	− 7.93
Columbus, Ohio	3,141	7,194,240	2,117	3,915,030	− 3,279,210	−45.58
Dallas, Tex	1,523	4,293,464	814	3,577,849	− 715,615	−16.67
Denver, Colo	2,578	4,014,590	2,357	4,252,000	+ 237,410	+ 5.91
Des Moines, Iowa	855	3,375,945	982	2,640,469	− 735,476	−21.79
Detroit, Mich	16,489	51,068,310	12,109	39,666,800	− 11,401,510	−22.33
Duluth, Minn	1,963	10,223,598	1,460	4,508,665	− 5,714,933	−55.90
El Paso, Tex	1,654	3,551,909	1,474	3,749,407	+ 197,498	+ 5.56
Flint, Mich	3,002	4,733,447	1,453	2,454,805	− 2,278,642	−48.14
Fort Wayne, Ind	823	3,479,531	569	3,329,091	− 150,440	− 4.32
Grand Rapids, Mich	1,748	3,519,245	1,351	1,817,165	− 1,702,080	−48.36
Hartford, Conn	1,423	7,383,163	1,082	7,671,616	+ 288,453	+ 3.91
Houston, Tex	3,449	3,086,871	2,423	2,644,468	− 442,403	−14.33
Indianapolis, Ind	5,746	8,934,694	5,086	7,103,102	− 1,831,592	−20.50
Jersey City, N. J	1,036	5,005,243	364	2,628,283	− 2,376,960	−47.49
Kansas City, Mo	3,620	11,563,444	3,259	10,128,450	− 1,434,994	−12.41
Los Angeles, Cal	7,565	15,036,045	6,699	16,932,082	+ 1,896,037	+12.61
Louisville, Ky	2,299	3,853,140	1,267	1,758,060	− 2,095,080	−54.37
Memphis, Tenn	2,439	3,091,970	1,694	2,626,855	− 465,115	−15.04
Milwaukee, Wis	4,008	13,010,312	14,983	11,270,292	− 1,740,020	−13.37
Minneapolis, Minn	6,970	22,917,290	4,992	9,258,365	− 13,658,925	−59.60
Nashville, Tenn	6,367	3,657,510	1,615	1,036,676	− 2,620,834	−71.66
Newark, N. J	3,627	10,236,316	2,488	9,395,920	− 840,396	− 8.21
New Bedford, Mass	949	4,762,081	384	3,054,161	− 1,707,920	−35.86
New Haven, Conn	1,465	5,022,556	1,230	5,642,869	+ 620,313	+12.35
New Orleans, La	1,015	3,117,604	823	2,814,051	− 303,553	− 9.74
Newton, Mass	989	3,166,948	654	1,756,586	− 1,410,362	−44.53
New York, N. Y.:						
Bronx	3,687	18,425,060	3,037	10,126,360	− 8,298,700	−45.04
Brooklyn	16,448	42,163,505	12,255	33,590,071	− 8,573,434	−20.33
Manhattan	4,448	134,078,044	3,756	42,738,169	− 91,339,875	−68.12
Richmond	2,002	4,565,567	1,643	3,766,757	− 798,810	−17.50
	26,585	199,232,176	20,691	90,221,357	−109,010,819	−54.72
Oakland, Cal	3,683	5,368,290	2,938	4,442,520	− 925,770	−17.25
Omaha, Nebr	1,454	7,226,107	1,039	7,737,047	+ 510,940	+ 7.07
Peoria, Ill	797	4,643,182	718	4,183,574	− 459,608	− 9.90
Philadelphia, Pa	13,708	49,319,225	7,555	33,050,220	− 16,269,005	−32.99
Pittsburgh, Pa	4,175	13,554,810	3,587	11,318,502	− 2,236,308	−16.50
Portland, Oreg	4,351	6,272,865	3,377	3,643,410	− 2,629,455	−41.92
Providence, R. I	3,661	9,248,900	2,881	3,817,800	− 5,431,100	−58.72
Richmond, Va	2,155	4,927,396	1,558	4,118,688	− 808,708	−16.41
Rochester, N. Y	3,136	9,379,447	2,268	6,739,620	− 2,639,827	−28.14
St. Louis, Mo	8,550	15,444,103	7,491	12,538,532	− 2,905,571	−18.81
St. Paul, Minn	1,845	8,811,961	2,794	7,266,706	− 1,545,255	−17.54
San Francisco, Cal	6,492	18,837,173	5,513	15,635,319	− 3,201,854	−17.00
Seattle, Wash	8,486	8,304,689	7,736	6,714,315	− 1,590,374	−19.15
Sioux City, Iowa	591	3,090,305	582	3,328,206	+ 237,901	+ 7.70
Springfield, Mass	1,695	7,101,032	1,199	3,779,612	− 3,321,420	−46.77
Toledo, Ohio	4,295	9,692,268	3,156	7,264,546	− 2,427,722	−25.05
Washington, D. C	5,239	17,494,804	3,141	12,507,311	− 4,987,493	−28.51
Waterbury, Conn	1,337	4,270,000	1,394	6,562,930	+ 2,292,930	+53.70
Worcester, Mass	1,816	6,164,871	1,705	4,838,840	− 1,326,031	−21.51
Youngstown, Ohio	1,355	3,400,079	1,641	4,542,395	+ 1,142,316	+33.60
	269,782	899,684,512	199,738	584,193,378	−315,491,134	−35.07

Building statistics of the larger cities of the United States in 1917.

City.	Wooden buildings.								Fire-resisting buildings. Brick or hollow tile.	
	New.		Additions, alterations, and repairs.		Miscellaneous.		Total.		New.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Akron, Ohio	3,782	$6,997,771	665	$320,070			4,447	$7,317,841	443	$6,349,247
Allentown, Pa	76	31,555	34	5,465			110	37,020	280	1,206,650
Altoona, Pa	108	117,840	124	57,308	125	$22,161	357	197,309	14	27,557
Atlanta, Ga	411	1,420,697	1,215	598,066	545	401,633	2,171	2,420,396	a 90	a 1,538,400
Atlantic City, N. J	56	109,412	422	385,143			478	494,555	79	1,031,501
Augusta, Ga	140	233,007	2,023	102,862			2,163	335,869	32	103,676
Baltimore, Md	61	238,800					61	238,800	1,363	6,060,843
Bayonne, N. J	78	307,673	64	68,858	18	17,030	160	393,561	16	92,950
Berkeley, Cal	195	668,150	257	178,200	443	74,655	895	921,005	16	174,600
Binghamton, N. Y	780	644,751	1,743	367,878			2,523	1,012,629	108	645,113
Birmingham, Ala	508	711,697	3,428	412,109			3,936	1,123,806	42	347,423
Boston, Mass	607	1,818,086	2,028	873,574			2,635	2,691,660	358	10,714,909
Bridgeport, Conn	555	1,344,430	311	120,788	100	90,545	966	1,555,763	150	2,143,000
Brockton, Mass	269	373,384	179	152,325			448	525,709	8	242,200
Buffalo, N. Y	2,763	4,086,000	1,001	900,000			3,764	4,986,000	160	2,282,000
Butte, Mont	392	668,862	235	89,037	44	4,971	671	762,870	58	534,565
Cambridge, Mass	127	323,529	189	128,277	79	43,975	395	495,781	35	1,304,950
Camden, N. J	49	197,550	94	20,966	195	91,079	338	309,595	336	1,091,163
Canton, Ohio	637	1,443,735	59	42,335			696	1,486,070	109	905,700
Charleston, S. C	131	176,163	85	20,110			216	196,273	31	201,819
Chattanooga, Tenn	78	182,200	1,098	98,600			1,176	280,800	73	399,860
Chester, Pa	5	500			63	15,625	68	16,125	491	1,025,550
Chicago, Ill	1,035	2,277,000					1,035	2,277,000	3,803	46,890,990
Cleveland, Ohio	2,681	8,471,300	6,653	1,314,435	1,282	476,290	10,616	10,262,025	551	7,782,025
Columbus, Ohio	1,136	1,527,380	341	114,765			1,477	1,642,145	259	1,629,215
Covington, Ky	47	75,825	69	22,195			116	98,020	57	116,730
Dayton, Ohio	1,328	1,999,950	205	96,490			1,533	2,096,440	113	1,262,790
Denver, Colo	4	4,000					4	4,000	b 1,270	b 3,562,330
Des Moines, Iowa	847	1,332,989	44	38,320			891	1,371,309	67	654,060
Detroit, Mich	8,060	15,870,540	2,494	1,096,445			10,554	16,966,985	756	9,582,780
Dubuque, Iowa	97	97,870	13	10,300			110	108,170	12	267,100

For footnotes see p. 581.

Building statistics of the larger cities of the United States in 1917—Continued.

City.	Wooden buildings.								Fire-resisting buildings. Brick or hollow tile.	
	New.		Additions, alterations, and repairs.		Miscellaneous.		Total.		New.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Duluth, Minn.	670	$975,447	636	$237,068			1,306	$1,212,515	51	$1,090,808
East St. Louis, Ill.	146	122,027	50	41,650	23	$3,425	219	167,102	150	1,024,060
Elizabeth, N. J.	229	512,925	52	46,530			281	559,455	27	675,472
Elmira, N. Y.	259	532,900					259	532,900	19	259,300
El Paso, Tex.			126	24,000	154	32,400	280	56,400	455	1,562,000
Evansville, Ind.	284	306,013	540	85,694			824	391,707	49	566,915
Fall River, Mass.	179	359,200	200	110,860			379	470,060	30	593,263
Fitchburg, Mass.	94	59,447	67	67,583	1	6,500	162	133,530	7	119,385
Flint, Mich.	961	952,768	353	146,667	3	850	1,317	1,100,285	72	1,118,660
Fort Wayne, Ind.	361	1,026,080	133	119,686			494	1,145,766	28	1,373,325
Fort Worth, Tex.	152	205,783	174	78,711			326	284,494	47	708,501
Galveston, Tex.	32	34,484	1,559	62,296	11	465	1,602	97,245	11	69,500
Grand Rapids, Mich.	612	563,006	431	164,761			1,043	727,767	60	854,510
Harrisburg, Pa.	89	77,265	38	10,875			127	88,140	223	1,690,115
Hartford, Conn.	543	1,077,616	224	135,547			767	1,213,163	135	5,183,525
Hoboken, N. J.	24	17,510	76	58,312			100	75,822	20	115,905
Holyoke, Mass.	52	136,230	26	8,675			78	144,905	59	547,225
Houston, Tex.	584	1,138,348	1,280	116,667	158	76,588	2,022	1,331,603	48	719,426
Indianapolis, Ind.	780	2,021,977	1,977	1,100,000	(c)	(c)	2,757	3,121,977	32	404,698
Jacksonville, Fla.	114	214,515	256	99,439			370	313,954	29	1,078,536
Kalamazoo, Mich.	75	141,010	22	29,700	23	20,040	120	190,750	5	53,365
Kansas City, Kans.	234	341,508	222	79,062			456	420,570	27	247,600
Kansas City, Mo.	889	2,255,700	611	270,305	978	409,010	2,478	2,935,015	282	5,238,100
Knoxville, Tenn.	89	246,670	882	234,147			971	480,817	19	282,927
Lancaster, Pa.									55	231,760
Lawrence, Mass.	57	247,425	76	72,080			133	319,505	14	138,500
Lincoln, Nebr.	243	458,502	44	48,250			287	506,752	72	380,881
Little Rock, Ark.	251	559,343	d 150	d 90,134	(d)	(d)	401	649,477	7	372,000
Los Angeles, Cal.	3,577	6,909,455	1,670	737,016	58	6,705	5,305	7,653,176	200	3,248,616
Louisville, Ky.	155	316,550	452	83,370	260	94,010	867	523,930	56	619,200
Lowell, Mass.	248	351,265	315	182,146			563	533,411	10	235,075

Lynn, Mass	213	58,726	174	157,550			387	216,276	13	556,700
McKeesport, Pa	80	182,195	30	15,065	19	3,920	129	201,180	48	236,430
Macon, Ga	51	64,603			e 350	e 231,735	401	296,338	26	454,708
Malden, Mass	83	160,000	141	62,495	8	5,000	232	227,495	11	213,000
Manchester, N. H	318	352,666	405	211,889			723	564,555	6	290,600
Milwaukee, Wis	1,309	2,111,045	1,257	1,171,851	f 11,964	f 2,498,154	14,530	5,781,050	227	1,585,051
Minneapolis, Minn	2,388	3,555,215	1,772	858,120			4,160	4,413,335	182	2,364,540
Mobile, Ala	50	53,515	25	12,165			75	65,680	8	58,100
Montgomery, Ala	103	92,651	1,071	103,323			1,174	195,974	17	82,540
Nashville, Tenn	71	68,975	571	77,169	299	25,717	941	171,861	g 99	g 674,775
Newark, N. J	1,100	1,691,709					1,100	1,691,709	829	5,510,152
New Bedford, Mass	101	344,559	113	170,449	34	26,050	248	541,058	27	1,166,953
New Haven, Conn	529	904,894			356	217,703	885	1,122,597	h 189	h 4,093,570
New Orleans, La	588	1,278,210	i 188	i 217,498			776	1,495,708	47	1,318,343
New York, N. Y.:										
Borough of Brooklyn	946	3,034,850	1,005	717,255	5,263	2,012,394	7,214	5,764,499	1,657	24,239,140
Borough of The Bronx	81	253,950	160	174,475	(k)	(k)	241	428,425	475	6,920,025
Borough of Manhattan	11	29,100	43	48,300			54	77,400	183	4,599,425
Borough of Richmond	614	925,685	324	136,666			938	1,062,351	385	2,209,952
Norfolk, Va	157	345,617	56	38,456	34	33,603	247	417,676	51	282,625
Oakland, Cal	1,838	2,522,593	967	406,100			2,805	2,928,693	65	643,565
Oklahoma, Okla	667	2,047,898	164	181,886	94	36,715	925	2,266,499	10	48,500
Omaha, Nebr	441	1,284,125	150	10,550	191	12,350	782	1,307,025	58	738,425
Passaic, N. J	99	107,105	71	35,955			170	143,060	69	1,508,600
Paterson, N. J	223	485,383	466	109,080			689	594,463	94	673,569
Pawtucket, R. I	78	290,850	114	57,892	114	49,540	306	398,282	28	507,100
Philadelphia, Pa	152	208,385	35	19,905	18	4,270	205	232,560	3,837	16,065,505
Portland, Me	176	254,448	131	102,370			307	356,818	27	190,700
Portland, Oreg	1,475	1,704,260	1,245	400,355	33	90,825	2,753	2,195,440	67	693,950
Providence, R. I	631	1,002,100	1,876	808,800			2,507	1,810,900	74	809,300
Pueblo, Colo	79	79,410			184	39,325	263	118,735	51	625,244
Quincy, Ill	10	33,500	1	1,200			11	34,700	20	268,700
Reading, Pa			44	4,500			44	4,500	151	683,100
Richmond, Va	197	346,647	248	68,924	14	3,832	459	419,403	270	2,632,650
Rochester, N. Y	1,210	2,246,772	539	288,703	79	18,739	1,828	2,554,214	89	1,841,429
Sacramento, Cal	97	232,025	604	217,051			701	449,076	28	772,258
Saginaw, Mich	149	175,010	96	36,798			245	211,808	18	190,578
St. Joseph, Mo	121	136,250	117	47,598	101	51,717	339	235,565	51	544,739
St. Louis, Mo	58	105,825	658	94,401	2,135	301,485	2,851	501,711	774	7,703,441
St. Paul, Minn	838	1,796,650	332	187,645	233	266,589	1,403	2,250,884	1,391	5,015,822
Salem, Mass	69	189,665	232	22,700			301	212,365	11	117,700
Salt Lake City, Utah	135	92,940	28	15,450			163	108,390	406	1,456,850
San Antonio, Tex	777	1,229,077	470	132,057	343	39,115	1,590	1,400,249	116	349,985
San Diego, Cal	407	402,737	(l)	(l)			407	402,737	34	145,418
San Francisco, Cal	1,196	5,579,163	3,690	1,021,156			4,886	6,600,319	111	3,615,504
Savannah, Ga	121	271,000	71	32,800	121	21,460	313	325,260	12	134,000
Schenectady, N. Y	379	578,590	340	79,269			719	657,859	17	101,575
Scranton, Pa	62	134,107	122	83,226	117	90,045	301	307,378	20	479,365
Seattle, Wash	3,618	4,772,775	3,582	1,271,875	278	25,120	7,478	6,069,770		
Sioux City, Iowa	383	1,055,970	75	154,465			458	1,210,435	79	846,506
South Bend, Ind	603	729,281	227	64,168	(k)	(k)	830	793,449	29	547,102

For footnotes see p. 581.

Building statistics of the larger cities of the United States in 1917—Continued.

City.	Wooden buildings.								Fire-resisting buildings. Brick or hollow tile.	
	New.		Additions, alterations, and repairs.		Miscellaneous.		Total.		New.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Spokane, Wash	87	$284,760	326	$113,920	484	$38,460	897	$437,140	46	$282,830
Springfield, Ill	197	345,225	201	124,025			398	469,250	39	365,800
Springfield, Mass	488	1,108,040	287	131,124	10	12,075	785	1,251,239	237	1,606,702
Superior, Wis	389	285,699	498	645,092			887	930,791	15	286,800
Syracuse, N. Y	688	1,163,393	813	1,093,119			1,501	2,256,512	255	1,453,154
Tacoma, Wash	259	184,960	554	275,840	51	4,485	864	465,285	1	20,000
Tampa, Fla	165	220,185	659	112,886	55	14,190	879	347,261	20	273,250
Terre Haute, Ind	187	177,911	185	69,266	372	247,177	744	494,354	22	253,383
Toledo, Ohio	1,736	3,040,764	930	571,551	179	75,708	2,845	3,688,023	229	3,413,401
Topeka, Kans	152	162,968	69	31,150			221	194,118	13	63,535
Troy, N. Y	15	62,689	264	54,296			279	116,985	10	268,000
Utica, N. Y	278	676,225	72	78,745			350	754,970	41	364,750
Washington, D. C	187	638,450	274	52,924	362	67,088	823	758,462	892	10,330,486
West Hoboken, N. J	3	4,700	91	39,160			94	43,860	31	99,000
Wichita, Kans	568	1,268,954	122	43,975			690	1,312,929	86	1,563,550
Wilkes-Barre, Pa	142	82,468	191	87,482	165	22,974	498	192,924	46	317,649
Woonsocket, R. I	37	162,137	81	77,414			118	239,551	22	199,789
Worcester, Mass	(*m*)	(*m*)	(*m*)	(*m*)	(*m*)	(*m*)	*m* 800	*m* 1,926,010	*m* 173	*m* 1,871,996
Yonkers, N. Y	179	472,300	34	28,800			213	501,100	53	648,600
York, Pa	16	27,481	142	25,199	67	12,076	225	64,756	22	217,675
	69,881	131,915,630	67,538	25,961,725	28,690	8,487,593	*n* 166,909	*n* 168,290,958	28,219	271,683,008
Percentage of total		20.85		4.10		1.34		26.59		42.94

For footnotes see p. 581.

Building statistics of the larger cities of the United States in 1917—Continued.

City.	Fire-resisting buildings.											
	Brick or hollow tile.		Stone.				Concrete.				Steel skeleton.	
	Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.		New.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Akron, Ohio	149	$499,730										
Allentown, Pa	84	90,262			2	$600	16	$32,825	2	$550		
Altoona, Pa	24	43,598					1	52,000				
Atlanta, Ga	(a)	(a)					13	1,008,880	(a)	(a)		
Atlantic City, N. J	33	45,259	2	$775,600	5	90,961						
Augusta, Ga	171	154,361	1	12,300							3	$516,915
Baltimore, Md												
Bayonne, N. J	9	40,800					7	140,753	1	350	5	161,000
Berkeley, Cal	23	33,795					8	78,950	1	4,500	1	30,750
Binghamton, N. Y												
Birmingham, Ala	325	253,757	1	40,000								
Boston, Mass	1,316	3,202,475	6	40,000	76	491,634	108	5,289,434	38	358,761	4	298,500
Bridgeport, Conn	182	700,400					113	91,700	80	7,120		
Brockton, Mass	13	37,100										
Buffalo, N. Y	41	235,000					39	750,000			64	2,248,000
Butte, Mont	68	116,169					1	181,453				
Cambridge, Mass	67	73,327	1	28,000	1	350	38	1,165,608	7	68,900		
Camden, N. J	105	325,975					9	156,750			6	422,000
Canton, Ohio	8	19,850	4	86,000								
Charleston, S. C	66	83,838										
Chattanooga, Tenn	628	74,200										
Chester, Pa	63	119,400	3	12,000	1	100,000	3	396,000			12	1,883,500
Chicago, Ill												
Cleveland, Ohio	432	1,207,750					127	5,988,375			61	4,571,600
Columbus, Ohio	283	428,305	1	900	2	10,075	25	165,925	7	12,300		
Covington, Ky	33	28,450										
Dayton, Ohio	38	112,150			1	3,070	7	17,450				
Denver, Colo	1,083	685,670					(b)	(b)				
Des Moines, Iowa	15	61,100					6	550,000				
Detroit, Mich	480	1,579,955			31	712,100	168	7,733,860	15	6,725	72	1,714,315
Dubuque, Iowa	7	105,500			1	60,000	9	62,400				

For footnotes see p. 581.

Building statistics of the larger cities of the United States in 1917—Continued.

City.	Fire-resisting buildings.											
	Brick or hollow tile.		Stone.				Concrete.				Steel skeleton.	
	Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.		New.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Duluth, Minn.	102	$205,342										
East St. Louis, Ill.	2	8,000										
Elizabeth, N. J.	13	141,345					13	$24,120	2	$890		
Elmira, N. Y.							18	48,300				
El Paso, Tex.	728	910,207					11	1,220,800				
Evansville, Ind.	78	84,109										
Fall River, Mass.	12	29,440	3	$4,900			13	28,800				
Fitchburg, Mass.	14	36,170	2	900			27	95,770	3	1,200		
Flint, Mich.	39	112,885	2	6,000			19	45,975	4	71,000		
Fort Wayne, Ind.	41	213,650					3	95,300	2	1,050		
Fort Worth, Tex.	110	170,053					10	603,740	8	12,440		
Galveston, Tex.	210	48,303					1	250	5	1,778		
Grand Rapids, Mich.	65	140,636					183	94,252				
Harrisburg, Pa.	74	183,925	8	43,000								
Hartford, Conn.	173	827,828					7	447,100				
Hoboken, N. J.	74	74,692					2	70,800				
Holyoke, Mass.	28	56,480					1	105,000				
Houston, Tex.	313	117,209	1	68,121			6	374,500	27	17,884		
Indianapolis, Ind.	451	96,241					70	1,938,086				
Jacksonville, Fla.	125	328,489										
Kalamazoo, Mich.	19	129,500										
Kansas City, Kans.							11	977,500				
Kansas City, Mo.	290	523,510									7	$1,420,000
Knoxville, Tenn.	99	94,015					2	414,000				
Lancaster, Pa.	129	84,276										
Lawrence, Mass.	30	76,400					43	35,500	7	22,500		
Lincoln, Nebr.	32	67,535	1	700			1	400,000				
Little Rock, Ark.							1	14,000			1	175,000
Los Angeles, Cal.							17	3,756,950	1,163	1,642,710	2	473,450
Louisville, Ky.	256	311,760					1	9,000				
Lowell, Mass.	69	230,603					35	118,737	1	1,500		

Lynn, Mass	27	369,440					8	5,650	2	15,500	11	232,525
McKeesport, Pa	14	59,365							4	1,175		
Macon, Ga												
Malden, Mass	16	52,025					20	8,000	10	4,000		
Manchester, N. H	34	241,790					3	167,000				
Milwaukee, Wis	1	30,000					225	3,874,191				
Minneapolis, Minn	365	581,195	1	300	16	$17,060	44	61,305	32	45,855	27	133,095
Mobile, Ala	8	8,000										
Montgomery, Ala	183	53,632			1	200	1	3,000	1	50		
Nashville, Tenn	g 575	g 190,040										
Newark, N. J							205	978,981			13	1,130,243
New Bedford, Mass	10	672,700					97	173,450	2	500,000		
New Haven, Conn												
New Orleans, La												
New York, N. Y.:												
Borough of Brooklyn	1,367	3,195,455										
Borough of The Bronx	322	1,046,100									78	1,368,400
Borough of Manhattan	2,787	8,866,530									127	24,440,000
Borough of Richmond	116	161,203									1	300,000
Norfolk, Va	84	177,690					10	303,100	3	18,000		
Oakland, Cal	12	39,255					50	715,007	3	38,000		
Oklahoma, Okla							22	716,138	6	58,600		
Omaha, Nebr	79	235,015					64	5,388,532				
Passaic, N. J	30	81,400										
Paterson, N. J	102	188,414	1	27,000			75	62,379	8	13,658		
Pawtucket, R. I												
Philadelphia, Pa	3,420	5,646,120	10	60,200	12	28,075	27	3,566,460	10	1,221,500	15	5,639,900
Portland, Me	51	210,025							1	12,000		
Portland, Oreg	461	284,755					4	143,000	90	111,265		
Providence, R. I	161	798,400	2	34,000	3	7,000	109	191,000	13	10,600		
Pueblo, Colo												
Quincy, Ill	7	112,300	1	40,000			2	182,000				
Reading, Pa	297	235,575	17	112,600	13	5,625	26	39,500	24	7,450		
Richmond, Va	493	683,702					2	100,000			1	129,000
Rochester, N. Y	192	978,639					93	972,085	46	45,986	4	344,500
Sacramento, Cal	204	313,153					3	228,416	1	67,400	1	65,000
Saginaw, Mich	23	22,110										
St. Joseph, Mo	52	48,325										
St. Louis, Mo	1,900	2,295,967									19	
St. Paul, Minn												1,524,400
Salem, Mass	4	81,280					16	29,527				
Salt Lake City, Utah	222	250,415					10	372,270			2	600,000
San Antonio, Tex	1	21,465			83	52,525	20	317,500	1	1,200		
San Diego, Cal									l 762	l 327,334		
San Francisco, Cal	184	530,000	12	1,232,000	22	249,068	100	3,157,486	198	250,942		
Savannah, Ga	40	256,400										
Schenectady, N. Y	40	47,510	12	4,705	1	1,234	54	76,624	3	3,261	11	976,400
Scranton, Pa	69	491,928					1	60,000				
Seattle, Wash							51	461,860	128	166,170		
Sioux City, Iowa	28	104,865					15	900,400			2	266,000

For footnotes see p. 581.

Building statistics of the larger cities of the United States in 1917—Continued.

City.	Fire-resisting buildings.									
	Brick or hollow tile.		Stone.				Concrete.				Steel skeleton.	
	Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.		New.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
South Bend, Ind.	52	$201,070					26	$125,415	5	$134,020		
Spokane, Wash.	118	410,790					4	1,000,000				
Springfield, Ill.	71	107,050										
Springfield, Mass.	164	814,031										
Superior, Wis.	35	69,887										
Syracuse, N. Y.							9	427,500			2	$181,839
Tacoma, Wash.	5	66,500					7	162,126				
Tampa, Fla.	115	57,189					4	123,600				
Terre Haute, Ind.	45	62,085					27	15,805				
Toledo, Ohio.	82	163,122										
Topeka, Kans.	28	53,865	10	$4,465	2	$3,200	4	265,000	1	4,800		
Troy, N. Y.	110	112,643					1	180,000				
Utica, N. Y.	42	147,020			1	10,000	13	14,930				
Washington, D. C.	1,014	1,290,008					10	74,280				
West Hoboken, N. J.	42	20,900										
Wichita, Kans.	22	27,700					9	760,500				
Wilkes-Barre, Pa.	93	123,233					2	875	8	711		
Woonsocket, R. I.	10	87,060					11	12,230	1	1,500		
Worcester, Mass.	m 732	m 1,040,834										
Yonkers, N. Y.	26	167,700	16	34,700	5	28,000	8	20,200				
York, Pa.	185	119,020	1	50,000								
	26,294	50,464,669	119	2,718,391	279	1,870,777	2,685	61,218,165	2,736	5,293,135	552	51,246,332
Percentage of total		7.98		.43		.30		9.67		.84		8.10

For footnotes see p. 581.

Building statistics of the larger cities of the United States in 1917—Continued.

City.	Fire-resisting buildings.						Grand total. (See also p. 581.)		Rank in cost of building operations.
	Steel skeleton. Additions, alterations, and repairs.		Miscellaneous.		Total.				
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	
Akron, Ohio					592	$6,848,977	5,039	$14,166,818	9
Allentown, Pa					384	1,330,887	494	1,367,907	87
Altoona, Pa					39	123,155	396	320,464	141
Atlanta, Ga					103	2,547,280	2,274	4,967,676	29
Atlantic City, N. J					119	1,943,321	597	2,437,876	62
Augusta, Ga			2	$117,500	209	904,752	2,372	1,240,621	97
Baltimore, Md					1,363	6,060,843	1,424	6,299,643	27
Bayonne, N. J	1	$8,000	18	39,025	57	482,878	217	876,439	108
Berkeley, Cal	1	250			50	322,845	945	1,243,850	95
Binghamton, N. Y					108	645,113	2,631	1,657,742	80
Birmingham, Ala	2	53,750			370	694,930	4,306	1,818,736	72
Boston, Mass	12	19,700	126	187,088	2,044	20,602,501	4,679	23,294,161	6
Bridgeport, Conn					525	2,942,220	1,491	4,497,983	33
Brockton, Mass					21	279,300	469	805,009	113
Buffalo, N. Y					304	5,515,000	4,068	10,501,000	14
Butte, Mont			89	9,941	216	842,128	887	1,604,998	82
Cambridge, Mass	2	260	15	9,191	166	2,650,586	561	3,146,367	50
Camden, N. J					456	1,995,888	794	2,305,483	63
Canton, Ohio			153	149,660	274	1,161,210	970	2,647,280	56
Charleston, S. C					97	285,657	313	481,930	131
Chattanooga, Tenn					701	474,060	1,877	754,860	116
Chester, Pa			52	126,160	625	3,662,610	693	3,678,735	43
Chicago, Ill					3,803	46,890,990	4,838	49,167,990	2
Cleveland, Ohio			165	671,975	1,336	20,221,725	11,952	30,483,750	5
Columbus, Ohio	1	200	62	25,965	640	2,272,885	2,117	3,915,030	39
Covington, Ky			20	2,750	110	147,930	226	245,950	142
Dayton, Ohio			2	14,100	161	1,409,560	1,694	3,506,000	47
Denver, Colo					2,353	4,248,000	2,357	4,252,000	36
Des Moines, Iowa			3	4,000	91	1,269,160	982	2,640,469	58
Detroit, Mich	33	1,370,080			1,555	22,699,815	12,109	39,666,800	3

For footnotes see p. 581.

Building statistics of the larger cities of the United States in 1917—Continued.

City.	Fire-resisting buildings.						Grand total. (See also p. 581.)		Rank in cost of building operations.
	Steel skeleton. Additions, alterations, and repairs.		Miscellaneous.		Total.				
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	
Dubuque, Iowa					29	$495,000	139	$603,170	123
Duluth, Minn			1	$2,000,000	154	3,296,150	1,460	4,508,665	32
East St. Louis, Ill					152	1,032,060	371	1,199,162	99
Elizabeth, N. J			6	52,360	61	894,187	342	1,453,642	84
Elmira, N. Y					37	307,600	296	840,500	110
El Paso, Tex					1,194	3,693,007	1,474	3,749,407	42
Evansville, Ind					127	651,024	951	1,042,731	101
Fall River, Mass			3	6,415	61	662,818	440	1,132,878	100
Fitchburg, Mass			7	80,275	60	333,700	222	467,230	132
Flint, Mich					136	1,354,520	1,453	2,454,805	61
Fort Wayne, Ind			1	500,000	75	2,183,325	569	3,329,091	48
Fort Worth, Tex			26	10,384	201	1,505,118	527	1,789,612	75
Galveston, Tex			8	1,588	235	121,419	1,837	218,664	143
Grand Rapids, Mich					308	1,089,398	1,351	1,817,165	73
Harrisburg, Pa	5	$1,335			310	1,918,375	437	2,006,515	68
Hartford, Conn					315	6,458,453	1,082	7,671,616	20
Hoboken, N. J					96	261,397	196	337,219	139
Holyoke, Mass					88	708,705	166	853,610	109
Houston, Tex	4	12,625	2	3,100	401	1,312,865	2,423	2,644,468	57
Indianapolis, Ind			c 1,776	c 1,542,100	2,329	3,981,125	5,086	7,103,102	23
Jacksonville, Fla			35	193,192	189	1,600,217	559	1,914,171	69
Kalamazoo, Mich	2	55,300			26	238,165	146	428,915	135
Kansas City, Kans					38	1,225,100	494	1,645,670	81
Kansas City, Mo			202	11,825	781	7,193,435	3,259	10,128,450	15
Knoxville, Tenn					120	790,942	1,091	1,271,759	92
Lancaster, Pa			41	49,580	225	365,616	225	365,616	138
Lawrence, Mass					94	272,900	227	592,405	124
Lincoln, Nebr					106	849,116	393	1,355,868	88
Little Rock, Ark					9	561,000	410	1,210,477	98
Los Angeles, Cal			12	157,180	1,394	9,278,906	6,699	16,932,082	7
Louisville, Ky			87	294,170	400	1,234,130	1,267	1,758,060	76
Lowell, Mass			8	122,025	123	707,940	686	1,241,351	96

Lynn, Mass	1	100			62	1,179,915	449	1,396,191	88
McKeesport, Pa	1	75			67	297,045	196	498,225	126
Macon, Ga			(e)	(e)	26	454,708	427	751,046	119
Malden, Mass	2	800	7	16,000	66	293,825	298	521,320	128
Manchester, N. H					43	699,390	766	1,263,945	93
Milwaukee, Wis			(f)	(f)	453	5,489,242	14,983	11,270,292	13
Minneapolis, Minn	23	48,140	142	1,593,540	832	4,845,030	4,992	9,258,365	17
Mobile, Ala					16	66,100	91	131,780	145
Montgomery, Ala	1	100			204	139,522	1,378	335,496	140
Nashville, Tenn					674	864,815	1,615	1,036,676	102
Newark, N. J			341	84,835	1,388	7,704,211	2,488	9,395,920	16
New Bedford, Mass					136	2,513,103	384	3,054,161	52
New Haven, Conn			156	426,702	345	4,520,272	1,230	5,642,869	28
New Orleans, La					47	1,318,343	823	2,814,051	54
New York, N. Y.:									
Borough of Brooklyn			2,017	390,977	5,041	27,825,572	12,255	33,590,071	
Borough of The Bronx			k1,921	k363,410	2,796	9,397,935	3,037	10,126,360	1
Borough of Manhattan	605	4,754,814			3,702	42,660,769	3,756	42,738,169	
Borough of Richmond			203	33,251	705	2,704,406	1,643	3,766,757	
Norfolk, Va			131	466,089	279	1,247,504	526	1,665,180	79
Oakland, Cal			3	78,000	133	1,513,827	2,938	4,442,520	34
Oklahoma, Okla					38	823,238	963	3,089,737	51
Omaha, Nebr			56	68,050	257	6,430,022	1,039	7,737,047	19
Passaic, N. J					99	1,590,000	269	1,733,060	78
Paterson, N. J	2	8,000	48	32,355	330	1,005,375	1,019	1,599,838	83
Pawtucket, R. I					28	507,100	334	905,382	106
Philadelphia, Pa	19	589,900			7,350	32,817,660	7,555	33,050,220	4
Portland, Me					79	412,725	386	769,543	115
Portland, Oreg	2	215,000			624	1,447,970	3,377	3,643,410	45
Providence, R. I	2	1,300	10	155,300	374	2,006,900	2,881	3,817,800	40
Pueblo, Colo			131	288,500	182	913,744	445	1,032,479	103
Quincy, Ill					30	603,000	41	637,700	122
Reading, Pa	69	44,300	830	143,380	1,427	1,271,530	1,471	1,276,030	91
Richmond, Va			333	153,933	1,099	3,699,285	1,558	4,118,688	38
Rochester, N. Y			16	2,767	440	4,185,406	2,268	6,739,620	24
Sacramento, Cal					237	1,446,227	938	1,895,303	70
Saginaw, Mich					41	212,688	286	424,496	136
St. Joseph, Mo					103	593,064	442	828,629	111
St. Louis, Mo			1,947	513,013	4,640	12,036,821	7,491	12,538,532	10
St. Paul, Minn					1,391	5,015,822	2,794	7,266,706	21
Salem, Mass					31	228,507	332	440,872	134
Salt Lake City, Utah					640	2,679,535	803	2,787,925	55
San Antonio, Tex			11	42,889	232	785,564	1,822	2,185,813	64
San Diego, Cal			110	30,608	906	503,360	1,313	906,097	105
San Francisco, Cal					627	9,035,000	5,513	15,635,319	8
Savannah, Ga			1	2,500	53	392,900	366	718,160	119
Schenectady, N. Y					138	1,211,309	857	1,869,168	71
Scranton, Pa					90	1,031,293	391	1,338,671	89
Seattle, Wash			79	16,515	258	644,545	7,736	6,714,315	25
Sioux City, Iowa					124	2,117,771	582	3,328,206	49

For footnotes see p. 581.

Building statistics of the larger cities of the United States in 1917—Continued.

City.	Fire-resisting buildings.						Grand total. (See also p. 581.)		Rank in cost of building operations.
	Steel skeleton. Additions, alterations, and repairs.		Miscellaneous.		Total.				
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	
South Bend, Ind.			k 390	k $227,924	502	$1,235,531	1,332	$2,028,980	67
Spokane, Wash.	1	$10,000			169	1,703,620	1,066	2,140,760	66
Springfield, Ill.					110	472,850	508	942,100	104
Springfield, Mass.			13	107,640	414	2,528,373	1,199	3,779,612	41
Superior, Wis.			7	875,575	57	1,232,262	944	2,163,053	65
Syracuse, N. Y.					266	2,062,493	1,767	4,319,005	35
Tacoma, Wash.			2	38,000	15	286,626	879	751,911	117
Tampa, Fla.					139	454,039	1,018	801,300	114
Terre Haute, Ind.					94	331,273	838	825,627	112
Toledo, Ohio					311	3,576,523	3,156	7,264,546	22
Topeka, Kans.					58	394,865	279	588,983	125
Troy, N. Y.					121	560,643	400	677,628	121
Utica, N. Y.			2	11,500	99	548,200	449	1,303,170	90
Washington, D. C.			402	54,075	2,318	11,748,849	3,141	12,507,311	11
West Hoboken, N. J.					73	119,900	167	163,760	144
Wichita, Kans.			19	10,180	136	2,361,930	826	3,674,859	44
Wilkes-Barre, Pa.			52	69,286	201	511,754	699	704,678	120
Woonsocket, R. I.					44	300,579	162	540,130	127
Worcester, Mass.					905	2,912,830	1,705	4,838,840	30
Yonkers, N. Y.			34	5,100	142	904,300	355	1,405,400	85
York, Pa.			16	32,045	224	418,740	449	483,496	130
	791	7,194,029	12,352	12,715,488	74,027	464,403,994	240,936	632,694,952	
Percentage of total.		1.14		2.01		73.41		100.00	

For footnotes see p. 581.

Building statistics of the larger cities of the United States in 1917—Continued.

City.	Grand total.		Rank in cost of building operations.
	Number of permits or buildings.	Cost.	
Bay City, Mich.	473	$561,942	126
Cincinnati, Ohio	4,262	9,151,925	18
Dallas, Tex.	814	3,577,849	46
Haverhill, Mass.	231	466,777	133
Jersey City, N. J	364	2,628,283	59
Memphis, Tenn.	1,694	2,626,855	60
New Britain, Conn.	489	1,254,479	94
Newton, Mass.	654	1,756,586	77
Peoria, Ill.	718	4,183,574	37
Pittsburgh, Pa.	3,587	11,318,502	12
Somerville, Mass.	348	883,412	107
Trenton, N. J.	592	1,801,549	74
Waterbury, Conn.	1,394	6,562,930	26
Wheeling, W. Va.	605	416,880	137
Wilmington, Del.	866	2,986,715	53
Youngstown, Ohio	1,641	4,542,395	31
Grand total	259,668	687,415,605	....

[a] New brick or hollow tile buildings for Atlanta include additions, etc., to brick and to concrete buildings.
[b] New brick or hollow tile buildings for Denver include new concrete buildings.
[c] With miscellaneous operations for fire-resisting buildings for Indianapolis are included miscellaneous operations for wooden buildings.
[d] Additions, etc., for wooden buildings for Little Rock include miscellaneous operations for wooden buildings.
[e] Miscellaneous operations for wooden buildings for Macon include miscellaneous operations for fire-resisting buildings and additions and repairs to all buildings.
[f] Miscellaneous operations for wooden buildings for Milwaukee include miscellaneous operations for fire-resisting buildings.
[g] New brick or hollow tile buildings and additions to the same for Nashville include all operations on fire-resisting buildings.
[h] New brick or hollow tile buildings for New Haven include all classes of new fire-resisting buildings.
[i] Additions, etc., to wooden buildings for New Orleans include additions, etc., to fire-resisting buildings.
[k] Miscellaneous operations for fire-resisting buildings for the Borough of the Bronx, New York City, and for South Bend, Ind., include miscellaneous operations for wooden buildings.
[l] Additions, etc., to concrete buildings for San Diego include additions, etc., to wooden buildings.
[m] Operations for wooden buildings for Worcester are undistributed and new brick and hollow tile buildings and additions to the same include all operations on fire-resisting buildings.
[n] Includes 800 undistributed permits for wooden buildings costing $1,926,010 for Worcester, or 0.3 of the total.

The 145 cities included in this table reported building operations costing $687,415,605 in 1917. Practically these same cities reported building operations costing $1,024,211,675 in 1916. Of this number 129 cities reported sufficient detail to permit the publication of statistics of operations by classes of structures. These 129 cities reported 240,936 permits or buildings that cost $632,694,952. Of this amount, new operations of every kind, represented by 101,456 permits or buildings, cost $518,781,526, or 82 per cent of the total; additions, alterations, and repairs, represented by 97,638 permits or buildings, cost $90,784,335, or 14 per cent; and miscellaneous operations cost $21,203,081, or more than 3 per cent of the total. In addition, unclassified operations on wooden buildings costing $1,926,010, or 0.3 per cent of the total cost of all building operations, were reported by Worcester, Mass.

The statistics of building operations by kinds, especially the totals, are only approximate, for many cities were unable to report strictly in accordance with the classification given in the table, but it is believed that the figures published are accurate enough to give a good idea of the relative importance of the various kinds of operations enumerated.

The rank of the several cities in the different classes of building operations is relative, not actual, as the expenditures in some cities that reported no details may have exceeded those in some cities that reported the cost of buildings by classes.

Taken by classes, the new wooden buildings in these 129 cities in 1917 cost $131,915,630, or 21 per cent of the total; new brick or hollow tile buildings cost $271,683,008, or 43 per cent of the total; new stone buildings $2,718,391, or 0.43 per cent; new concrete buildings $61,218,165, or 10 per cent; and new steel skeleton buildings $51,246,332, or 8 per cent of the total cost of all building operations. Of the new buildings those constructed of wood cost 25 per cent of the total for new buildings; new fire-resisting buildings cost $386,-865,896, or 75 per cent of the total, of which those of brick or hollow building tile cost 52 per cent; those of stone, 0.52 per cent; those of concrete, 12 per cent; and those of steel skeleton, 10 per cent.

Of the cost of all additions, alterations, and repairs, $25,961,725, or 29 per cent, was for wooden buildings. Alterations and repairs to fire-resisting buildings cost $64,822,610, or 71 per cent. Of this cost, additions, etc., to brick buildings cost $50,464,669, or 56 per cent; additions to stone buildings cost $1,870,777, or 2 per cent; to concrete buildings, $5,293,135, or 6 per cent; and to steel skeleton buildings, $7,194,029, or 8 per cent.

The cost in these cities of all operations on wooden buildings was $168,290,958, or 27 per cent of the total cost of all building operations; brick or hollow-tile buildings, new, and with additions, alterations, and repairs, cost $322,147,677, or 51 per cent; stone buildings, $4,589,168, or less than 1 per cent; concrete buildings, $66,511,300, or 11 per cent; and steel skeleton buildings, $58,440,361, or 9 per cent.

LIME.

By G. F. Loughlin.[1]

INTRODUCTION.

A preliminary estimate of the total quantity of all lime and also of hydrated lime sold in 1917 was published February 4, 1918. This estimate was based on returns made by the principal producers and was tabulated by States that marketed more than 50,000 tons. The estimates for some of the States were considerably at variance with the final figures, some being too high and some too low, but the estimated total was only 122,651 tons, or 3.2 per cent, lower than the final total. The estimated total for hydrated lime as published in February was 10,600 tons, or 1.5 per cent, too high.

Producers of lime were fairly prompt in making their annual returns to the Geological Survey, but the publication of this report has been delayed by the additional work required by the war, both of the mineral-resources division of the Survey and of the Government Printing Office.

Lime burned and sold in the United States in 1908–1917.

	Quantity (short tons).	Value.[a]	Average price per ton.	Number of plants in operation.
1908	2,766,873	$11,091,186	$4.01	949
1909	3,484,974	13,846,072	3.98	1,232
1910	3,505,954	14,088,039	4.02	1,125
1911	3,392,915	13,689,054	4.03	1,139
1912	3,529,462	13,970,114	3.96	1,017
1913	3,595,390	14,648,362	4.07	1,023
1914	3,380,928	13,268,938	3.92	954
1915	3,622,810	14,424,036	3.98	906
1916	4,073,433	18,509,305	4.54	778
1917	3,786,364	23,807,877	6.29	595
Percentage of increase or decrease in 1917	−7.4	+28.6		

[a] The value given represents the value of bulk lime f. o. b. at point of shipment and does not include weight or cost of barrel or package.

LIME SOLD IN 1917.

The total quantity of lime sold in 1917 was 3,786,364 short tons, valued at $23,807,877—a decrease from the sales of 1916 of 287,069 tons, or 7 per cent, in quantity, but an increase of $5,298,572, or 28.6 per cent, in value. This was the first year, as shown in the accom-

[1] The statistical tables of this report were prepared by Miss A. T. Coons, with the exception of those on imports and exports, which were compiled by J. A. Dorsey, both of the United States Geological Survey.

panying table, in which the lime marketed in the United States equaled or exceeded $20,000,000 in value.

Lime in 1917, as in 1916, was burned and sold in 40 States and 2 Territories. Sales increased in 11 States and in Porto Rico. These States were Arizona, California, Colorado, Florida, Idaho, Illinois, Michigan, Missouri, New Mexico, Oregon, and Vermont. The greatest percentage of increase in quantity (64 per cent) was in Idaho, but the actual increase was only from 4,400 to 7,200 tons. Michigan, with a gain of 57 per cent, increased its sales from 86,000 to nearly 136,000 tons, and California increased its sales 38 per cent with one less plant operating than in 1916. In Missouri only 21 plants instead of 32 were active, but the output reported increased 18 per cent. The decrease in the other States was due to high cost of supplies, scarcity of labor, shortage of railway cars, lack of fuel, and decrease in demand for building and agricultural lime.

The causes that brought about a decreased production also made the number of plants operating in 1917 smaller than in any other year since the United States Geological Survey began recording the progress of the industry. There was a decrease of 183 active plants, following a decrease of 128 plants in 1916. The total number of plants reported in operation in 1917 was 595, or about one-half the usual number before the war, a strong indication of the continued tendency of the lime industry to pass into the hands of companies that have the capital and equipment to meet the present-day requirements of the many industries in which lime is used.

The marked increase in the total value of lime sold was due to increased price made necessary by increase in cost of labor and of all supplies, including fuel, cooperage, explosives, and feed. It is reported, however, that the increase in cost of production was greater than the increase in price. The average price per ton, which remained within a few cents of $4 for a number of years until 1916, when it rose to $4.54, a record figure, advanced to $6.29 in 1917. This was an increase of nearly 39 per cent over the price in 1916 and 57 per cent over the normal average price of $4.

Only in the small producing States of New Mexico and Nevada did the average price per ton decrease in 1917—59 cents in New Mexico and 11 cents in Nevada. In the other States and Territories the increase in average price ranged from 3 cents in Florida and 13 cents in Kentucky and New Jersey to $3.32 in Rhode Island and $9.31 in Wyoming. The increase in average price for Florida lime would have been greater but for the fact that one new plant sold its whole output at a very low price for agricultural use. The lime made in Kentucky and New Jersey is made in small lots by a few farmers who sell to their neighbors for use on the land. Demand for this lime was reported poor in some places and good in others, the average price remaining practically the same as in 1916; but the average price of lime shipped into these two States was much higher. The very large advance in price recorded for Rhode Island and Wyoming, as shown in the table, was paid for the comparatively small output of single producers and was evidently possible because of high transportation costs from other lime-producing districts. Of the 39 States and Territories in which there was an increase in average price, 14 States, or 36 per cent, gained from $1.30 to $1.60 and 4 States gained from 70 to 80 cents. The States which made a common advance in price are not contiguous, however; for instance, the advance of 70 to 80 cents a ton in average price was in Connecticut, Hawaii, South Dakota, and Utah.

The four leading States in quantity of lime sold were the same in 1917 as in 1916 and 1915—Pennsylvania, Ohio, Virginia, and West Virginia. The fifth, sixth, and seventh in rank have been Wisconsin, Missouri, and Maine, but in 1917 they were Missouri, Wisconsin, and Michigan. Missouri and Wisconsin changed places, Maine dropped from seventh to tenth place, and Michigan rose from thirteenth to seventh place. Six States exceeded $1,000,000 in value of sales in 1917, compared with five in 1916. Pennsylvania's output, which exceeded $3,000,000 in value for the first time in 1916, was valued at nearly $6,000,000 in 1917; Ohio's output advanced still nearer (by about $273,000) to the $3,000,000 mark; and Virginia's exceeded $1,800,000, increasing more than $500,000 in 1917.

Lime burned and sold in the United States in 1916.

State or Territory.	Rank of State by quantity.	Quantity (short tons).	Percentage of total quantity.	Value.	Rank of State by value.	Average price per ton.	Number of plants in operation.
Alabama	16	67,524	1.66	$312,531	17	$4.63	9
Arizona	23	15,173	.37	94,540	23	6.23	3
Arkansas	22	19,199	.47	102,683	22	5.35	4
California	17	56,820	1.40	393,930	13	6.93	15
Colorado	31	5,479	.13	36,473	31	6.66	6
Connecticut	14	85,063	2.09	589,257	10	6.93	7
Florida	26	8,666	.21	49,536	25	5.71	4
Hawaii	36	(a)	(a)	(a)	30	13.15	1
Idaho	33	4,389	.11	31,786	34	7.24	3
Illinois	15	80,012	1.96	369,038	16	4.61	12
Indiana	10	121,306	2.98	495,283	12	4.08	8
Iowa	25	(a)	(a)	(a)	26	5.00	2
Kansas	41	(a)	(a)	(a)	41	3.98	2
Kentucky	40	1,236	.03	6,304	40	5.10	9
Maine	7	162,100	3.98	956,371	6	5.90	4
Maryland	8	157,673	3.87	574,998	11	3.65	36
Massachusetts	9	145,020	3.56	811,402	8	5.60	10
Michigan	13	86,447	2.12	385,341	14	4.46	7
Minnesota	21	20,150	.50	103,000	21	5.11	5
Missouri	6	199,260	4.89	956,300	7	4.80	32
Montana	29	(a)	(a)	(a)	28	6.29	2
Nevada	31	(a)	(a)	(a)	33	6.52	1
New Jersey	27	7,110	.17	26,084	36	3.67	12
New Mexico	39	1,582	.04	11,670	39	7.38	4
New York	11	117,490	2.88	636,668	9	5.42	22
North Carolina	28	(a)	(a)	(a)	29	5.50	1
Ohio	2	570,972	14.02	2,702,953	2	4.73	34
Oklahoma	37	(a)	(a)	(a)	38	6.35	2
Oregon	34	4,225	.10	35,289	32	8.35	5
Pennsylvania	1	972,343	23.87	3,857,553	1	3.97	335
Porto Rico	35	3,640	.09	26,436	35	7.26	26
Rhode Island	38	(a)	(a)	(a)	37	7.70	1
South Dakota	30	5,772	.14	44,033	27	7.63	4
Tennessee	12	109,533	2.69	378,017	15	3.45	17
Texas	18	54,049	1.33	307,759	18	5.69	10
Utah	24	12,472	.31	77,133	24	6.18	13
Vermont	19	43,365	1.07	236,133	19	5.45	9
Virginia	3	326,812	8.02	1,279,658	3	3.88	33
Washington	20	26,895	.66	166,653	20	6.19	8
West Virginia	4	277,721	6.82	1,008,021	5	3.63	25
Wisconsin	5	266,805	6.55	1,207,059	4	4.52	34
Wyoming	42	(a)	(a)	(a)	42	12.62	1
Undistributed	....	37,130	.91	239,413	....	....	....
	....	4,073,433	100.00	18,509,305	....	4.54	778

a Included in "Undistributed."

Lime burned and sold in the United States in 1917.

State or Territory.	Number of plants in operation.	Quantity (short tons).	Percentage of total quantity.	Rank of State by quantity.	Value.	Percentage of total value.	Rank of State by value.	Average price per ton.	Increase or decrease in 1917. Quantity (short tons).	Increase or decrease in 1917. Percentage of quantity.	Increase or decrease in 1917. Value.	Increase or decrease in 1917. Percentage of value.	Increase or decrease in 1917. Average price per ton.
Alabama	10	66,744	1.76	16	$383,211	1.61	17	$5.74	− 780	− 1.2	+ $70,680	+ 22.6	+$1.11
Arizona	3	15,856	.42	23	119,995	.50	21	7.57	+ 683	+ 4.4	+ 25,455	+ 26.9	+ 1.34
Arkansas	4	17,350	.46	22	117,593	.49	23	6.78	− 1,849	− 9.6	+ 14,910	+ 14.5	+ 1.43
California	14	78,401	2.07	15	597,528	2.51	13	7.62	+ 21,581	+37.9	+ 203,598	+ 51.6	+ .69
Colorado	4	6,212	.16	30	54,676	.23	28	8.80	+ 733	+13.3	+ 10,203	+ 49.9	+ 2.14
Connecticut	5	64,389	1.70	17	492,678	2.07	16	7.65	− 20,674	−24.3	− 96,579	− 16.3	+ .72
Florida	4	9,914	.26	24	56,903	.24	27	5.74	+ 1,248	+14.4	+ 7,367	+ 14.8	+ .03
Hawaii	1	(a)	(a)	37	(a)	(a)	33	13.94	(a)	(a)	(a)	(a)	+ .79
Idaho	3	7,228	.19	27	62,331	.26	25	8.63	+ 2,839	+64.6	+ 30,545	+ 96.1	+ 1.39
Illinois	11	83,409	2.20	14	501,320	2.11	15	6.00	+ 3,397	+ 4.3	+ 132,282	+ 35.8	+ 1.39
Indiana	6	118,530	3.13	11	646,555	2.72	12	5.45	− 2,776	− 2.3	+ 151,272	+ 30.5	+ 1.37
Iowa	2	(a)	(a)	25	(a)	(a)	26	6.45	(a)	(a)	(a)	(a)	+ 1.45
Kentucky	4	723	.02	40	3,783	(a)	40	5.23	− 513	−41.5	− 2,521	− 39.9	+ .13
Maine	4	124,199	3.28	10	950,811	3.99	7	7.67	− 37,901	−23.3	− 5,560	− .6	+ 1.77
Maryland	24	133,087	3.52	9	694,576	2.92	11	5.22	− 24,586	−15.5	+ 119,578	+ 20.7	+ 1.57
Massachusetts	10	134,937	3.56	8	916,569	3.85	8	6.79	− 10,083	− 7.0	+ 105,167	+ 12.9	+ 1.19
Michigan	7	135,920	3.59	7	892,682	3.75	16	6.57	+ 49,473	+57.2	+ 507,341	+131.6	+ 2.11
Minnesota	5	18,072	.48	21	119,704	.50	22	6.62	− 2,078	−10.3	+ 16,704	+ 16.2	+ 1.51
Missouri	21	234,936	6.21	5	1,435,914	6.03	4	6.11	+ 35,676	+17.9	+ 479,614	+ 50.1	+ 1.31
Montana	3	5,281	.14	31	35,512	.15	34	6.72	(a)	(a)	(a)	(a)	+ .43
Nevada	1	(a)	(a)	29	(a)	(a)	30	6.41	(a)	(a)	(a)	(a)	− .11
New Jersey	7	5,002	.13	32	18,978	.08	38	3.80	− 2,108	−29.6	− 7,056	− 27.1	+ .13
New Mexico	3	1,829	.05	39	12,327	.05	39	6.79	+ 247	+22.1	+ 657	+ 5.6	− .59
New York	20	108,788	2.87	12	892,855	3.75	9	8.20	− 8,702	− 7.4	+ 256,187	+ 40.2	+ 2.78
North Carolina	2	(a)	(a)	28	(a)	(a)	29	7.41	(a)	(a)	(a)	(a)	+ 1.91
Ohio	31	479,856	12.67	2	2,975,466	12.50	2	6.20	− 91,116	−15.9	+ 272,507	+ 10.0	+ 1.48
Oklahoma	2	(a)	(a)	36	(a)	(a)	36	7.71	(a)	(a)	(a)	(a)	+ 1.36
Oregon	5	4,498	.12	33	40,065	.17	31	8.90	+ 273	+ 6.4	+ 4,776	+ 13.5	+ .55
Pennsylvania	222	936,209	24.73	1	5,900,056	24.78	1	6.28	− 36,134	− 3.7	+2,042,503	+ 52.9	+ 2.31
Porto Rico	23	3,803	.10	35	29,139	.12	35	7.66	+ 163	+ 4.4	+ 2,703	+ 10.2	+ .40
Rhode Island	1	(a)	(a)	38	(a)	(a)	37	11.02	(a)	(a)	(a)	(a)	+ 3.32
South Dakota	4	4,463	.12	34	37,589	.16	32	8.37	− 1,309	−22.6	− 6,444	− 14.6	+ .74
Tennessee	14	101,836	2.69	13	504,599	2.12	14	4.96	− 7,697	−70.2	+ 117,582	+ 31.1	+ 1.51
Texas	8	52,742	1.39	18	361,308	1.52	19	6.83	− 1,307	− 2.4	+ 53,549	+ 17.3	+ 1.14
Utah	9	9,130	.24	26	63,574	.27	24	6.96	− 3,342	−26.7	− 13,559	− 17.5	+ .78
Vermont	7	46,169	1.22	19	364,071	1.53	18	7.89	+ 2,804	+ 6.5	+ 127,938	+ 54.1	+ 2.44
Virginia	32	307,195	8.11	3	1,820,446	7.65	3	5.93	− 19,617	− 6.0	+ 540,788	+ 42.2	+ 2.05
Washington	7	23,328	.62	20	156,553	.66	20	6.71	− 3,567	−13.2	− 10,100	− 6.1	+ .52

West Virginia	23	245,569	6.49	4	1,268,343	5.33	5	5.16	− 32,152	−11.5	+ 260,322	+ 25.8	+ 1.53
Wisconsin	28	169,650	4.48	6	1,037,578	4.36	6	6.12	− 97,155	−36.4	− 169,481	− 14.1	+ 1.60
Wyoming	1	(a)	(a)	41	(a)	(a)	41	21.93	(a)	(a)	(a)	(a)	+ 9.31
Undistributed	....	31,109	.82	....	242,589	1.02	....	....	− 6,021	− 1.6	+ 3,176	+ 1.3	....
	595	3,786,364	100.00	....	23,807,877	100.00	....	6.29	−287,069	− 7.4	+5,298,572	+ 28.6	+ 1.75

a Included in "Undistributed."

About one-third of the States showed an increase in quantity of lime burned and sold, but for the most part the increase was very small in number of tons, although in some of the less productive States the percentage of increase was high. Michigan and California showed the largest percentages of increase among the more productive States—57 per cent and 38 per cent, respectively.

Although two-thirds of the producing States sold less lime in 1917 than in 1916, only one-sixth of them showed a decrease in total value, owing to the general increase in price. The States which had a decreased value also had a decreased output. They were Connecticut, Maine, New Jersey, South Dakota, Utah, Washington, and Wisconsin.

In the New England States the total production of lime in 1917 was 371,673 tons, a decrease of 15 per cent compared with the production in 1916. The output of hydrated lime in 1917, however, was 28,813 tons, an increase of 74 per cent. All producers reported increase in price up to 40 per cent. Costs also were higher, and some producers stated that by the end of 1917 the cost of production had more than doubled. Labor and fuel were scarce and transportation facilities poor. In some districts the shortage of labor for supplying wood fuel had become so great that it was feared that wood-burning kilns might remain idle during a considerable part of 1918. The demand for building lime as a whole was decidedly less than in 1916, some producers reporting a decline of 40 per cent. A few companies, however, reported good demand, and some stated that the decline was not evident until late in the year.

In the Middle Atlantic States (New York, Pennsylvania, New Jersey, and Maryland) the total production of lime in 1917 was 1,183,086 tons, or 5.7 per cent less than in 1916, but that of hydrated lime increased from 170,000 to 171,000 tons. Prices were almost uniformly reported higher, a few producers reporting an advance of 25 to 34 per cent. Costs showed greater increase, however, one producer reporting an increase of 30 per cent in selling price but an increase of 150 per cent in costs. Shortage of labor, fuel, and cars also curtailed output and, together with high cost of operating, forced some plants to remain idle during the greater part of the year. In these States the building-lime trade was prevailingly dull. Although a few producers reported that the demand was the same or slightly improved in 1917 compared with 1916, most of them reported marked decline, ranging from 10 to 50 per cent in Pennsylvania and even to 75 per cent in New York and New Jersey. The demand for chemical lime, however, which increased greatly in 1916, continued to increase in 1917, according to most producers, who reported demand far in excess of their producing capacity. Comments on the agricultural-lime industry were about equally divided as regards improvement or decline. Some reported increase of as much as 30 per cent; others decrease up to 50 and even 65 per cent. The decline was attributed mainly to the prevailing difficulties of production and to shortage of farm labor, which prevented a demand in keeping with the country's agricultural needs. The demand for lime from other sources, notably paper mills, tanneries, and metallurgic plants, was the same as or better than in 1916. This statement applies also to dead-burned dolomite for refractory use.

The Southern States—those south of the Potomac and the Ohio and east of the Mississippi—produced 739,000 tons of lime in 1917, which was about 7 per cent less than in 1916, all States except Florida showing decrease. This total quantity of lime included 79,0C0 tons of hydrated lime, which showed a gain of 11 per cent. Hydrated lime gained in Florida, Tennessee, and West Virginia but lost in Alabama. Prices were uniformly reported higher, though no remarkable advances were mentioned. About three-fifths of the producers reported a decline in the demand for building lime, especially in the last half of the year. One company in Tennessee attributed the decline mainly to lack of cars, which prevented the supplying of a good demand. Another company in Tennessee had to close in December, owing to lack of coal. Practically all producers reporting sales of chemical lime stated that the demand in 1917 was as good as or better than in 1916. About two-thirds of the producers reported a decrease in the sales of agricultural lime; the others reported the same or improved sales. Two producers reported good demand but inability to supply it owing to shortage of fuel and labor. Two producers reported decrease in lime sold to sugar factories.

The East Central States, including Ohio, Indiana, Illinois, Michigan, and Wisconsin, produced 987,365 short tons of lime in 1917, 12 per cent less than in 1916. This quantity included 363,591 short tons of hydrated lime, a decrease of 10 per cent. The production in Illinois increased about 3,000 tons and that in Indiana decreased 3,000 tons. Michigan's output was 57 per cent greater than in 1916, but Ohio's was 16 per cent less and Wisconsin's 36 per cent less than in 1916. All producers reported an increase in price, one stating an increase of 80 per cent to equalize increase in cost of production; but more than three-fourths of them reported marked decline in the building-lime trade. Decrease ranging from 30 to 65 per cent was reported by producers in Wisconsin. The demand in Ohio was reported as above normal during the first half of the year, but production was curtailed by the prevailing conditions of labor, fuel, and transportation. The chemical-lime industry was generally reported better than in 1916. The agricultural-lime trade in 1917 was reported poorer by about two-fifths of the producers, the remainder reporting trade equal to or better than that in 1916. Increased sales to paper mills, tanneries, and glass factories were reported by a few producers, the amount of increase depending largely on transportation conditions.

The West Central States—Missouri, Minnesota, Iowa, and South Dakota—produced 266,864 short tons of lime in 1917, 13 per cent more than in 1916. Increase of 18 per cent was shown by Missouri, but the other States showed decrease. Very little hydrated lime was produced in any of these States except Missouri, whose output is shown in the table. The increase in price was as high as 20 per cent. The demand was reported good by producers in Minnesota and Iowa and by more than half of those in Missouri, but production was retarded by difficulties in transportation. The few producers of chemical lime reported increased activity, and the demands for agricultural and other lime continued essentially the same as in 1916.

The Southwestern States, including Arkansas, Oklahoma, Texas, and New Mexico, produced 75,381 short tons of lime in 1917, 2.6 per cent less than in 1916. Hydrated lime was produced in Texas in almost the same quantity as in 1916. Increased prices were reported by all producers. The building-lime trade, slightly improved in Arkansas, was somewhat poorer in Texas. Two producers in Oklahoma reported large increase in sales, but the State as a whole showed a large percentage of decrease. The demand for chemical lime improved in Texas and Arkansas; that for agricultural lime improved in Arkansas but declined in Texas.

The Rocky Mountain States, including Montana, Wyoming, Colorado, and Utah, produced 20,683 short tons of lime, a decrease of 16 per cent compared with 1916. A gain was made, however, in Colorado. Hydrated lime is not made in these States. Prices increased. The demand for building lime remained about the same except in Utah, where it declined. The demand for chemical lime increased in Colorado and remained the same in Utah. There continues to be little or no demand for agricultural lime in these States.

The Pacific Coast States here reported include Idaho, Nevada, and Arizona, which are closely allied with Washington and California in the lime industries. These States and Oregon produced 135,846 short tons of lime in 1917, or 19 per cent more than in 1916. Increased production was reported from Arizona, California, Idaho, and Oregon. This quantity included 12,259 tons of hydrated lime, 7 per cent more than in 1916, produced in Washington, California, Arizona, and at a new plant in Idaho. Prices remained about the same in Nevada but increased in the other States. In southern California and Arizona prices had increased as much as 50 per cent by the end of 1917, and further advances were predicted. These increases followed increases in the cost of oil fuel (100 to 150 per cent), wood fuel (15 per cent), and labor (40 per cent). The building-lime trade declined as a whole but was reported improved by a few producers in Idaho and Washington. The usual difficulties with labor and transportation were cited as causes for the decline. Decreases of as much as 40 per cent were reported from parts of Washington and California. There was also a general decline in sales of agricultural lime, and some companies reported decline in sales of lime for chemical works; others, however, reported increased sales of this product and a great increase in fluxing lime for steel plants.

USES.

Sales of lime in the different States in 1916 and 1917, classified according to principal uses, are shown in the following table. Lime for glass works, formerly included in "Other uses," is shown separately in the columns for 1917, and this accounts in part for some of the apparent decrease in lime for "Other uses." Likewise the apparent decrease in quantity and value of lime sold to dealers is due to the fact that producers were better able to specify uses, and so much of the lime formerly accounted for under "Dealers—uses not specified" is now distributed under the proper headings, most important of which are building lime and agriculture.

According to the figures in this table the quantity of lime used for building decreased 13 per cent and that for agriculture 20 per cent. That used in paper-making increased slightly, in tanneries 11 per cent, in blast furnaces 16 per cent, in chemical works 24 per cent, and in sugar factories 117 per cent. The total value of lime for all uses increased, except that sold to dealers and for "Other uses." The value of that sold to chemical works more than doubled and that to sugar factories more than trebled. The increases in both quantity and value were for uses greatly stimulated by the war both for domestic and foreign consumption, exports of paper and leather and manufactures of them in the first eight months of 1917 more than doubling in value those for the corresponding period of 1914, and exports of refined sugar and of iron, steel, and copper manufactures increasing several fold in value.[1]

Lime sold in the United States in 1916 and 1917, by uses.

	Percentage of total quantity.	Quantity (short tons).	Value.	Average price per ton.
1916.				
Building lime	37.1	1,509,968	$7,859,614	$5.21
Chemical works	15.2	621,120	2,298,246	3.70
Paper mills	8.7	353,187	1,461,412	4.14
Sugar factories	.5	21,923	118,572	5.41
Tanneries	1.5	59,919	278,003	4.64
Agriculture	15.1	613,527	2,224,401	3.63
Fluxing	4.4	180,018	712,101	3.96
Dealers—uses not specified	9.2	373,011	1,846,730	4.95
Other uses [a]	8.3	340,760	1,710,226	5.02
	100.0	4,073,433	18,509,305	4.54
Hydrated lime (included in total)		717,382	3,626,998	5.06
1917.				
Building lime	34.7	1,313,493	8,713,845	6.63
Chemical works	20.4	772,787	4,476,191	5.79
Paper mills	9.4	355,768	2,008,433	5.65
Glassworks	1.6	60,624	316,280	5.22
Sugar factories	1.3	47,546	381,746	8.03
Tanneries	1.8	66,629	408,976	6.14
Agriculture	12.9	488,297	2,475,731	5.07
Fluxing	5.5	209,976	1,141,647	5.44
Dealers—uses not specified	5.1	194,028	1,245,654	6.42
Other uses [b]	7.3	277,216	2,639,374	9.09
	100.0	3,786,364	23,807,877	6.29
Percentage of increase or decrease in 1917		−7.4	+28.6	
Hydrated lime (included in total)		709,157	4,643,004	6.55
Percentage of increase or decrease in hydrated lime in 1917		−1.2	+28.0	

[a] Includes lime for sand-lime brick, slag cement, alkali works, glassworks, sheep dipping, disinfectant, manufacture of soap, cyanide plants, glue factories, purification of water, etc.
[b] Includes items under footnote [a] except glassworks.

[1] Foreign Trade Record, Nat. City Bank of New York, Nov. 19, 1917.

Lime sold in the United States in 1916 and 1917, by States and uses.

1916.

State or Territory.	Building.		Fluxing.		Chemical works.		Paper mills.		Sugar factories.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama	7,744	$33,069			703	$2,571	(a)	(a)		
Arizona	(a)	(a)								
Arkansas	17,637	94,875			(a)	(a)	(a)	(a)		
California	15,529	119,198	(a)	(a)	4,351	28,308			9,225	$51,488
Colorado	299	1,790	(a)	(a)	(a)	(a)			(a)	(a)
Connecticut	84,707	587,528			(a)	(a)				
Florida	4,898	30,216								
Hawaii										
Idaho	3,217	21,686					(a)	(a)		
Illinois	43,903	224,141			16,770	62,434	7,401	$30,459	(a)	(a)
Indiana	22,401	112,099	(a)	(a)	13,762	47,027	23,716	89,708		
Iowa	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)		
Kansas	(a)	(a)			(a)	(a)				
Kentucky	685	3,924								
Maine	95,837	632,209					(a)	(a)		
Maryland	6,357	24,681			41,398	140,744				
Massachusetts	82,973	546,307			(a)	(a)	(a)	(a)		
Michigan	2,649	13,824	(a)	(a)	59,510	261,441	4,739	20,522		
Minnesota	18,150	90,750								
Missouri	55,846	289,415	12,104	$49,546	16,050	82,874	(a)	(a)	(a)	(a)
Montana	(a)	(a)	(a)	(a)						
Nevada	(a)	(a)								
New Jersey	(a)	(a)								
New Mexico	637	5,023								
New York	9,660	52,405	(a)	(a)	3,162	19,129	35,449	176,180	(a)	(a)
North Carolina							(a)	(a)		
Ohio	400,481	2,078,533	(a)	(a)	(a)	(a)	36,988	130,921	(a)	(a)
Oklahoma			(a)	(a)						
Oregon	179	2,270								
Pennsylvania	212,095	962,266	56,404	197,436	131,201	451,759	69,474	245,601	(a)	(a)
Porto Rico	743	4,104							1,702	16,845
Rhode Island					(a)	(a)				
South Dakota	1,884	12,732	3,888	31,301						
Tennessee	39,443	151,814			(a)	(a)	26,540	79,460	5,658	22,952
Texas	17,837	110,803	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Utah	6,041	46,144	(a)	(a)					(a)	(a)
Vermont	7,741	44,822	(a)	(a)	5,160	30,717	15,306	80,244	(a)	(a)
Virginia	73,592	330,715	(a)	(a)	189,335	695,027	(a)	(a)	(a)	(a)
Washington	5,494	35,931			(a)	(a)	(a)	(a)	(a)	(a)
West Virginia	44,604	156,600	(a)	(a)	97,342	338,923				
Wisconsin	219,805	995,120	(a)	(a)			13,013	54,599		
Wyoming	(a)	(a)								
Undistributed	6,900	44,620	107,622	433,818	42,376	137,292	120,561	553,718	5,338	27,287
	1,509,968	7,859,614	180,018	712,101	621,120	2,298,246	353,187	1,461,412	21,923	118,572

[a] Included in "Undistributed."

Lime sold in the United States in 1916 and 1917, by States and uses—Continued.

1916.

State or Territory.	Tanneries.		Agriculture.		Dealers.		Other uses.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama	(a)	(a)	592	$2,246	50,007	$243,582	1,787	$7,149	67,524	$312,531
Arizona	......	......	(a)	(a)	(a)	(a)	......	......	15,173	94,540
Arkansas	......	......	(a)	(a)	......	......	......	......	19,199	102,683
California	1,289	$10,793	5,386	31,974	14,962	100,738	4,061	36,867	56,820	393,930
Colorado	......	......	(a)	(a)	(a)	(a)	(a)	(a)	5,479	36,473
Connecticut	......	......	(a)	(a)	......	......	......	......	85,063	589,257
Florida	......	......	(a)	(a)	(a)	(a)	......	......	8,666	49,536
Hawaii	......	......	(a)	(a)	......	......	......	......	(a)	(a)
Idaho	......	......	......	......	......	......	(a)	(a)	4,389	31,786
Illinois	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	80,012	369,038
Indiana	7,285	31,269	3,401	14,598	(a)	(a)	36,710	145,548	121,306	495,283
Iowa	......	......	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Kansas	......	......	......	......	......	......	......	......	(a)	(a)
Kentucky	......	......	241	790	(a)	(a)	(a)	(a)	1,236	6,304
Maine	......	......	9,553	39,729	(a)	(a)	......	......	162,100	956,371
Maryland	......	......	109,468	407,930	(a)	(a)	......	......	157,673	574,998
Massachusetts	......	......	4,500	12,226	(a)	(a)	(a)	(a)	145,020	811,402
Michigan	1,300	6,250	(a)	(a)	16,786	76,117	(a)	(a)	86,447	385,341
Minnesota	......	......	......	......	(a)	(a)	......	......	20,150	103,000
Missouri	5,279	23,927	(a)	(a)	67,028	329,172	32,796	139,219	199,260	956,300
Montana	......	......	......	......	(a)	(a)	......	......	(a)	(a)
Nevada	......	......	......	......	(a)	(a)	(a)	(a)	(a)	(a)
New Jersey	......	......	6,517	22,202	(a)	(a)	......	......	7,110	26,034
New Mexico	......	......	......	......	(a)	(a)	(a)	(a)	1,582	11,670
New York	2,555	20,973	12,649	44,891	14,446	90,240	33,169	200,866	117,490	636,668
North Carolina	(a)	(a)	(a)	(a)	(a)	(a)	......	......	(a)	(a)
Ohio	(a)	(a)	49,527	224,120	37,251	125,999	33,829	113,882	570,972	2,702,953
Oklahoma	......	......	......	......	(a)	(a)	......	......	(a)	(a)
Oregon	......	......	......	......	(a)	(a)	......	......	4,225	35,289
Pennsylvania	17,757	70,955	318,722	1,036,222	9,570	33,341	156,110	856,409	972,343	3,857,553
Porto Rico	(a)	(a)	1,066	4,513	......	......	89	694	3,640	26,436
Rhode Island	(a)	(a)	(a)	(a)	(a)	(a)	......	......	(a)	(a)
South Dakota	......	......	......	......	......	......	......	......	5,772	44,033
Tennessee	(a)	(a)	2,080	4,410	10,412	43,173	......	......	109,533	378,017
Texas	......	......	(a)	(a)	23,303	131,074	3,102	16,073	54,049	307,759
Utah	......	......	......	......	(a)	(a)	(a)	(a)	12,472	77,133
Vermont	6,407	34,568	1,276	3,864	4,223	23,695	3,204	18,083	43,365	236,133
Virginia	1,470	5,180	38,751	147,843	......	......	14,598	66,028	326,812	1,279,658
Washington	......	......	(a)	(a)	13,566	84,149	(a)	(a)	26,895	166,653
West Virginia	(a)	(a)	41,507	160,959	(a)	(a)	(a)	(a)	277,721	1,008,021
Wisconsin	1,828	9,264	(a)	(a)	31,604	146,606	......	......	266,805	1,207,059
Wyoming	......	......	......	......	......	......	......	(a)	(a)	(a)
Undistributed	14,749	64,824	8,291	65,884	79,853	418,844	21,305	109,408	[b] 37,130	[b] 239,413
	59,919	278,003	613,527	2,224,401	373,011	1,846,730	340,760	1,710,226	4,073,433	18,509,305

[a] Included in "Undistributed."
[b] Includes Hawaii, Iowa, Kansas, Montana, Nevada, North Carolina, Oklahoma, Rhode Island, and Wyoming.

Lime sold in the United States in 1916 and 1917, by States and uses—Continued.

1917.

State or Territory.	Building. Quantity (short tons).	Building. Value.	Fluxing. Quantity (short tons).	Fluxing. Value.	Chemical works. Quantity (short tons).	Chemical works. Value.	Paper mills. Quantity (short tons).	Paper mills. Value.
Alabama	40,336	$237,410	....	....	3,222	$16,503	7,660	$35,968
Arizona	13,646	104,525	(a)	(a)	(a)	(a)	....	....
Arkansas	12,650	88,456	3,184	$22,478	(a)	(a)	(a)	(a)
California	17,841	147,447	5,284	47,520	8,607	49,886	(a)	(a)
Colorado	(a)	(a)	....	....	(a)	(a)	....	....
Connecticut	54,176	411,722	....	....	(a)	(a)	....	....
Florida	8,354	54,366	....	....			....	....
Hawaii	....	....	....	....	....	....	....	....
Idaho	2,151	20,568	....	....	....	....	(a)	(a)
Illinois	39,669	243,867	....	....	29,689	165,703	2,915	16,974
Indiana	9,309	55,246	(a)	(a)	51,678	288,315	25,679	137,172
Iowa	(a)	(a)	(a)	(a)	....	....	(a)	(a)
Kentucky	98	838	....	....	....	....	....	....
Maine	61,542	537,135	....	....	(a)	(a)	46,652	328,107
Maryland	10,138	44,751	(a)	(a)	30,047	139,496	....	....
Massachusetts	62,222	516,944	....	....	25,907	167,781	(a)	(a)
Michigan	1,273	8,569	(a)	(a)	110,174	721,107	8,452	53,150
Minnesota	16,272	106,704	....	....	....	....	....	....
Missouri	59,986	357,519	(a)	(a)	68,051	397,473	14,576	75,428
Montana	(a)	(a)	(a)	(a)	....	....	....	....
Nevada	....	....	(a)	(a)	....	....	....	....
New Jersey	....	....	....	....	....	....	....	....
New Mexico	687	4,904	....	....	....	....	....	....
New York	14,848	101,117	(a)	(a)	9,906	73,559	29,394	201,070
North Carolina	(a)	(a)	....	....	....	....	....	....
Ohio	371,920	2,352,342	2,035	11,080	2,688	15,447	11,665	63,743
Oklahoma	(a)	(a)	....	....	....	....	....	....
Oregon	3,498	32,065	....	....	....	....	....	....
Pennsylvania	162,658	1,034,504	90,688	445,609	129,791	705,594	78,181	377,933
Porto Rico	670	3,359	....	....	....	....	....	....
Rhode Island	....	....	....	....	(a)	(a)	....	....
South Dakota	1,630	12,796	(a)	(a)	....	....	....	....
Tennessee	44,717	247,546	....	....	(a)	(a)	27,798	113,486
Texas	37,482	261,036	(a)	(a)	(a)	(a)	(a)	(a)
Utah	3,623	28,601	(a)	(a)	....	....	....	....
Vermont	11,303	92,768	(a)	(a)	8,508	70,692	18,963	140,953
Virginia	65,598	454,133	(a)	(a)	166,549	952,142	(a)	(a)
Washington	4,660	37,136	(a)	(a)	(a)	(a)	1,178	11,381
West Virginia	(a)	(a)	(a)	(a)	97,747	500,063	(a)	(a)
Wisconsin	141,374	865,773	(a)	(a)	(a)	(a)	14,880	89,132
Wyoming	(a)	(a)	....	....	....	....	....	....
Undistributed	38,162	249,698	108,785	614,960	30,223	212,430	67,775	363,936
	1,313,493	8,713,845	209,976	1,141,647	772,787	4,476,191	355,768	2,008,433

[a] Included in "Undistributed."

Lime sold in the United States in 1916 and 1917, by States and uses—Continued.

1917.

State or Territory.	Sugar factories.		Tanneries.		Glass factories.		Agriculture.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama	1,210	$7,459	(a)	(a)			1,791	$9,816
Arizona								
Arkansas	(a)	(a)					(a)	(a)
California	33,614	272,220	(a)	(a)			6,196	32,447
Colorado	(a)	(a)						
Connecticut							(a)	(a)
Florida							(a)	(a)
Hawaii	(a)	(a)					(a)	(a)
Idaho							(a)	(a)
Illinois	(a)	(a)	4,175	$27,679			(a)	(a)
Indiana			1,830	11,176	4,520	$25,946	2,297	12,143
Iowa								
Kentucky							(a)	(a)
Maine			(a)	(a)			10,243	35,216
Maryland			(a)	(a)			85,633	463,081
Massachusetts							5,073	18,185
Michigan			1,681	11,738			(a)	(a)
Minnesota								
Missouri			6,085	31,996	(a)	(a)	4,317	26,844
Montana								
Nevada								
New Jersey							5,002	18,978
New Mexico								
New York	(a)	(a)	3,222	28,868			9,588	40,540
North Carolina			(a)	(a)			(a)	(a)
Ohio			(a)	(a)	39,934	200,634	29,997	161,205
Oklahoma								
Oregon								
Pennsylvania	2,078	15,603	24,236	138,305	9,954	58,707	246,608	1,218,316
Porto Rico	2,193	20,334					927	5,323
Rhode Island							(a)	(a)
South Dakota								
Tennessee	3,900	24,800	2,905	12,178			1,904	9,835
Texas	1,660	11,595					(a)	(a)
Utah	(a)	(a)	(a)	(a)				
Vermont			5,824	46,731			502	1,380
Virginia	(a)	(a)	2,775	13,129			44,335	235,568
Washington	(a)	(a)					(a)	(a)
West Virginia			8,484	48,771	(a)	(a)	21,999	106,892
Wisconsin			2,400	15,289	(a)	(a)	954	5,024
Wyoming								
Undistributed	2,891	29,735	3,012	23,116	6,216	30,993	10,931	74,938
	47,546	381,746	66,629	408,976	60,624	316,280	488,297	2,475,731

[a] Included in "Undistributed."

Lime sold in the United States in 1916 and 1917, by States and uses—Continued.

1917.

State or Territory.	Dealers.		Other uses.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama	11,290	$69,879	(a)	(a)	66,744	$383,211
Arizona					15,856	119,995
Arkansas	(a)	(a)			17,350	117,593
California	5,751	46,903	2,418	$19,656	78,401	597,528
Colorado	(a)	(a)			6,212	54,676
Connecticut					64,389	492,678
Florida			(a)	(a)	9,914	56,903
Hawaii					(a)	(a)
Idaho					7,228	62,331
Illinois	(a)	(a)	(a)	(a)	83,409	501,320
Indiana	(a)	(a)	7,869	39,802	118,530	646,555
Iowa					(a)	(a)
Kentucky	(a)	(a)	(a)	(a)	723	3,783
Maine					124,199	950,811
Maryland					133,087	694,576
Massachusetts			(a)	(a)	134,937	916,569
Michigan	(a)	(a)	(a)	(a)	135,920	892,682
Minnesota			(a)	(a)	18,072	119,704
Missouri	63,537	452,491	4,004	21,963	234,936	1,435,914
Montana	(a)	(a)			5,281	35,512
Nevada			(a)	(a)	(a)	(a)
New Jersey					5,002	18,978
New Mexico			(a)	(a)	1,829	12,327
New York	2,648	20,030	29,387	347,463	108,788	892,855
North Carolina					(a)	(a)
Ohio	6,334	40,021	15,257	130,814	479,856	2,975,466
Oklahoma	(a)	(a)			(a)	(a)
Oregon	(a)	(a)			4,498	40,065
Pennsylvania	12,057	68,306	178,958	1,837,179	936,209	5,900,056
Porto Rico			13	123	3,803	29,139
Rhode Island	(a)	(a)			(a)	(a)
South Dakota					4,463	37,589
Tennessee	10,669	53,914	3,843	15,240	101,836	504,599
Texas	3,172	22,227	( )	(a)	52,742	361,308
Utah	(a)	(a)	(a)	(a)	9,130	63,574
Vermont	(a)	(a)	(a)	(a)	46,169	364,071
Virginia	11,334	67,073			307,195	1,820,446
Washington	8,969	53,538	(a)	(a)	23,328	156,553
West Virginia	12,730	62,229	16,414	99,596	245,569	1,268,343
Wisconsin	7,790	48,855			169,650	1,037,578
Wyoming					(a)	(a)
Undistributed	37,747	240,188	19,053	127,538	31,109	242,589
	194,028	1,245,654	277,216	2,639,374	3,786,364	23,807,877

[a] Included in "Undistributed."

In 1917 Pennsylvania was the only State that supplied lime for all the uses listed in the table, so far as shown by reports from producers. Alabama, California, Illinois, Indiana, Michigan, Missouri, New York, Ohio, Tennessee, Texas, Vermont, Virginia, West Virginia, Washington, and Wisconsin supplied lime for all but one or two of the uses.

BUILDING.

Lime sold for building decreased about 200,000 tons from the record production of 1916 but surpassed the value of that year, exceeding for the first time $8,000,000. The average price per ton rose from $5.21 in 1916 to $6.63 in 1917. The output of 1,313,493 tons, valued at $8,713,845, represented 35 per cent in quantity and 39 per cent in value of the total lime sold in 1917. The total quantity of lime actually used for building should doubtless include the greater part of that reported as sold to dealers.

The production of the leading States, Ohio, Pennsylvania, and Wisconsin, decreased in quantity, but the output of Ohio, nevertheless, exceeded all previous records in value, which was $2,352,342, in comparison with the record figure of $2,078,533 in 1916. Ohio was the only State exceeding $2,000,000 in value of building lime, and Pennsylvania was the only other State exceeding $1,000,000. The output of Maine, Massachusetts, and Wisconsin was valued at more than $500,000 each.

The building-lime trade declined in all parts of the country. The unprecedented demand for building lime in 1916 continued until February, 1917, when the effects of the war, augmented in some northern districts by severe weather, brought it to a close. A fair to good demand continued in many districts, however, through the spring, and then a general decline in building set in. This decline was due to the uncertainties of war, to increased shortage of labor, fuel, and cars, and to the fact that lime being perishable the trade would not order car lots as demanded by the railroads.

FLUXING.

Lime for fluxing, which was shown separately for the first time in 1916, increased from 180,018 tons, valued at $712,101, in that year, to 209,976 tons, valued at $1,141,647, in 1917. This increase of nearly 17 per cent in quantity was caused by increased activity in the iron and steel industry because of the war. Lime for fluxing was sold in 21 States, well distributed throughout the country, but in only four States were there more than three producers. Pennsylvania was the leading State, producing 42 per cent of the total quantity, as compared with 31 per cent of the total quantity in 1916. The average price of lime for fluxing increased from $3.96 in 1916 to $5.44 in 1917.

CHEMICAL WORKS.

Lime for chemical works again passed all previous records, amounting to 772,787 tons, valued at $4,476,191, as compared with 621,120 tons in 1916, valued at $2,298,246. This represents a gain of 24 per cent in quantity and 95 per cent in value in a single year. The average price per ton ($5.79) increased $2.09 over the price of $3.70 in 1916, or six times the increase recorded for that year. The great activity in chemical industries presages a greater use of lime by chemical works in 1918. Virginia was the largest producer, with 166,549 tons, valued at $952,142. Pennsylvania ranked second in quantity but third in value, and Michigan third in quantity and second in value; West Virginia ranked fourth in both and Missouri fifth.

In addition to burned lime for chemical works 3,124,026 short tons of limestone, valued at $1,417,898, was sold to alkali works in 1917. This limestone, sold and reported by the producers as stone, is included in the report on stone in 1917.

PAPER MILLS.

Lime for paper mills exceeded all former records in quantity, total value, and average price per ton. The increase in quantity sold was nominal, but the increase in value was more than 37 per cent. The average price per ton was $5.65, as compared with $4.14 in 1916. Lime sold to paper mills in 1917 is recorded as 355,768 tons, valued at $2,008,433, in comparison with 353,187 tons, valued at $1,461,412, in 1916. The total value exceeded $2,000,000 for the first time. Pennsylvania sold 78,181 tons, valued at $377,933, considerably outranking all other States and increasing both the quantity and value of her output. Maine ranked second, New York third, and Tennessee fourth in quantity, and Maine, New York, Vermont, and Indiana second, third, fourth, and fifth in value. Six States each exceeded $100,000 in value of output, in comparison with three States in 1916.

An attempt was made for the first time in 1917 to classify the lime sold to paper mills according to processes of manufacture, with the following results:

Lime sold to paper mills in 1917.

Process.	Quantity (short tons).	Value.
Soda	171,865	$994,417
Sulphite	77,020	422,026
Sulphate	28,154	172,635
Strawboard	9,918	55,149
Unspecified	68,811	364,196
	355,768	2,008,423

"Unspecified" includes a small quantity reported by one producer for the rag process and the total of several producers who did not specify the process in which their lime was used. The quantity reported as used in the soda process represents almost half the total quantity and would probably have represented a considerably higher proportion had all producers specified uses. High-calcium lime is required for this process. The quantity reported as sold for the sulphite process, which is supplied mainly by magnesian lime in some regions and by calcium lime in others, represents nearly one-fourth of the total, but the quantity actually used for this process was doubtless larger. In the Pacific Coast States calcined magnesite has been used, probably exclusively, in the sulphite process.

SUGAR FACTORIES.

The decrease in sales of 36 per cent in quantity and 49 per cent in value which lime for sugar factories showed in 1916 was offset by an increase in 1917 of 117 per cent in quantity and 222 per cent in value. The total output used for this purpose in 1917 was 47,546 tons, valued at $381,746, as compared with 21,923 tons, valued at $118,572, in 1916. The average price per ton increased from $5.41 in 1916 to $8.03, the highest average price for lime for any purpose here classified except that sold for "other uses." Lime burned and sold for sugar factories was reported from 12 States and from Hawaii and Porto Rico. California produced 33,614 tons, 70 per cent of the total quantity, or 50 per cent more than the output of the whole country in 1916 for this use. The marked increase in 1917 is in keeping with the urgent demand for sugar both in this country and in the allied and neutral foreign countries.

As both carbon dioxide and lime are used in the manufacture of sugar and as many manufacturers therefore prefer to buy or quarry limestone and burn their own lime, the demand for lime for this use in this country is more adequately shown in the following table:

Limestone and lime used by sugar factories, 1913–1917.

	1913	1914	1915		1916		1917	
			Quantity (short tons).	Value.	Quantity (short tons.)	Value.	Quantity (short tons).	Value.
Limestone	$387,724	$323,796	394,122	$381,038	369,028	$369,694	530,612	$666,138
Lime	216,768	187,605	34,025	230,368	21,923	118,572	47,546	381,746
	604,492	511,401	....	611,406	....	488,266	....	1,047,884

TANNERIES.

Lime for tanneries amounted to 66,629 tons, valued at $408,976, as compared with 59,919 tons, valued at $278,003, in 1916. This was an increase of 11 per cent in quantity and 47 per cent in value and surpassed all previous years in value and all years except 1909 in quantity, the output for 1909 being 72,899 tons. The average price per ton was $6.14, an increase of $1.50 over 1916. Lime for tanneries was sold in 18 States, and Pennsylvania was by far the largest producer, with 24,236 tons, or more than one-third of the total.

GLASS FACTORIES.

Lime sold to glassworks, reported separately here for the first time, amounted to 60,624 tons, valued at $316,280. These sales were made in six States, Indiana, Missouri, Ohio, Pennsylvania, West Virginia, and Wisconsin, all of which are large producers of glass, except Wisconsin. This total evidently does not include all the lime used for making glass, because New York and Maryland, which produced lime in large quantity for many purposes, are also considerable producers of glass, and yet no sales of lime to glassworks are recorded from them. It would seem that in these States and in California, Tennessee, and others which have glass factories, some of the lime reported as sold to dealers or chemical works or for "other uses" must have been used by glassworks. It is hoped that in the future this phase of the lime industry may be more accurately represented.

The available figures show that Ohio produced 66 per cent of the total quantity and 63 per cent of the total value of all lime recorded as sold to glassworks. Pennsylvania ranked second and Indiana third.

AGRICULTURE.

Lime and limestone.—The quantity of lime sold for use in agriculture has decreased annually since the record figure of 1914. It fell off 2 per cent in 1915, nearly 9 per cent in 1916, and 20 per cent in 1917, the use in 1917 being less than for any year since 1908. According to the best available data the lime sold in the United States in 1917 for agriculture amounted to 488,297 tons, valued at $2,475,731. The principal producing States in order of output were Pennsylvania, Maryland, Virginia, Ohio, and West Virginia. Pennsylvania's part was a little more than 50 per cent of the whole. This was the only State whose output of agricultural lime exceeded 100,000 tons in quantity or $500,000 in value. Maryland followed with 17 per cent, and Virginia was third with 9 per cent of the total. Virginia was the only one of the five leading States whose output was larger than in 1916. On account of the increased price the total value for some of the States, as Pennsylvania and Maryland, which showed decreased tonnage, was nevertheless greater than in the previous year, and the total value of all agricultural lime was $250,000 more than in 1916. The average price per ton in 1917 was $5.07, as compared with $3.63 in 1916. Sales were made in 29 States.

In addition to burned lime, a quantity of pulverized limestone, which steadily increased up to 1916, inclusive, has been sold for agricultural purposes at an average price of a little more than $1 per ton. In 1917, however, this also decreased slightly in quantity, although it increased considerably in value.

Lime and pulverized limestone sold for use in agriculture, 1911–1917.

Year.	Lime.		Limestone.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1911	596,664	$1,714,386	174,290	$205,006
1912	604,607	1,852,530	200,000	311,702
1913	590,229	1,798,566	408,627	493,718
1914	684,348	2,139,444	615,197	688,961
1915	673,260	2,163,874	810,399	893,530
1916	613,527	2,224,401	1,066,376	1,146,582
1917	488,297	2,475,731	1,040,243	1,352,397

Marl.—Marl sold for agricultural use in the United States in 1917 amounted to 73,900 short tons, valued at $165,223, compared with 58,088 short tons, valued at $144,768, in 1916, an increase of 25 per cent in quantity and 13 per cent in value. The average price, however, unlike that of nearly all other commodities, decreased from $2.32 to $2.21 a ton.

Of the total output, 47,914 tons, valued at $112,075, or $2.34 a ton, was fresh-water marl, a calcareous ooze consisting mainly of an accumulation of small shells formed of carbonate of lime and of minute crystals deposited from the same material by the action of bacteria. This output came from nine companies—three in Virginia, two in California, and one each in New York, Pennsylvania, West Virginia, and Arkansas. The production in 1916 (revised figures) was 48,447 tons, valued at $126,345, or $2.60 per ton, and was made by seven companies—three in Virginia, and one in each of the other States named except West Virginia.

Marine marl, derived from fragments of marine shells, loose or partly consolidated, was produced by the five companies in the Coastal Plain region of North Carolina and South Carolina, the output amounting to 25,986 tons, valued at $53,148, or $2.35 a ton, in 1917, compared with 9,641 tons, valued at $18,423, or $1.91 a ton, in 1916.

Waste lime.—In addition to the quantities of lime, limestone, and marl here noted, local agricultural demands have been supplied by waste or spent lime from sugar factories, paper mills, and other industrial plants.

DEALERS AND OTHER USES.

The large decrease in quantity of lime reported as sold to dealers is only an indication that the final use made of the lime has become better known than in former years or that a larger percentage is going direct to the consumer. Lime for "other uses" has wide application and wide distribution. Pennsylvania continues to supply much more than any other State for the various purposes given in the table on pages 594–596.

The principal item in "Other uses" in 1917 was dead-burned or sintered dolomite, which took the place of Austrian magnesite for maintaining the bottoms and lining the walls of open-hearth and electric furnaces. Reported sales of dead-burned dolomite in 1917 amounted to 223,330 short tons, valued at $2,326,663, and raw stone sold by quarrymen for dead burning amounted to 232,421 short tons, valued at $171,257. A brief, interesting account of the development of dead-burned dolomite as a substitute for magnesite has been written by Jones.[1]

HYDRATED LIME.

Hydrated lime, according to the accompanying table, after making an increase annually for a number of years and in 1916 a very notable increase of 23 per cent in quantity, in 1917 declined about 1 per cent in quantity but made an increase of 28 per cent in value. The quantity marketed amounted to 709,157 tons, valued at $4,643,004, in comparison with 717,382 tons, valued at $3,626,998, in 1916. This final figure for quantity is 1.5 per cent below the preliminary estimate of 719,757 tons, published in February, 1918. Hydrated lime represented nearly 19 per cent of total lime in 1917, or practically the same percentage as in 1916. The average price per ton increased 29 per cent and was $6.55 in 1917, which is notable in view of the fact that the average price per ton was under $4.50 from 1911 to 1915 and exceeded $5 for the first time in 1916.

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[1] Jones, F. A., American enterprise leaves no chance for imported lime products: Rock Products, July 23, 1918, pp. 23–24.

Hydrated lime manufactured and sold in the United States, 1906–1917.

Year.	Quantity (short tons).	Value.	Average price per ton.	Number of plants reporting operations.
1906	120,357	$479,079	$3.98	30
1907	140,135	657,636	4.69	33
1908	136,411	548,262	4.02	46
1909	204,611	904,900	4.43	50
1910	320,819	1,288,789	4.02	51
1911	304,593	1,372,057	4.50	60
1912	416,890	1,829,064	4.39	64
1913	493,269	2,205,657	4.47	80
1914	515,121	2,239,916	4.35	82
1915	581,114	2,457,602	4.23	84
1916	717,382	3,626,998	5.06	89
1917	709,157	4,643,004	6.55	90

There were 90 hydrated-lime plants in operation in 1917, an increase of one. This increase was made by a gain of nine plants and a loss of eight from those which were active in 1916. California and Pennsylvania each gained two plants; Illinois, Missouri, Virginia, and West Virginia each gained one; and Idaho, an intermittent producer of hydrated lime (with one plant), again joined the active list. On the other hand, Iowa, New Jersey, and Rhode Island each lost its only plant and New York lost five. The distribution of these plants is shown in the following table:

Lime-hydrating plants in operation in 1908–1917.

State or Territory.	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917
Alabama	1	3	2	2	2	2	3	3	3	3
Arizona	1	1	1	1					1	1
California	2	2	2	3	3	4	2	2	1	3
Colorado		1	1							
Connecticut		1			1		1	1	1	1
Florida	1		1			1		1	1	1
Georgia	1			1	1	1				
Hawaii			1					1		
Idaho		1	1	1	1			1		1
Illinois	1	2	2	1	1	1	1	1	2	3
Indiana	2	2	2	2	2	2	3	3	3	3
Iowa		1				1	1		1	
Kansas		1								
Kentucky						1	1			
Maine	1	1	1	1	1	1	1	1	1	1
Maryland	1	1	3	3	3	4	6	5	7	7
Massachusetts			1	2		1	1	1	1	1
Michigan	2	1	2	3	1	3	2	3	2	2
Missouri	2	3	3	3	4	4	6	5	6	7
New Jersey	1	1		2	1	1	1	1	1	
New York	2	3		2	3	4	4	6	9	4
North Carolina				1						
Ohio	11	8	11	15	17	19	20	21	20	20
Pennsylvania	11	9	8	8	15	15	14	11	11	13
Rhode Island							1	1	1	
South Dakota			1	1		1	1	1	1	1
Tennessee	1	1	1	1	1	2	2	2	3	3
Texas	1	3	3	3	3	3	3	3	3	3
Vermont									1	1
Virginia	1	2		1		2	1	2	2	3
Washington				1	1	2	2	2	2	2
West Virginia	1		2	1	2	3	3	4	3	4
Wisconsin	2	2	2	1	1	2	2	2	2	2
	46	50	51	60	64	80	82	84	89	90

Ohio, the leading State in the production of hydrated lime and in number of hydrating plants, has 20 plants, and Pennsylvania increased the number in operation from 11 to 13. These are the only States with more than 10 hydrating plants. Forty per cent of the hydrating plants are in three contiguous States, New York, Ohio, and Pennsylvania, and 82 per cent of the plants are east of Mississippi River.

The production of hydrated lime by States was shown for the first time in 1916. The tabulation is far from satisfactory, because in many States there are only one or two plants and the State total can not be published without revealing figures of individual production.

Hydrated lime sold in the United States in 1916 and 1917.

State.	1916		1917	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama	6,780	$36,864	6,541	$48,089
Arizona	(a)	(a)	(a)	(a)
California	(a)	(a)	3,512	31,529
Connecticut	(a)	(a)	(a)	(a)
Florida	(a)	(a)	(a)	(a)
Idaho			(a)	(a)
Illinois	(a)	(a)	(a)	(a)
Indiana	22,615	111,278	21,867	134,835
Iowa	(a)	(a)		
Maine	(a)	(a)	(a)	(a)
Maryland	31,913	158,311	20,580	143,133
Massachusetts	(a)	(a)	(a)	(a)
Michigan	(a)	(a)	(a)	(a)
Missouri	24,647	128,903	32,120	219,600
New Jersey	(a)	(a)		
New York	10,909	51,948	8,562	58,852
Ohio	351,792	$1,806,974	316,252	2,038,944
Pennsylvania	126,890	585,847	142,254	974,936
Rhode Island	(a)	(a)		
South Dakota	(a)	(a)	(a)	(a)
Tennessee	14,634	72,777	18,594	126,455
Texas	14,575	86,852	13,999	93,861
Vermont	(a)	(a)	(a)	(a)
Virginia	(a)	(a)	7,393	46,864
Washington	(a)	(a)	(a)	(a)
West Virginia	48,309	209,155	51,545	274,718
Wisconsin	(a)	(a)	(a)	(a)
Undistributed	64,318	378,089	65,938	451,188
	717,382	3,626,998	709,157	4,643,004

a Included in "Undistributed."

Of the 24 States which produced hydrated lime in 1917, only 12 had three or more hydrating plants, thus permitting the publication of State totals without revealing individual output. In several States the quantity produced was less than in 1916, but the value of the output was greater. In Maryland both quantity and value decreased, but in four States, Missouri, Pennsylvania, Tennessee, and West Virginia, both quantity and value increased. Ohio, the leading State, showed a little more than twice the quantity and value of Pennsylvania, the only other State whose quantity exceeded 100,000 tons. West Virginia, with four active plants, produced

51,545 tons and held third place. Missouri, which had seven active plants, held fourth place with 32,120 tons. Indiana and Maryland ranked fifth and sixth, respectively.

The greater part of the hydrated lime marketed, as shown in the table below, is used for building. The figures here given, 402,223 tons, represent 30 per cent of the total quantity of lime used for building and nearly 57 per cent of all hydrated lime sold. The decrease from the quantity sold for building in 1916 is a measure of the decrease in building operations. Hydrated lime sold for agricultural use decreased slightly from the sales in 1916 but was 37 per cent of all the burned lime used for agriculture. The quantity and value of hydrated lime sold for other uses than building and agriculture is itemized here for the first time. The total quantity sold for these other uses in 1917 exceeded the total sold in 1916 by 28,263 short tons.

Hydrated lime sold in the United States in 1916 and 1917, by uses.

Use.	Quantity. (short tons).	Value.
1916.		
Building	431,582	$2,276,365
Agriculture	184,944	869,654
Other	100,856	480,979
	717,382	3,626,998
1917.		
Building	402,223	2,694,143
Chemical	52,255	354,177
Paper mills	6,728	43,513
Sugar factories	5,227	38,298
Tanneries	13,979	91,554
Glass factories	2,827	19,358
Agriculture	177,815	1,114,359
Dealers	30,630	170,732
Other	17,473	116,870
	709,157	4,643,004

CONSUMPTION OF LIME.

CONSUMPTION BY STATES.

The first attempt to show the consumption of domestic lime and its relation to production in different States was made in 1916. The producers cooperated heartily in furnishing the additional information requested of them, showing the distribution of their output by States, and from the data received, which represented more than 99 per cent of the total production, a table was prepared and published. Data are on hand and it would be very interesting to publish a table showing the quantity and destination of lime shipped from each State, but this can not be done without revealing many individual transactions. The following table is like the one published in the report on lime in 1916, with the exception that quicklime and hydrated lime are here shown separately.

Lime consumed in the United States in 1917.

	Lime, 1917.					Consumption of lime per capita (short tons).		
	Produced (short tons).	Consumed.		Shipped out of State (short tons).	Shipped into State (short tons).	1916	1917	Population in 1917 (estimated).
		Quicklime (short tons).	Hydrated lime (short tons).					
Alabama	66,744	20,026	2,895	47,426	3,603	0.01	0.01	2,363,939
Arizona	15,856	5,280	98	12,836	2,358	.02	.02	263,788
Arkansas	17,350	8,571	1,233	10,894	3,348	.006	.006	1,766,343
California	78,401	87,064	5,845	1,897	16,405	.024	.03	3,029,032
Colorado	6,212	13,612	2,708	...	10,108	.015	.016	988,320
Connecticut	64,389	32,405	6,467	41,553	16,036	.04	.03	1,265,373
Delaware	...	32,270	8,962	...	41,232	.15	.19	215,160
District of Columbia	...	8,003	4,461	...	12,464	.05	.03	369,282
Florida	9,914	10,250	5,981	264	6,581	.015	.017	916,185
Georgia	...	33,317	6,640	...	39,957	.01	.01	2,895,841
Hawaii	(a)	3,044	233	...	(a)	.016	.015	219,580
Idaho	7,228	4,355	86	6,465	3,678	.01	.01	445,176
Illinois	83,409	224,049	30,317	28,317	199,274	.056	.04	6,234,995
Indiana	118,530	55,443	34,415	75,444	46,772	.03	.03	2,835,492
Iowa	(a)	21,310	7,258	(a)	20,008	.01	.01	2,224,771
Kansas	...	19,014	3,553	...	22,567	.01	.01	1,851,870
Kentucky	723	16,078	3,782	...	19,137	.01	.008	2,394,093
Louisiana	...	19,332	8,373	...	27,705	.016	.015	1,856,954
Maine	124,199	95,102	5,949	62,712	39,564	.12	.13	777,340
Maryland	133,087	128,785	34,673	64,129	94,500	.14	.12	1,373,673
Massachusetts	134,937	108,111	9,114	104,691	86,979	.04	.03	3,775,973
Michigan	135,920	180,178	44,810	11,702	100,770	.06	.07	3,094,266
Minnesota	18,072	23,569	5,490	6,505	17,492	.01	.01	2,312,445
Mississippi	...	10,061	1,307	...	11,368	.006	.006	1,976,570
Missouri	234,936	71,324	7,913	170,849	15,150	.02	.02	3,429,595
Montana	5,281	6,451	1,075	45	2,290	.02	.015	472,935
Nebraska	...	14,131	1,867	...	15,998	.01	.01	1,284,126
Nevada	(a)	8,118	...	(a)	2,161	.07	.07	110,738
New Hampshire	...	28,947	1,646	...	30,593	.076	.068	444,429
New Jersey	5,002	85,861	41,620	...	122,479	.05	.04	3,014,194
New Mexico	1,829	2,558	218	400	1,347	.005	.007	423,649
New York	108,788	225,946	71,810	57,984	246,952	.03	.028	10,460,182
North Carolina	(a)	53,440	7,129	(a)	55,557	.03	.02	2,434,381
North Dakota	...	1,577	640	...	2,217	.004	.003	765,319
Ohio	479,856	152,728	134,825	269,205	76,902	.05	.055	5,212,085
Oklahoma	(a)	16,021	4,488	1,173	18,222	.01	.01	2,289,855
Oregon	4,498	6,796	2,317	3,114	7,729	.01	.015	861,992
Pennsylvania	936,209	762,837	135,344	238,960	200,932	.12	.10	8,660,042
Porto Rico	3,803	3,803	...	...	...	.003	.003	1,231,880
Rhode Island	(a)	9,539	586	(a)	8,507	.02	.016	625,865
South Carolina	...	12,255	1,835	...	14,090	.01	.01	1,643,205
South Dakota	4,463	5,152	955	507	2,151	.01	.01	716,972
Tennessee	101,836	19,767	3,994	80,769	2,694	.01	.01	2,304,629
Texas	52,742	31,252	10,490	12,112	1,112	.01	.01	4,515,423
Utah	9,130	8,880	240	250	240	.03	.025	443,866
Vermont	46,169	4,368	225	42,340	764	.01	.025	364,946
Virginia	307,195	209,102	17,531	115,729	35,167	.11	.10	2,213,025
Washington	23,328	14,055	2,855	9,782	3,364	.01	.01	1,597,400
West Virginia	245,569	26,012	10,387	230,415	21,245	.03	.025	1,412,602
Wisconsin	169,650	126,617	13,094	81,948	52,009	.04	.055	2,527,167
Wyoming	(a)	2,072	310	...	(a)	.01	.01	184,970
Undistributed	31,109	...	...	3,772	2,929	...	...	...
	[b] 3,786,364	3,068,838	708,044	[b] 1,794,189	1,784,707	.04	.037	105,091,933

[a] Included in "Undistributed."
[b] Includes 315 tons shipped to South America and 9,167 tons shipped to Canada.

In considering this table it should be borne in mind that the ratio of production to consumption is governed not only by the presence of suitable deposits of limestone and of large markets within a State, but by the proximity of these markets to producing centers of adjacent States and to convenient lines of transportation. Thus, Alabama shipped to Georgia and South Carolina, nonproducers in 1917, more lime than she consumed, and Arizona, a small producer, sent most of her output to California, which produces six times more than Arizona but consumes more than she produces. The city of Greater New York can be more cheaply supplied from Maine, western Connecticut and Massachusetts, and eastern Pennsylvania than from the deposits in the central part of New York State. Another factor is the shipment of special grades of lime, usually in small lots, to remote States.

In 19 States production exceeded consumption. The list includes the largest and some of the smallest producers. Pennsylvania, whose production exceeded that of any other State by more than 450,000 tons, consumed 37,000 tons more than it produced in 1916 but produced 38,000 tons more than it consumed in 1917. Other States with production in excess of 100,000 tons that produced more than they consumed were Indiana, Maine, Massachusetts, Missouri, Ohio, Tennessee, Virginia, West Virginia, and Wisconsin. Only three States with a production of more than 100,000 tons, Maryland, Michigan, and New York, consumed more than they produced.

Shipments of lime from New England States went to other New England States and to New York, Ohio, and Pennsylvania, with very small lots to the District of Columbia, Maryland, and Wisconsin. Shipments to New England States came from other States in that district, from New York, Ohio, and Pennsylvania, and in small lots from Maryland and Missouri. The bulk of Maine shipments went to Massachusetts and New York; Massachusetts sent more than one-third of her output to New York; Vermont sent more than one-half her output to Massachusetts; Connecticut sent considerable quantities to Maine, Massachusetts, New Hampshire, and New York. Rhode Island, which shipped very little, received the bulk of the lime that it consumed from Maine and Massachusetts.

Lime shipped from New York went in large quantity to New England, New Jersey, Ohio, and Pennsylvania, and shipments aggregating more than 1,000 tons each went to Alabama, Michigan, and Minnesota. New York received lime in large quantity from New England, Ohio, Pennsylvania, Virginia, and West Virginia and more than 1,000 tons from Alabama. Lime from Pennsylvania was shipped to 24 States and received from 11 States, the heaviest shipments being to adjacent States, particularly to New Jersey and New York, and the heaviest receipts from West Virginia, Ohio, and Maryland.

None of New Jersey's small production was shipped out of the State, and most of it was used for agriculture. Her principal sources of supply in order of amount received were Pennsylvania, Maryland, Virginia, and Ohio. Maryland ships to near-by States, principally to Pennsylvania, New Jersey, and Delaware; about half of what she consumes comes from West Virginia, Virginia, and Pennsylvania. The largest consumer of Virginia lime sent out of the State is North Carolina, and Maryland is second. The neighboring States, Pennsylvania, New Jersey, the District of Columbia, and Delaware, also received considerable quantities, as did New York, Ohio, and Wisconsin. A few hundred tons was shipped to Texas. Virginia received small quantities from several States, nearly all of them near by. The largest quantity, 12,000 tons, came from Ohio. West Virginia, though the fourth largest producer of lime in the

United States, ranked twentieth in consumption. Her largest shipments in order of quantity went to Pennsylvania, Maryland, New York, and Michigan. A few thousand tons was received from Ohio and Pennsylvania.

North Carolina and Florida produce only a few thousand tons, and South Carolina, Georgia, Mississippi, and Louisiana produce none. These States obtain most of their lime from Alabama and Tennessee. Lousiana in addition gets a few thousand tons from Missouri and Texas. Alabama's production exceeded her consumption, and very little lime was shipped into the State. Her market was mostly in the Southern States. The same may be said of Tennessee, with the addition that a few thousand tons went to Indiana and Ohio.

Kentucky's production and consumption were small. No lime was shipped out of the State, and adjoining States provided her supply. Ohio shipped large quantities of lime, including much hydrate, to Michigan, Indiana, Illinois, New York, New Jersey, and Pennsylvania. Ohio received lime principally from Indiana, New York, Pennsylvania, Tennessee, and West Virginia. Indiana produced somewhat more lime than it consumed and shipped considerable quantities to Illinois, Kentucky, Michigan, and Ohio. Illinois, on the other hand, consumed much more than it produced and drew large supplies from other States, more than 70,000 tons each from Missouri and Wisconsin and more than 20,000 tons from Indiana. Michigan used much more lime than it produced and received 9 tons to every ton sold outside the State. Her largest receipts came from Ohio and West Virginia. Shipments of a few thousand tons were sold to Indiana, Wisconsin, and Minnesota.

Wisconsin, whose production exceeded her consumption, shipped mainly to Illinois, small shipments going to other near-by States. Small lots, including specially prepared lime, were shipped as far east as New Jersey. Lime shipped into Wisconsin came chiefly from Indiana, Missouri, and Virginia. North Dakota, Kansas, and Nebraska did not produce lime, and Iowa, Minnesota, and South Dakota were small producers. All were small consumers, however. North Dakota derived the bulk of her supply from Minnesota, Nebraska and Kansas from Missouri, and Iowa from Illinois, Missouri, and Ohio (hydrated lime only). Missouri produced three times as much as she consumed, and she shipped to 30 States, the largest quantities to Illinois, Wisconsin, and Kansas.

None of the Rocky Mountain States produced more than 10,000 tons of lime in 1917. Montana, Wyoming, and Colorado each used more than was produced. Montana's largest purchase was hydrated lime from Washington; Wyoming received most of her supply from Missouri. Colorado, which produced 6,000 tons and used 16,000 tons, obtained more from Missouri than from any other State and received several hundred tons of quicklime from Pennsylvania. The larger part of her hydrated lime came from Ohio. Utah consumed nearly all her product, and her only receipt was a small quantity of hydrated lime from Missouri.

New Mexico, a small producer, augmented her supply by bringing a total of 1,200 tons from Arizona and Texas, and Arizona, producing three times as much as she used, sent more than two-thirds of her product to California.

California was the largest producer on the Pacific coast but brought in 12,000 tons from Arizona, 2,500 tons from Washington, and more than 100 tons of hydrated lime from Ohio. She shipped to Nevada and Oregon only. Oregon used nearly twice as much as she produced and acquired the difference from Idaho and Washington. She shipped virtually the same amount to Idaho as was received from that State, markets in each State being more readily reached from producing centers in the other State. Washington produced more than she needed. She shipped mainly to California and Oregon and received lime from Idaho.

CONSUMPTION PER CAPITA.

The apparent average consumption of lime per capita, as shown in the foregoing table, was 0.037 short ton in 1917, in comparison with 0.04 short ton in 1916. There was considerable variation in the different States—from 0.19 in Delaware to 0.003 in North Dakota and Porto Rico. Twelve States, as in 1916, had a per capita consumption above the average, and these, with the exception of Nevada, lie east of the Mississippi and from Virginia, inclusive, northward. By far the greatest per capita consumption was in the contiguous area covered by Pennsylvania, Maryland, Delaware, and Virginia and in Maine, which is second only to Delaware in per capita consumption. Illinois and New Jersey had a per capita consumption of 0.04 short ton, or about 13 ounces per individual, which was nearer the average per capita consumption of the country than that of any other State.

The States having the lowest per capita consumption were Kentucky, 0.008; New Mexico, 0.007; Arkansas, 0.006; Mississippi, 0.006; North Dakota, 0.003; and Porto Rico, 0.003. None of these States have any manufacturing centers that would consume large quantities of lime for building or for chemical purposes, only a small portion of their population is in cities or large towns, and by far the most of the inhabitants live in small houses and cabins that call for much less lime than the average dwelling in thickly populated States.

IMPORTS.

The quantity of lime imported in 1917 was 7,311 short tons, valued at $70,161, as compared with 7,959 short tons, valued at $71,663, in 1916. This quantity imported was about 0.2 per cent of the domestic marketed production.

Most of the lime imported into the United States came from Canada, and a considerable part of the Canadian lime was brought from British Columbia to Pacific coast ports. The source of the imported lime is shown below.

The following table of general imports, which in 1916 and 1917 were the same as imports for consumption, was compiled from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce:

Lime imported into the United States, 1915–1917.

	1915		1916		1917	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Germany	302	$5,547				
England	a 1	134	15	$64		
Canada	1,727	15,290	7,775	70,390	7,068	$69,144
Mexico	114	723	168	1,187	242	1,004
Hongkong	(b)	2				
Japan	(c)	11	1	22	d 1	13
	2,144	21,707	7,959	71,663	7,311	70,161

a 2,300 pounds. b 200 pounds. c 1,000 pounds. d 1,300 pounds.

EXPORTS.

Exports of lime, as shown in the following table, decreased in quantity but increased in value in 1917. They represent 0.5 per cent of the quantity marketed, compared with 0.6 per cent in 1916.

Lime exported from the United States, 1913–1917.

Year.	Quantity (short tons).	Value.	Average price per ton.
1913	29,475	$212,345	$7.20
1914	24,141	170,744	7.07
1915	16,223	106,312	6.55
1916	23,973	132,769	5.54
1917	18,794	168,671	8.97

The statistics in the following table were furnished by the Bureau of Foreign and Domestic Commerce, United States Department of Commerce.

Lime exported from the United States, 1916–1917.

Country.	1916		1917	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Canada	22,280	$107,820	16,087	$122,635
Newfoundland and Labrador	(a)	10		
Mexico	368	5,722	773	11,450
Central America:				
British Honduras	6	61	6	79
Costa Rica	13	164		
Guatemala	4	39	2	17
Honduras	167	1,454	313	3,554
Nicaragua	258	3,226	122	2,223
Panama	149	3,208	169	3,620
Salvador	(a)	9	6	93
West Indies:				
Cuba	161	1,553	190	2,429
Haiti	1	18		
Dominican Republic	247	4,947	388	9,602
Danish West Indies b	66	985	82	1,407
French West Indies			15	406
Barbados	5	100	90	2,114
Bermuda	(a)	6	(a)	12
Trinidad and Tobago	(a)	6	5	104
Other British West Indies	(a)	5	(a)	16

a Less than 1 ton.
b The Danish West Indies were transferred to the United States March 31, 1917, and are now known as the Virgin Islands of the United States.

Lime exported from the United States, 1916–1917—Continued.

Country.	1916		1917	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
South America:				
Argentina	(a)	$6	7	$239
Bolivia			(a)	10
Brazil	7	112	2	45
Chile	5	93	192	3,246
British Guiana			4	64
Dutch Guiana			3	49
French Guiana	1	20		
Peru	163	2,033	113	1,773
Venezuela	9	222	5	160
England			215	3,211
Scotland	34	340		
Australia	24	480		
Straits Settlements			(a)	18
British Oceania	5	130	2	56
French Oceania			3	37
German Oceania			(a)	2
	23,973	132,769	18,794	168,671

[a] Less than 1 ton.

Canada, as usual, received almost the entire exports, and Mexico and Central America received more than one-half of the remainder. Cuba and the Dominican Republic, the largest consumers in the West Indies, showed increase. Chile became the largest consumer in South America instead of Peru, increasing from 5 tons in 1916 to 192 tons in 1917. England, the only country in the Eastern Hemisphere to import more than 5 tons from the United States in 1917, imported 215 tons, as against none in 1916.

FUELS.

The following table shows that the number of kilns using various kinds of fuel decreased from 2,341 in 1916 to 1,966 in 1917. Kilns burning coal decreased from 1,254 to 1,138, about 9 per cent; those burning wood decreased about 37 per cent; those burning oil, 34 per cent; those burning natural gas, 28 per cent; those burning coke, 16 per cent; those burning coal and coke, 41 per cent; those burning producer gas decreased from 89 to 86; and those burning coal and wood increased from 176 to 182.

The number of coal-burning kilns in Massachusetts increased from 16 to 17, but the number burning coal and wood decreased from 16 to 11, indicating a shortage of wood. In a number of States the number of kilns burning coal decreased 25 to 60 per cent, as in Indiana, Maryland, and New Jersey; in other States there was a marked increase in coal-burning kilns, as in Ohio, Tennessee, and Virginia. The largest increase in number of coal-burning kilns was in Ohio, which had 224 in 1916 and 280 in 1917. Kilns in Ohio burning natural gas, however, decreased from 32 to 16, and those using producer gas decreased from 49 to 31. In Pennsylvania the number of coal-burning kilns decreased from 618 to 502, all kilns burning wood and natural gas were idle, those burning coke decreased from 92 to 65, but those using producer gas increased from 6 to 10.

States which have more than 20 kilns and in which the total number of kilns increased in 1917 are Illinois, Maine, Michigan, Ohio, and Tennessee.

Number of lime kilns using various kinds of fuel in 1916 and 1917.

1916.

State or Territory.	Coal.	Wood.	Oil.	Natural gas.	Producer gas.	Coke.	Shavings.	Coal and wood.	Coal and coke.	Total.
Alabama	7	6						20		33
Arizona		7								7
Arkansas		12								12
California		10	33		3					46
Colorado	6									6
Connecticut	5	27			4					36
Florida		16								16
Hawaii			2							2
Idaho		6				1				7
Illinois	2	5			2		a 9	11		29
Indiana	41	2			2					45
Iowa		5								5
Kansas	1									1
Kentucky	2	2			1			1		6
Maine	36	19								55
Maryland	48	3				b 49		8	23	131
Massachusetts	16	8			10			16		50
Michigan		23			1					24
Minnesota	7	5								12
Missouri	29	32			1			29		91
Montana		6								6
Nevada			2							2
New Jersey	19									19
New Mexico	3							1		4
New York	44	8			2			4		50
North Carolina								4		7
Ohio	224	7		c 32	49			5		318
Oklahoma		2								2
Oregon		3						2		4
Pennsylvania	618	34		1	6	92		39	64	856
Rhode Island	1	1								5
South Dakota	3	3								6
Tennessee	34	9						7		52
Texas	12	5	4	2		5				28
Utah	13	2				7				24
Vermont		4			5			7		12
Virginia	46	15			3	32		18		114
Washington		14								14
West Virginia	37	9				39		3		88
Wisconsin		115								115
Wyoming								1		1
	1,254	425	41	35	89	225	9	176	87	2,341

a Four kilns using also coal and wood.
b Three kilns using coke and wood.
c Two kilns using also coal and wood.

Number of lime kilns using various kinds of fuel in 1916 and 1917—Continued.

1917.

	Coal.	Wood.	Oil.	Natural gas.	Producer gas.	Coke.	Coal and wood.	Coal and coke.	Total.
Alabama	4	1					12		17
Arizona		5							5
Arkansas		7							7
California		6	23			5			34
Colorado	8								8
Connecticut	4	2			2		18		26
Florida		11							11
Hawaii			1						1
Idaho	1	6							7
Illinois	4	4		7			a 27		42
Indiana	31				2				33
Iowa		4							4
Kentucky	1	3							4
Maine	40	18							58
Maryland	26	4				50	3	a 28	111
Massachusetts	17	5			9		11		42
Michigan	2	17			16				35
Minnesota	8	4							12
Missouri	24	10			3		44		81
Montana	1	6							7
Nevada			3						3
New Jersey	6								6
New Mexico	3								3
New York	27	16			2				45
North Carolina							5		5
Ohio	280	6		a 16	31				333
Oklahoma		2							2
Oregon		3					3		6
Pennsylvania	502				10	65	23	20	620
Porto Rico	1	16							17
Rhode Island		1							1
South Dakota	2	3							5
Tennessee	42	1			1		8		52
Texas	14			2		2			18
Utah	5	3				6			14
Vermont		6			4		7		17
Virginia	52	13			3	22	12	3	105
Washington		12					1		13
West Virginia	33	1			3	39	7		83
Wisconsin		72							72
Wyoming							1		1
	1,138	268	27	25	86	189	182	51	1,966

a Includes in Illinois 13 kilns using shavings; in Maryland, 20 kilns using coal, wood, and coke; in Ohio, 2 kilns using coal, wood, and natural gas.

KILNS.

By W. E. Emley.

The accompanying table contains evidence of a certain amount of confusion in the common usage of the names applied to different types of limekilns. It was thought advisable to include kilns called "shaft," "vertical," "continuous," or "gas" in the column headed "flame or patent kilns," assuming these all to be different names for the same thing. It is possible that this assumption may be incorrect.

In order to avoid such confusion in the future, and for the broader purpose of establishing a system of nomenclature within the industry, the following definitions of the different types of kilns are suggested:

A "field" kiln is distinguished from all other types by being intermittent in its operation. Firing is continued until the contents of the kiln are calcined, when the kiln is entirely emptied. Under some conditions it may be demolished and rebuilt after each burn. A "continuous" kiln is a kiln of any type other than a field kiln.

A "pot" kiln is a vertical shaft kiln which is continuous in its operation. Its peculiar characteristic is that the fuel and stone are charged into the kiln in alternate layers.

A "flame" kiln is a vertical shaft kiln which is continuous in its operation. Its name is derived from the fact that only the flame of the fuel and not the fuel itself comes into contact with the stone or lime. This type is sometimes known as a "patent" kiln, but the term "flame" is to be preferred as more significant.

A "rotary" kiln needs no description.

The term "gas kiln" is to be avoided in this connection because it indicates the kind of fuel rather than the type of kiln.

Capacity and kind of limekilns used in United States in 1917.

State.	Capacity (short tons per day).	Pot.	Flame.	Rotary.	Field and unspecified.	Total.
Alabama	317	9	14			23
Arizona	110		10		1	11
Arkansas	127		12			12
California	494	11	17	6	2	36
Colorado	21				8	8
Connecticut	300		28			28
Florida	47	7	6		4	17
Hawaii	25		2			2
Idaho	42	2	5		1	8
Illinois	426	15	28		1	44
Indiana	486		42		1	43
Iowa	66		6			6
Kentucky	13	1			3	4
Maine	458		65			65
Maryland	605	88	10		24	122
Massachusetts	439	7	35	2	10	54
Michigan	585		38	1		39
Minnesota	93	1	11		1	13
Missouri	964	7	81		3	91
Montana	74	4	4			8
Nevada	42	3				3
New Jersey	25	8			4	12
New Mexico	12	2	1			3
New York	402	15	33		9	57
North Carolina	20		4		1	5
Ohio	3,626	173	186	1	8	368
Oklahoma	22	1	1			2
Oregon	37	1			3	4
Pennsylvania	3,638	173	283	7	225	688
Porto Rico					23	23
Rhode Island	20		3			3
South Dakota	9	1	2		4	7
Tennessee	546	5	48	1	13	67
Texas	316	4	24		2	30
Utah	96	3	9		7	19
Vermont	243	4	15	1	5	25
Virginia	1,123	45	58		24	127
Washington	216	5	20			25
West Virginia	1,095	43	27		13	83
Wisconsin	1,437	11	96		2	109
Wyoming					1	1
	18,617	649	1,224	19	403	2,295

STONE.

By G. F. Loughlin and A. T. Coons.

INTRODUCTION.

The tables in this report were completed about the middle of August, 1918, and advance statements showing the output of the more important products in 1917—such as limestone from Indiana, from Carthage, Mo., and from Warren County, Ky.; granite for paving blocks and building stones; limestone for furnace flux; lithographic stone; calcareous marl; mica schist for furnace lining; and "ganister" (sandstone) for furnace lining and for the manufacture of refractory brick—were published before September 1, 1918, by the Geological Survey.

Many of the reports of the larger producers were received at a later date than usual, the delay being due, as stated by them, to lack of clerical assistance. The same lack and additional work due to the war retarded the further publication by the Survey of the statistics of stone, but at the end of 1918 all the figures had been given to the public through the press.

The figures in this as in previous reports represent stone produced and sold or used by the quarrymen. They include only such manufactured products as are put on the market by the quarrymen themselves—some building and monumental stone, crushed stone, flagstone, curbstone, and paving blocks. The value given to these manufactured products is the price received by the producer free on board at point of shipment. The value given for the rough stone sold to local trade is, so far as ascertainable, that of the stone at the quarry, but occasionally, if the producer also delivers the stone, includes the cost of delivery. In a few places, where the producer has a long haul to market or to a railroad shipping point, this cost materially increases the selling price.

For the first time a full statement of the total quantity as well as the total value of the stone sold is given. On account both of the different units of quantity reported by different producers and of the different measurements used for the various products the accurate conversion of all of them to one unit (the short ton) has presented difficulties and has necessitated estimates based on the specific gravity of the various stones. Estimates were necessary also on about 5 per cent of the total value of the entire output, for which no quantities were given by the producers. The figures showing the quantity for 1916 presented for comparison contain a somewhat higher percentage of estimates but approximate the actual figures closely enough to permit a satisfactory comparison of the industry for the two years.

For simplicity of treatment the kinds of stone included under the statistics of this report are classified as granite, basalt and related rocks (trap rock), marble, limestone, sandstone, and "miscellaneous." Prior to 1917 small quantities of other kinds of stone less commonly used have been included in one or another of these groups; but as these other kinds of stone have been increasing both in quantity and in variety in recent years, the classification became less and less satisfactory, and they have been segregated under the heading "miscellaneous."

From "granite," which includes true granite and also such allied rocks as monzonite, syenite, and gneiss, have been excluded certain other igneous and metamorphic rocks which are quarried by too few producers to permit their production to be shown separately. The varieties of igneous rocks excluded are mostly of the light-colored volcanic type, such as tuff, rhyolite, trachyte, and andesite, but from time to time small quantities of dark igneous rocks, such as diorite and gabbro, used for monumental and building work are necessarily included with granite.

"Basalt and related rocks," included under the term "trap rock" until 1914, comprise, besides typical basalt and diabase, fine-grained diorite, gabbro, and other basic rocks which are less common in occurrence but are similar in chemical and physical properties and are used largely as crushed stone.

"Marble" includes a small quantity of serpentine quarried and sold as marble in California, Georgia, Maryland, Massachusetts, Pennsylvania, and Vermont, and also (when produced) a small quantity of the so-called onyx marble or travertine obtained from caves and other deposits in Kentucky and other States.

The "limestone" represented in the tables of this report does not include limestone burned into lime, bituminous limestone, nor limestone entering into the manufacture of Portland cement. Separate reports are made on the lime, asphalt, and cement industries.

"Sandstone" includes the quartzites of South Dakota, Minnesota, and Wisconsin and the fine-grained sandstones of New York and Pennsylvania, known to the trade as "bluestone." As "bluestone" is the product of a distinct local industry, its production is shown separately from that of the other sandstones. "Bluestone" is also quarried in New Jersey and West Virginia, but this output is small and is not separated from sandstone. In Kentucky most of the sandstone quarried and sold is known locally as freestone. The figures given for sandstone do not include the value of the grindstones, whetstones, and pulpstones made from sandstones quarried in Arkansas, Indiana, Michigan, Ohio, and West Virginia. These products are included in the report on abrasives. Sandstone crushed into sand and used in the manufacture of glass and as molding sand is considered in the report on sand and gravel.

"Miscellaneous" includes, as mentioned above, light-colored volcanic rocks including tuff, rhyolite, trachyte, andesite, and some mica schist, which have previously been classed with granite or basalt; flint rock, previously classed with limestone; conglomerate, argillite, and mica schist used for furnace lining previously classed with sandstone. The separation may not be complete for 1917, but it is hoped to make the classification better as more knowledge is obtained of the character of the stone for which statistical reports are made.

PRODUCTION.

PRODUCTION, BY KINDS OF STONE AND USES.

The total value of stone sold in the United States in 1917 was $82,215,671, an increase of 4 per cent over the value of that sold in 1916. This increase followed an increase of 6 per cent in 1916 and a decrease of 4 per cent in 1915. The quantity of stone sold in 1917 was approximately 83,562,000 short tons, a decrease of about 9 per cent from that sold in 1916. The increase in value in 1917 was due entirely to the greater value of limestone sold, as the total value of all other varieties of stone sold was less, the decrease ranging from 1 to 11 per cent. An increase of 12 per cent in the value of limestone was due to a large increase in the output of stone quarried for use as furnace flux—from 23,623,508 long tons, valued at $13,946,882, in 1916 to 25, 574,146 long tons, valued at $18,679,213, in 1917. The production of limestone sold to industrial works, such as paper mills, sugar factories, glass works, and alkali works, also showed an increase in both quantity and value. The output of limestone for agricultural use, however, decreased 3 per cent in quantity, although it increased 22 per cent in value.

Of the stone classified according to uses monumental stone increased in value and output, and paving stone remained about the same, an increase in the value of sandstone for paving offsetting decreases in the values of other varieties. Building stone, curbing, flagging, riprap, and crushed stone decreased in both quantity and value.

The value of monumental stone in 1917 ($8,102,493) increased 10 per cent over the value in 1916 ($7,372,620). This is the largest value ever reported. It was due to the increase of 38 cents in the average price per cubic foot, as the quantity decreased 10 per cent—from 4,553,040 cubic feet in 1916 to 4,058,626 cubic feet in 1917. In 1917, 83 per cent of the quantity and 70 per cent of the value was for granite, the remainder being for marble.

Continued depression in the building industry in 1917, which affected the better grade of building stone of all kinds, caused a decrease of more than 17 per cent in value and of 30 per cent in quantity. The output for 1917 was 17,467,920 cubic feet, valued at $12,102,914, and that for 1916 was 25,060,040 cubic feet, valued at $14,677,808. The value of paving blocks sold in 1917 was $2,732,434, practically the same as in 1916. This sum represented an output of 48,907,670 blocks, having an average value per 1,000 blocks of $55.87. Though figures showing the exact quantity produced in 1916 are not available, a close estimate, based on an exact knowledge of 87 per cent of the output, showed an output of 55,061,840 blocks, a decrease of 11 per cent. The value of both curbing and flagging decreased 13 per cent in 1917, that of stone for riprap decreased 31 per cent, and that of stone for rubble increased nearly 5 per cent. The figures representing sales of stone of these classes are as follows: Curbing, 3,698,280 linear feet, valued at $1,402,980; flagging, 3,027,110 square feet, valued at $356,327; riprap, 2,933,877 short tons, valued at $2,208,373; rubble, 915,646 short tons, valued at $864,321. Crushed stone amounting to 40,285,377 short tons, valued at $29,065,509, was produced in 1917, a decrease of 7,790,204 tons (16 per cent) in quantity and $397,043 (1.3 per cent) in value. The average value was 72 cents a ton in 1917, an increase of 11 cents.

Value of the different kinds of stone produced and sold in the United States, 1908–1917

Year.	Granite.	Basalt and related rocks (trap rock).[a]	Sandstone.	Marble.	Limestone.	Miscellaneous.[b]	Total.
1908	$18,420,080	$4,282,406	$7,594,091	$7,733,920	$27,682,002	....	$65,712,499
1909	19,581,597	5,133,842	8,010,454	6,548,905	32,070,401	....	71,345,199
1910	20,541,967	6,452,141	7,930,019	6,992,779	34,603,678	....	76,520,584
1911	21,194,228	6,739,141	7,730,868	7,546,718	33,897,612	....	77,108,567
1912	19,223,302	7,560,049	6,893,611	7,786,458	36,729,800	....	78,193,220
1913	20,733,217	9,134,494	7,248,965	7,870,890	38,745,429	....	83,732,995
1914	20,160,730	7,865,998	7,501,808	8,121,412	33,894,155	....	77,544,103
1915	17,864,439	8,489,222	6,095,800	6,916,025	35,229,866	....	74,595,352
1916	17,456,838	7,666,297	5,603,778	7,033,171	41,309,599	....	[c]79,069,683
1917	15,544,957	7,570,885	5,512,421	6,330,387	46,263,379	$993,642	82,215,671
Percentage of increase or decrease in 1917	−11.0	−1.2	−1.6	−10.0	+12.0	....	+4.0
Percentage of total	18.9	9.2	6.7	7.7	56.3	1.2	100

[a] The term "trap rock" has been variously interpreted and in some localities has been made to include a number of widely different rocks. It is here replaced by the title "basalt and related rocks."
[b] Includes mica schist used for furnace lining, conglomerate, argillite, and various light volcanic rocks used mainly for crushed stone, which can not be properly classified in any of the main groups.
[c] Revised figures.

Stone sold in the United States in 1916 and 1917.

Use.	1916		1917	
	Quantity.	Value.	Quantity.	Value.
Building stone .... cubic feet..	25,060,040	$14,677,808	17,467,920	$12,102,914
Approximate equivalent in short tons	2,106,050	....	1,469,120	....
Monumental stone .... cubic feet..	4,553,040	7,372,620	4,058,626	8,102,493
Approximate equivalent in short tons	382,960	....	341,420	....
Paving blocks .... number..	55,061,840	2,730,861	48,907,670	2,732,434
Approximate equivalent in short tons	575,250	....	511,060	....
Curbing .... linear feet..	4,609,830	1,611,001	3,698,280	1,402,980
Approximate equivalent in short tons	246,370	....	196,800	....
Flagging .... square feet..	3,183,000	409,665	3,027,110	356,327
Approximate equivalent in short tons	78,700	....	73,330	....
Rubble .... short tons..	1,034,660	825,330	915,646	864,321
Riprap .... do....	5,315,340	3,635,167	2,933,877	2,208,373
Crushed stone .... do....	48,075,581	29,462,552	40,285,377	29,065,509
Furnace flux (limestone) .... long tons..	23,623,508	13,946,882	25,574,146	18,679,213
Equivalent in short tons	26,458,329	....	28,640,044	....
Refractory stone[a] .... short tons..	898,518	577,109	1,573,573	1,607,743
Manufacturing industries (limestone) .... do....	4,734,420	2,847,339	5,446,558	4,070,351
Other uses .... do....	1,924,490	973,349	1,175,070	1,023,013
Total (quantities, approximate in short tons).	91,831,000	79,069,683	83,562,000	82,215,671

[a] In 1916 includes ganister and mica schist; in 1917, ganister, mica schist, and dolomite.

Value of stone sold in 1916 and 1917, by kinds and uses.

	Building (rough and dressed).	Monumental (rough and dressed).	Paving.	Curbing.	Flagging.	Rubble.	Riprap.	Crushed.	Other.	Total.
1916.										
Granite	$3,964,433	$5,293,210	$2,331,742	$828,761	$9,395	$254,129	$992,788	$3,543,416	$238,964	$17,456,838
Basalt and related rocks (trap rock)	64,277		571,618			186,491	796,048	6,539,008	22,855	7,666,297
Sandstone	1,316,287	(b)	327,264	702,902	389,859	86,938	488,874	1,664,694	626,960	5,603,778
Limestone	4,588,205	(b)	14,237	79,338	10,411	297,772	1,357,457	17,715,434	17,246,745	41,309,599
Marble	a 4,744,606	2,079,410						(b)	209,155	7,033,171
	14,677,808	7,372,620	2,730,861	1,611,001	409,665	825,330	3,635,167	29,462,552	18,344,679	79,069,683
1917.										
Granite	3,161,294	5,704,776	2,319,598	699,444	(b)	199,766	583,409	2,700,620	176,050	15,544,957
Basalt and related rocks (trap rock)	39,200		52,755			328,561	506,616	6,600,957	42,796	7,570,885
Sandstone	1,043,226	(b)	352,808	651,564	348,000	65,667	263,464	1,400,705	1,386,987	5,512,421
Limestone	4,115,366	(b)	7,273	51,927	8,327	270,327	854,884	17,541,098	23,414,132	46,263,379
Marble	3,702,563	2,397,717							230,107	6,330,387
Miscellaneous	41,265							822,129	130,248	993,642
	12,102,914	8,102,493	2,732,434	1,402,980	356,327	864,321	2,208,373	29,065,509	25,380,320	82,215,671
Percentage of increase or decrease for 1917	−17.5	+9.9	+0.06	−12.9	−13.0	+4.7	−30.9	−1.3	+38.4	+4.00

a Includes stone for both exterior and interior building.

b Small values included under "Other."

PRODUCTION, BY STATES.

Pennsylvania, Ohio, Vermont, New York, and Indiana were the ranking States in value of stone produced in 1917 as in 1916. Of the 50 producing States and Territories in 1917—two more (Nevada and Mississippi) than in 1916—28 decreased and 22 increased the value of their output. In the region east of Mississippi River 15 States showed increase and 11 States decrease in value of output; in the region west of this river 9 States showed increase and 15 States decrease in value of output.

Wyoming, which ranked forty-third, made the greatest percentage of increase (142 per cent) in value in 1917, an increase due to a large output of stone for use in sugar factories. Delaware, which ranked forty-first, made an increase of 78 per cent in value, owing to stone quarried for use by the United States Government for the Reedy Island breakwater in Delaware River. The percentages of increase made by Michigan, Alabama, Pennsylvania, West Virginia, and New Jersey (37 per cent, 34 per cent, 27 per cent, 22 per cent, and 12 per cent, respectively) were due almost entirely to the increase in the value of furnace flux. In all these States except Pennsylvania there was an increase in both quantity and value. Other States showing a noteworthy increase in value were Florida (36 per cent), for building stone, crushed stone, and stone for use in agriculture; Kansas (11 per cent), for crushed stone; Maine (17 per cent), for building stone; Nebraska (17 per cent) and South Dakota (11 per cent), for stone for use in sugar factories. The largest decrease was in Washington (49 per cent) and was due to lessened production of riprap. The decrease in the other States ranged from 0.1 to 21 per cent, and included stone for all purposes.

The number of plants reporting operations in 1917 was 2,647, which was 388 less than in 1916. A large number of the small quarries were closed on account of scarcity of labor, increased cost of supplies, lack of local demand, and substitution of cheaper material. Many of the larger producers reported that the demand was very good, but that shortage of cars and railroad embargoes on shipments curtailed the output. The increase in the cost of operation was from 20 to 75 per cent and the advance in the selling price was from 20 to 50 per cent. Many contracts entered into early in the year were made unprofitable by the constantly increasing costs without corresponding change in price.

Value of stone sold in the United States, 1916 and 1917, by States.

1916.

Rank of State.	State or Territory.	Total value.	Percentage of total.	Number of plants.
1	Pennsylvania	$11,021,655	13.94	516
2	Ohio	6,611,266	8.36	183
3	Vermont	5,729,676	7.25	56
4	New York	5,342,954	6.76	197
5	Indiana	4,657,813	5.89	105
6	Illinois	3,403,094	4.31	91
7	Massachusetts	3,138,165	3.97	118
8	California	3,133,305	3.96	126
9	Wisconsin	2,757,790	3.49	181
10	Michigan	2,494,284	3.16	45
11	Missouri	2,242,742	2.84	155
12	North Carolina	1,975,876	2.50	43
13	Minnesota	1,833,800	2.32	84
14	Georgia	1,799,210	2.28	39
15	Tennessee	1,753,180	2.22	66
16	New Jersey	1,655,692	2.09	79
17	Virginia	1,580,161	2.00	71
18	West Virginia	1,500,809	1.90	60
19	Kentucky	1,429,838	1.78	119
20	Alabama	1,202,256	1.52	25
21	Connecticut	1,143,011	1.45	52
22	New Hampshire	1,141,810	1.44	28
23	Maine	1,068,485	1.35	51
24	Colorado	975,794	1.23	47
25	Maryland	921,909	1.17	53
26	Washington	903,635	1.14	26
27	Texas	698,449	.88	37
28	Rhode Island	632,452	.80	18
29	Oklahoma	621,056	.79	32
30	Kansas	603,490	.76	65
31	Iowa	561,084	.71	64
32	Florida	479,837	.61	18
33	South Carolina	447,940	.57	20
34	Oregon	443,524	.56	29
35	Alaska	(a)		2
36	Nebraska	406,707	.51	17
37	Hawaii	393,477	.50	9
38	Arkansas	374,465	.47	16
39	Utah	368,705	.47	16
40	Arizona	306,579	.39	15
41	Montana	261,460	.33	13
42	South Dakota	205,497	.26	18
43	Delaware	121,354	.15	5
44	Idaho	96,382	.12	7
45	New Mexico	77,290	.10	6
46	Wyoming	64,509	.08	6
47	Louisiana	(a)		1
48	District of Columbia	3,315	.62	5
	Undistributed	483,901		
		79,069,683	100.00	3,035

a Included in "Undistributed."

Value of stone sold in the United States, 1916 and 1917, by States—Continued.

1917.

Rank of State.	State or Territory.	Total value.	Percentage of total.	Number of plants.
1	Pennsylvania	$14,048,158	17.09	459
2	Ohio	6,486,605	7.89	162
3	Vermont	5,920,799	7.20	48
4	New York	5,399,403	6.57	156
5	Indiana	4,449,809	5.41	93
6	Michigan	3,423,825	4.16	35
7	Illinois	3,322,041	4.04	82
8	Massachusetts	3,113,423	3.79	107
9	California	2,911,462	3.54	104
10	Wisconsin	2,787,023	3.39	147
11	Missouri	1,983,300	2.41	137
12	North Carolina	1,896,554	2.31	47
13	New Jersey	1,860,397	2.26	72
14	West Virginia	1,841,071	2.24	51
15	Georgia	1,797,098	2.19	35
16	Minnesota	1,711,318	2.08	66
17	Tennessee	1,635,573	1.99	69
18	Virginia	1,612,118	1.96	68
19	Alabama	1,611,497	1.96	29
20	Maine	1,254,637	1.53	40
21	Connecticut	1,238,684	1.51	46
22	Kentucky	1,118,434	1.36	90
23	Maryland	938,637	1.14	42
24	New Hampshire	921,943	1.12	23
25	Colorado	823,904	1.00	47
26	Texas	697,540	.85	28
27	Kansas	673,831	.82	57
28	Florida	654,845	.80	16
29	Oklahoma	625,048	.76	28
30	Iowa	520,083	.63	45
31	Rhode Island	518,785	.63	16
32	Hawaii	483,453	.59	7
33	Nebraska	476,307	.58	15
34	Washington	454,594	.55	26
35	South Carolina	427,531	.52	15
36	Oregon	413,867	.50	27
37	Arkansas	371,732	.45	15
38	Arizona	319,724	.39	15
39	Utah	305,968	.37	17
40	Montana	255,835	.31	15
41	Delaware	216,346	.26	5
42	South Dakota	182,907	.22	15
43	Wyoming	156,180	.19	9
44	Idaho	94,644	.12	6
45	Alaska	(a)		1
46	New Mexico	72,411	.09	5
47	Louisiana	(a)		1
48	Nevada	31,625	.04	3
49	District of Columbia	4,615	.01	4
50	Mississippi	(a)		1
	Undistributed	150,087	.18	
		82,215,671	100.00	2,647

a Included in "Undistributed."

EXPORTS.

In spite of generally unfavorable building markets and of difficulties in shipping, the value of stone exported from the United States in 1917 was $1,680,282, which was 13 per cent more than in 1916. The value of the unmanufactured stone exported increased 42 per cent and that of the manufactured stone about 3 per cent.

The following tables were compiled by J. A. Dorsey from statistics furnished by the Bureau of Foreign and Domestic Commerce, Department of Commerce:

Stone exported from the United States 1913–1917.

Kind.	1913	1914	1915	1916	1917
Marble and stone, unmanufactured	$606,745	$559,556	$400,510	$403,303	$572,097
All others	1,250,147	803,686	635,614	1,077,447	1,108,185
	1,856,892	1,363,242	1,036,124	1,480,750	1,680,282

Comparison of exports to different countries given in the table on page 624 shows that about 68 per cent of the total value of the exports in 1917 represented stone shipped to countries in North America, an increase of 35 per cent over 1916. Canada, as usual, took the greater part of the exports (81 per cent, valued at $929,434), which represented an increase over 1916 in both manufactured and unmanufactured stone. Cuba ranked second, with $72,810, but its imports decreased 13 per cent; Mexico stood third, with $58,880, an increase of 366 per cent; and Panama stood fourth, with $33,037, an increase of 56 per cent.

The exports of stone to Europe, which represented 25 per cent of the total value of the exports of stone in 1916, represented only 14 per cent of the total value in 1917. They fell from $371,723 to $230,109, a decrease of 38 per cent. Great Britain, with $169,672, and Italy, with $93,843, our best customers in 1916, took considerably less stone in 1917—34 per cent and 86 per cent less, respectively. The value of the stone exported to France ($46,770) increased 34 per cent. The value of that exported to South America ($146,271) increased 51 per cent. Argentina, Brazil, and Chile were our best customers in South America. The exports to Asia, valued at $93,981, decreased 15 per cent. Nearly one-half of this value represents stone shipped to the Dutch East Indies, and about one-fourth represents stone shipped to the British East Indies. The value of the stone exported to Oceania and Africa showed an increase.

Stone (including marble) exported from the United States in 1916 and 1917.

Country.	Manufactured.	Unmanufactured.
1916.		
Europe:		
Denmark	$8,146	$5
France	33,129	1,779
Great Britain	162,063	7,609
Greece	2,904	....
Italy	93,843	....
Netherlands	10,307	300
Norway	9,416	3,873
Russia	2,799	....
Sweden	3,100	....
Other Europe	31,782	668
	357,489	14,234
North America:		
Canada	325,274	368,135
Newfoundland	6,550	2,607
Mexico	9,027	3,608
Central America	6,973	693
Panama	19,292	1,794
Cuba	77,418	6,824
Bermuda	721	10
Jamaica	5,622	33
Other British West Indies	1,793	83
French West Indies	218	....
Other West Indies	5,903	389
	458,791	384,176
South America:		
Argentina	41,993	201
Brazil	15,729	1,636
Chile	8,728	450
Colombia	12,630	699
Peru	4,890	145
Uruguay	1,681	....
Venezuela	3,630	115
Other South America	4,068	134
	93,349	3,380
Asia:		
China	4,439	....
British East Indies	62,311	....
Dutch East Indies	7,354	....
Japan	10,901	1,011
Other Asia	25,534	15
	110,539	1,026
Oceania:		
Australia	21,643	110
New Zealand	11,269	....
Philippines	1,497	7
Other Oceania	207	....
	34,616	117
Africa:		
British South Africa	20,360	370
Other Africa	2,303	....
	22,663	370
Total exports	1,077,447	403,303
Grand total	1,480,750	

Country.	Manufactured.	Unmanufactured.
1917.		
Europe:		
Denmark	$4,779	....
France	46,539	$231
Great Britain	111,387	1,181
Greece	250	....
Italy	13,314	....
Netherlands	584	....
Russia in Europe	3,271	....
Sweden	2,161	....
Other Europe	46,412	....
	228,697	1,412
North America:		
Canada	405,433	524,001
Newfoundland, Labrador, etc	7,175	2,157
Mexico	29,417	29,463
Central America	8,479	240
Panama	30,869	2,168
Cuba	66,718	6,092
Jamaica	5,874	....
Other British West Indies	10,692	64
French West Indies	561	....
Other West Indies	8,254	244
	573,472	564,429
South America:		
Argentina	41,877	....
Brazil	31,402	124
Chile	29,388	803
Colombia	12,218	....
Peru	9,677	4,494
Uruguay	1,358	6
Venezuela	4,703	30
Other South America	10,191	....
	140,814	5,457
Asia:		
China	8,867	25
British India	21,570	....
Dutch East Indies	43,949	30
Japan	9,852	701
Other Asia	8,987	....
	93,225	756
Oceania:		
Australia	31,640	....
New Zealand	11,010	....
Philippines	1,769	30
Other Oceania	595	13
	45,014	43
Africa:		
British South Africa	25,106	....
Other Africa	1,857	....
	26,963	....
Total exports	1,108,185	572,097
Grand total	1,680,282	

IMPORTS.

The term "general imports" in this publication embraces both imported articles entered for immediate consumption on arrival and articles entered for warehouse, as distinguished from the "imports for consumption," which embrace imports entered for immediate consumption and withdrawals from warehouse for consumption.

The statement of general imports and the statement of imports for consumption for any period will differ to the extent that the value of the entries for warehouse for the period differs from the value of the withdrawals from warehouse for consumption. The term "entry for consumption" is the technical name of the import entry made at the customhouse and does not imply that the goods have been actually consumed, but simply that they have been delivered into the custody of the importer and that the duties have been paid on the dutiable portion.

The stone imported for consumption in the United States in 1917 was valued at $681,475, which was $277,892, or 29 per cent, less than in 1916. The imports of marble, including the usual small imports of "onyx marble," amounted to $581,422, or 85 per cent of the total stone imported for consumption, a decrease of $141,989, or 20 per cent, compared with 1916.

Stone imported for consumption in the United States in 1915, 1916, and 1917.

Kind.	1915		1916		1917	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Marble:						
In block, rough, etc........cubic feet..	334,279	$488,157	350,941	$529,125	267,250	$428,396
Sawed..........................do....	76	61	51	246	9	25
Slabs or paving tiles......square feet..	95,778	18,388	70,545	15,221	124,935	27,884
All other manufactures..................	....	87,429	....	122,145	....	87,177
Mosaic cubes:						
Loose...................................	....	13,697	....	22,285	....	13,434
Attached to paper.......................	....	19	....	....	....	....
	....	607,751	....	689,022	....	556,916
Onyx:						
In blocks, rough, etc.......cubic feet..	5,944	30,184	9,071	32,282	6,935	22,439
Slabs or paving tiles......square feet..	....	....	....	....	5,976	1,595
All other manufactures..................	....	522	....	2,077	....	472
	....	30,706	....	34,359	....	24,506
Granite:						
Dressed.................................	....	134,720	....	66,331	....	25,119
Rough.....................cubic feet..	18,956	9,662	23,773	9,366	18,982	9,923
	....	144,382	....	75,697	....	35,042
Stone (other):						
Dressed.................................	....	14,254	....	11,456	....	15,296
Rough (monumental or building stone), cubic feet............................	83,758	41,557	95,005	66,337	53,537	40,330
Rough (other)...........................	....	54,018	....	82,496	....	9,385
	....	109,829	....	160,289	....	65,011
Grand total.............................	....	892,668	....	959,367	....	681,475

More than 90 per cent of the marble imported came from Italy. England and France, the countries furnishing the next largest imports, together sent less than 8 per cent. Mexico, which ranked next to Italy in 1915 and 1916 and annually sent general imports of marble averaging in value about $34,000, furnished general imports valued at only $3,257 in 1917. Mexico supplied mainly or wholly "onyx marble." The preceding table, however, shows that the value of the onyx imported in 1917 was $24,506, and as the greater part of this doubtless came from Mexico, the great difference between the figures given indicates that during the year a much larger quantity was taken from warehouses and marketed than was brought into the country. No imports of Grecian marble were recorded for 1917, but some of the marble received from England (which nearly doubled in value) may have come from Greece through England.

The port of entry for 86 per cent of the marble imported in 1917 was New York. Practically all the French, Mexican, and Japanese marble was received at this port. Of the Italian marble 87 per cent entered by New York and 7 per cent by Chicago. About half of the marble imported from England entered at Chicago and half at New York.

General imports of marble and onyx, rough and manufactured, into the United States in 1916 and 1917.

1916.		1917.	
Belgium	$99	France	$18,952
France	32,069	Gibraltar	49
Greece	9,688	Italy	516,239
Italy	640,805	Spain	208
Great Britain	11,870	England	22,493
Denmark	4,179	Ireland	73
Spain	598	Total Europe	558,014
Total Europe	699,308	Canada	314
Canada	891	Mexico	3,257
Mexico	35,657	Cuba	1,917
Cuba	216	Total North America	5,488
Guatemala	2	Other countries[a]	4,338
Total North America	36,766	Grand total	567,840
Other countries	1,614		
Grand total	737,688		

[a] Includes China, Japan, Hongkong, Philippine Islands, and Colombia.

The value of the granite imported decreased 53 per cent in 1917, this decrease following a decrease of 47 per cent in 1916. The value of dressed granite decreased 62 per cent. The value of rough granite increased slightly, but the quantity decreased 20 per cent.

The value of stone other than marble and granite imported in 1917 decreased nearly 60 per cent. Dressed stone showed a larger value in 1917 than in either 1915 or 1916, but rough building and monumental stone decreased both in quantity (43 per cent) and in value (39 per cent), and other rough stone decreased in value 89 per cent. The general decrease in the value of stone imported was due mainly to lack of shipping facilities. In March, 1918, an embargo was placed on the imports of monumental and building stone, but it is stated that some stone shipped from the allied countries has been admitted since then on condition that the time necessary for its loading and unloading should not appreciably delay the delivery of material essential to the prosecution of the war.

GRANITE.

GENERAL STATISTICS.

The figures here given for the granite produced and sold in the United States in 1917 represent for the first time both quantity and value. Small quantities of other crystalline and igneous rocks such as schist, rhyolite, trachyte, and andesite, heretofore included under granite, have been omitted from the table for 1917 and included under a general group entitled "Miscellaneous."

Gabbro and diabase, or "black granite," quarried for monumental work have, however, been included, and also syenite, monzonite, and gneiss, which are closely related to granite, both geologically and commercially. The tables given in previous reports showing the production of the most important granite States in detail have been omitted, as the table on pages 629–630 shows the quantity of every product in each State. Production by counties has become impracticable on account of the closing of many quarries. For localities of production the reader is referred to previous reports.

The granite sold in the United States in 1917 amounted to 5,564,200 short tons, valued at $15,544,957, about 7 per cent of the quantity and 19 per cent of the value of the entire output of stone during the year. The figures show a decrease of 40 per cent in quantity and 11 per cent in value from 1916 and were the lowest recorded in any year since 1901. The same adverse conditions were reported by the quarrymen for 1917 as for 1916—high wages, shortage of cars and boats for transportation, lack of labor, and high cost of all supplies, as well as substitution of cheaper material. Prices were advanced but, according to many producers, not enough to cover the increased cost of production.

As 1917 is the first year for which complete figures showing the quantity of granite produced have been recorded, in order to compare the production with that of 1916, the output in that year has been revised and determined largely from actual reports and partly from estimates. The quantities are given according to the usual unit of measurement, but in order to get the total the units have been reduced to short tons.

Granite produced in the United States in 1916 and 1917.

	1916		1917	
	Quantity.	Value.	Quantity.	Value.
Building stone (rough and dressed)......cubic feet..	7,067,060	$3,964,433	3,604,330	$3,161,294
Approximate equivalent in short tons...........	593,600	....	302,800	....
Monumental stone......................cubic feet..	3,611,960	5,293,210	3,373,068	5,704,776
Approximate equivalent in short tons...........	303,000	....	282,800	....
Paving..........................number of blocks..	45,961,245	2,331,742	40,224,951	2,319,598
Approximate equivalent in short tons...........	482,600	....	422,400	....
Curbing..............................linear feet..	[a] 2,002,600	828,761	1,401,783	699,444
Approximate equivalent in short tons...........	111,300	....	77,900	....
Rubble..............................short tons..	[a] 250,000	254,129	164,712	199,766
Riprap......................................do....	[a] 2,207,000	992,788	1,018,452	583,409
Crushed stone...............................do....	4,723,305	3,543,416	3,065,126	2,700,620
Other stone.................................do....	[a] 600,000	248,359	[a] 230,000	176,050
Total (quantities approximate, in short tons)..	[a] 9,270,800	17,456,838	[a] 5,564,200	15,544,957

[a] Estimated in part.

Value of granite sold in the United States in 1916, by States and uses.

State.	Sold in the rough.				Dressed for—		Made into paving blocks.	Curbing, and flagging.	Crushed stone.			Other.	Total.
	Build-ing.	Monu-mental.	Rubble.	Riprap.	Building.	Monu-mental.			Road metal.	Railroad ballast.	Concrete.		
Arizona	(a)	(a)	....	(a)	(a)	(a)	....	....	(a)	(a)	(a)	....	$203,702
California	$6,933	$25,201	$824	$350,160	$316,864	$98,495	$17,963	$53,611	$196,340	$122,154	$203,833	$40,644	1,433,022
Colorado	7,910	15,276	(a)	....	(a)	21,040	....	....	....	....	(a)	(a)	78,823
Connecticut	29,723	50,937	2,360	50,536	35,939	61,188	17,975	14,754	(a)	....	....	6,777	270,740
Delaware	(a)	(a)	(a)	53,026	(a)	....	(a)	(a)	(a)	....	(a)	(a)	121,354
District of Columbia	....	....	2,950	....	....	....	....	....	....	....	....	(a)	3,315
Georgia	9,918	36,764	18,099	160	91,066	(a)	105,350	224,560	51,587	29,028	156,801	(a)	813,068
Maine	152,792	51,337	....	1,961	274,295	48,930	430,753	96,510	3,702	(a)	(a)	137	1,068,485
Maryland	86,481	11,334	4,896	(a)	9,367	7,369	32,646	....	169,300	194,061	114,755	2,095	633,218
Massachusetts	192,896	412,778	31,738	4,671	636,552	30,685	287,640	167,399	86,798	1,262	97,315	47,416	1,997,150
Minnesota	(a)	68,521	5,447	20,811	243,572	596,918	85,106	(a)	(a)	....	(a)	200	1,048,816
Missouri	(a)	(a)	(a)	(a)	(a)	....	37,094	(a)	(a)	....	(a)	(a)	80,390
Montana	(a)	(a)	(a)	....	9,665	5,635	....	....	....	....	....	....	18,175
New Hampshire	58,441	56,019	7,024	(a)	436,954	210,170	247,177	79,636	16,233	....	(a)	22,720	1,141,810
New Jersey	1,517	....	....	(a)	(a)	....	....	....	(a)	(a)	....	(a)	91,421
New Mexico	....	....	....	....	....	....	....	....	....	(a)	....	....	(a)
New York	15,230	2,810	(a)	(a)	158,201	(a)	(a)	....	27,354	(a)	25,457	(a)	368,119
North Carolina	11,079	57,673	84,106	160,140	8,965	379,197	200,851	124,845	88,437	69,210	558,476	55,108	1,798,087
Oklahoma	....	(a)	(a)	(a)	35,250	15,059	....	....	....	....	....	(a)	80,597
Oregon	....	(a)	....	....	(a)	(a)	....	(a)	(a)	....	....	....	17,080
Pennsylvania	224,360	(a)	22,724	18,903	24,900	(a)	(a)	10,878	21,648	(a)	31,082	(a)	446,868
Rhode Island	26,529	170,511	(a)	(a)	37,923	115,353	35,027	16,270	118,781	....	82,484	28,150	631,237
South Carolina	1,667	(a)	24,993	20,455	(a)	....	....	13,210	(a)	15,160	267,807	....	447,570
South Dakota	....	....	....	....	(a)	(a)	....	....	....	....	(a)	....	(a)
Texas	1,056	34,541	....	(a)	....	(a)	....	2,400	....	....	....	(a)	84,379
Utah	(a)	....	....	....	....	....	....	....	....	....	....	....	(a)
Vermont	30,930	1,547,075	(a)	(a)	641,927	320,919	41,966	(a)	(a)	....	(a)	8,601	2,598,835
Virginia	27,694	6,010	4,967	69,889	(a)	(a)	19,115	(a)	158,351	54,795	70,061	8,505	451,697
Washington	(a)	(a)	(a)	(a)	24,736	10,858	....	(a)	(a)	....	(a)	(a)	90,525
Wisconsin	1,474	23,115	6,359	(a)	(a)	498,511	685,622	1,105	84,274	....	82,478	(a)	1,390,968
Undistributed	16,416	114,680	37,642	242,076	75,211	188,301	87,457	32,978	157,151	95,669	91,572	18,111	67,387
	903,046	2,684,582	254,129	992,788	3,061,387	2,608,628	2,331,742	838,156	1,179,956	581,339	1,782,121	238,964	17,456,838

a Included in "Undistributed."

Granite sold in the United States in 1917, by States and uses.

State.	Sold in the rough.				Dressed for—			
	Building.		Monumental.		Building.		Monumental.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Cubic ft.		*Cubic ft.*		*Cubic ft.*		*Cubic ft.*	
Arizona	(a)	(a)	(a)	(a)	....	....	(a)	(a)
California	11,464	$8,253	36,693	$34,475	57,140	$201,454	15,788	$64,902
Colorado	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Connecticut	92,376	20,789	43,234	52,816	11,353	23,546	11,965	61,970
Delaware	99,002	12,957	....	....	(a)	(a)	....	....
Dist. of Columbia	(a)	(a)	....	....	....	....	....	....
Georgia	7,494	3,491	57,391	27,792	61,800	160,698	12,400	39,474
Maine	262,925	100,941	58,629	49,658	144,240	425,363	7,651	17,564
Maryland	267,668	55,112	(a)	(a)	(a)	(a)	....	....
Massachusetts	570,251	143,847	335,956	394,644	291,370	495,156	30,782	85,924
Minnesota	(a)	(a)	73,120	91,475	52,666	120,335	191,074	711,895
Missouri	(a)	(a)	(a)	(a)	(a)	(a)	....	....
Montana	991	929	(a)	(a)	3,844	13,435	2,111	9,935
New Hampshire	89,988	78,859	81,476	64,549	88,150	258,749	74,902	187,973
New Jersey	1,577	1,647	....	....	....	....	....	....
New York	163	206	(a)	(a)	(a)	(a)	(a)	(a)
North Carolina	23,674	4,952	82,739	41,931	8,500	8,100	107,998	351,090
Oklahoma	....	....	12,307	11,807	(a)	(a)	2,775	5,550
Oregon	....	....	(a)	(a)	(a)	(a)	(a)	(a)
Pennsylvania	1,047,826	87,978	(a)	(a)	(a)	(a)	(a)	(a)
Rhode Island	12,458	4,139	105,323	158,702	(a)	(a)	(a)	(a)
South Carolina	7,308	582	(a)	(a)	(a)	(a)	(a)	(a)
South Dakota	....	....	....	....	....	....	(a)	(a)
Texas	(a)	(a)	27,280	32,050	....	....	2,800	17,245
Utah	....	....	(a)	(a)	....	....	....	....
Vermont	(a)	(a)	1,478,623	1,693,653	191,689	596,757	141,841	506,856
Virginia	14,457	27,217	(a)	(a)	(a)	(a)	(a)	(a)
Washington	....	....	6,825	5,514	8,732	23,703	4,310	9,626
Wisconsin	(a)	(a)	15,809	16,774	....	....	99,446	521,596
Undistributed	89,310	59,590	208,030	183,300	85,914	222,509	43,790	254,036
	2,598,932	611,489	2,623,435	2,859,140	1,005,398	2,549,805	749,633	2,845,636
Average price	....	$0.24	....	$1.09	....	$2.53	....	$3.80

State.	Made into paving blocks.		Curbing and flagging.		Rubble.		Riprap.	
	Number of blocks.	Value.	Quantity.	Value.	Quantity	Value.	Quantity.	Value.
			Linear ft.		*Short tons.*		*Short tons.*	
Arizona	....	....	....	....	....	....	(a)	(a)
California	(a)	(a)	31,384	$18,042	(a)	(a)	323,926	$158,550
Colorado	....	....	(a)	(a)	....	....	....	....
Connecticut	458,683	$24,921	33,500	17,898	1,810	$1,058	6,007	6,118
Delaware	....	....	(a)	(a)	(a)	(a)	(a)	(a)
Dist. of Columbia	....	....	(a)	(a)	(a)	(a)	(a)	(a)
Georgia	1,570,680	70,797	371,705	114,123	36,657	23,946	(a)	(a)
Maine	8,781,816	569,300	138,976	74,821	....	....	(a)	(a)
Maryland	(a)	(a)	....	....	(a)	(a)	(a)	(a)
Massachusetts	6,277,073	365,874	312,062	174,593	8,323	9,607	50,122	41,330
Minnesota	1,231,869	86,875	2,020	2,095	(a)	(a)	42,753	25,635
Missouri	460,260	26,538	....	....	....	....	(a)	(a)
Montana	....	....	(a)	(a)	(a)	(a)	....	....
New Hampshire	4,873,413	213,099	123,647	59,084	1,205	1,162	(a)	(a)
New Jersey	....	....	....	....	....	....	(a)	(a)
New York	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
North Carolina	4,032,200	204,690	286,852	160,663	12,833	19,218	243,703	111,369
Oklahoma	....	....	....	....	(a)	(a)	(a)	(a)
Oregon	....	....	(a)	(a)	....	....	....	....
Pennsylvania	(a)	(a)	8,327	7,211	8,339	13,108	(a)	(a)
Rhode Island	330,393	21,142	18,800	10,980	1,605	1,949	....	....
South Carolina	(a)	(a)	33,980	9,258	4,240	5,343	(a)	(a)
Texas	....	....	(a)	(a)	....	....	(a)	(a)
Vermont	1,191,762	38,781	(a)	(a)	....	....	(a)	(a)
Virginia	250,765	10,530	31,848	44,121	1,199	1,999	556	1,092
Washington	....	....	(a)	(a)	(a)	(a)	(a)	(a)
Wisconsin	8,834,922	564,466	(a)	(a)	4,306	2,023	(a)	(a)
Undistributed	1,931,115	122,585	8,682	6,555	84,195	120,353	351,385	239,315
	40,224,951	2,319,598	1,401,783	699,444	164,712	199,766	1,018,452	583,409
Average price	Per M.	$57.67	....	$0.50	....	$1.21	....	$0.57

a Included in "Undistributed."

Granite sold in the United States in 1917, by States and uses—Continued.

State.	Crushed stone.						Other value.	Total value.
	Road making.		Railroad ballast.		Concrete.			
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
	Short tons.		*Short tons.*		*Short tons.*			
Arizona	(a)	(a)	....	....	....	....	....	$135,080
California	412,095	$199,632	(a)	(a)	154,776	$87,961	$6,050	844,453
Colorado	....	....	....	....	....	....	(a)	113,800
Connecticut	(a)	(a)	....	....	(a)	(a)	1,969	212,665
Delaware	(a)	(a)	....	....	(a)	(a)	....	216,346
Dist. of Columbia	(a)	(a)	....	....	(a)	(a)	(a)	4,615
Georgia	15,816	15,554	21,921	$16,483	93,380	90,359	4,646	568,143
Maine	(a)	(a)	....	....	(a)	(a)	7,706	1,254,529
Maryland	267,774	265,208	86,715	53,591	219,770	187,546	13,833	603,062
Massachusetts	59,637	77,154	....	....	107,337	138,589	5,793	1,932,511
Minnesota	(a)	(a)	(a)	(a)	(a)	(a)	(a)	1,102,493
Missouri	(a)	(a)	....	....	....	....	....	58,241
Montana	....	....	....	....	....	....	(a)	25,831
New Hampshire	33,660	35,152	....	....	(a)	(a)	5,093	909,700
New Jersey	(a)	(a)	....	....	(a)	(a)	(a)	47,372
New Mexico	....	....	(a)	(a)	(a)	(a)	....	(a)
New York	(a)	(a)	(a)	(a)	(a)	(a)	(a)	182,515
North Carolina	107,768	110,854	(a)	(a)	300,552	340,624	103,703	1,486,541
Oklahoma	....	....	....	....	(a)	(a)	....	37,071
Oregon	....	....	....	....	....	....	....	(a)
Pennsylvania	22,624	31,972	(a)	(a)	6,585	6,702	4,274	290,748
Rhode Island	23,858	36,634	....	....	(a)	(a)	(a)	477,779
South Carolina	5,494	5,100	(a)	(a)	223,222	287,541	2,379	427,531
South Dakota	....	....	....	....	....	....	....	(a)
Texas	....	....	....	....	....	....	....	95,867
Utah	....	....	....	....	....	....	....	(a)
Vermont	....	....	....	....	(a)	(a)	(a)	2,850,615
Virginia	99,639	103,476	103,399	63,409	48,965	52,020	(a)	307,224
Washington	....	....	....	....	(a)	(a)	(a)	52,053
Wisconsin	54,214	37,095	....	....	114,482	98,987	5,621	1,248,112
Undistributed	73,978	83,245	266,632	135,735	140,833	139,997	14,983	60,060
	1,176,557	1,001,076	478,667	269,218	1,409,902	1,430,326	176,050	15,544,957
Average price	....	$0.85	....	$0.56	....	$1.02	....	....

[a] Included in "Undistributed."

Of the 30 States having granite output in 1917, 21 showed decrease and 9 increase in value of output. Six States in 1917, compared with eight in 1916 and seven in 1915, had a marketed production exceeding $1,000,000 each, and together they represented more than 63 per cent of the total value. These States in order of rank were Vermont, Massachusetts, North Carolina, Maine, Wisconsin, and Minnesota. California and New Hampshire were in this group in 1916. Of these larger producing States Maine increased in value of output (17 per cent), owing to increased value in spite of decreased quantity of building stone and paving blocks; and Minnesota (5 per cent), owing to increased value in spite of decreased quantity of monumental stone and paving blocks; and Vermont (9.7 per cent), owing to increase in both quantity and value of monumental stone. The decrease in Massachusetts was 3 per cent, in North Carolina 1.7 per cent, and in Wisconsin 10 per cent. The decrease in Wisconsin was due to decrease in both quantity and value of paving blocks, which more than offset a small increase in monumental stone. The other States that showed an increase in value were Colorado, Delaware. District of Columbia, Montana, Oregon, and Texas. The decrease for all other States was general for all purposes, and in nearly every State decrease in quantity was greater than that in value.

The number of operators decreased from 598 to 483 in 1917, and several of those that operated reported their quarries closed during part of the working year.

BUILDING STONE.

The total value of granite sold for building stone in 1917 was $3,161,294, a decrease of $803,139, or 20 per cent, compared with 1916. The rough stone sold was valued at $611,489, which was $291,557, or 32 per cent, less than in 1916; the dressed or manufactured stone was valued at $2,549,805, which was $511,582, or about 17 per cent, less than in 1916.

The total quantity of building granite marketed in 1917 was 3,604,330 cubic feet compared with 6,767,051 cubic feet in 1916—a decrease of 3,162,721 cubic feet, or 47 per cent. The six States—Massachusetts, Vermont, New Hampshire, Maine, California, and Minnesota—whose sales represented 75 per cent of the total value in 1916 and 77 per cent in 1917, decreased 35 per cent in quantity.

The reduction in output in 1907 was caused by the marked increase in the cost of labor, material, and freight. The general average increase in costs was probably about 30 per cent, but some items increased much more.

Prices increased, though in most places not in proportion to the increase in costs. Some producers reported an increase of 20 to 30 per cent. One company in Maine reported an increase of 50 per cent and two companies in New Jersey an increase of 100 per cent for rough stone. A few companies in New Hampshire, Maryland, and the District of Columbia reported no increase in price. The total average price in 1917 was 88 cents per cubic foot, 29 cents more than in 1916.

The demand was prevailingly small, owing to a general curtailment in the erection of both Government and private buildings in which granite is ordinarily used. This curtailment in turn was caused by a shortage of labor for building, a shortage of other building materials, and the increased price of these materials and of building stone. New York's marked decrease was largely due to the completion of the Kensico Dam, for which a considerable quantity of granite was sold in 1916. One producer in Wisconsin attributed decreased demand in part to eastern competition, and two small producers in Massachusetts complained of competition with artificial substitutes for granite. The adverse conditions compelled several quarries in different parts of the country to suspend operation.

One company each in California, Maine, New Hampshire, and Pennsylvania reported that the demand in 1917 equaled that in 1916, and a few companies in Rhode Island, Delaware, Maryland, and Colorado reported that it was even better. Some of these companies, however, particularly those in Maryland, could not take advantage of the favorable demand because of shortage of labor and cars. The increase in Georgia, Maine, and Rhode Island was due mainly to an increase in the production of a single company in each State. Arizona reported the sale of considerable granite in both 1916 and 1917. This was used in building the Yavapai County courthouse.

As building operations in general were very active early in 1917, the curtailment in them not becoming marked until about midsummer, the production in 1917 may be considered an average between very good and very poor. The period of severe depression has continued through the first six months of 1918, and as there is no prospect of early improvement the production of building stone, as well as of other materials that are used mainly in buildings of the better classes, will probably be considerably less in 1918 than in 1917. The present abnormal period, in which many of the buildings erected are temporary, will probably be followed by a period in which permanent buildings of high architectural merit will be constructed, and this change will be reflected in a rapid recovery of the building granite industry.

Sales of granite for building were reported from 27 States in 1917, compared with 28 in 1916. Massachusetts, with a total of 861,621 cubic feet, valued at $639,003, and Vermont, with 497,151 cubic feet, valued at $602,785, ranked first and second. Maine ranked third, with 407,165 cubic feet, valued at $526,304. New Hampshire, third in rank in 1916, was fourth in 1917, with 178,138 cubic feet, valued at $337,608. Of these States Massachusetts, with 570,251 cubic feet, valued at $143,847, and Maine, with 262,925 cubic feet, valued at $100,941, were the only States whose sales of rough granite exceeded $100,000 in value in 1917, and in each of these there was a decrease of about one-third compared with 1916. Pennsylvania, which ranked first in sales of rough granite in 1916 with a value of $224,360, was credited with only $87,978 in 1917. This low value represented 1,047,826 cubic feet of stone, the greater part of which is the product of a number of quarries—many in the vicinity of Philadelphia which ordinarily supply large quantities of low-grade stone for local foundation work. Most of these quarries were idle in 1917. New Hampshire was next with 89,988 cubic feet, valued at $78,859, a gain of about 25 per cent. The few other States that showed gains had outputs valued at less than $15,000.

In sales of dressed granite Vermont, although chiefly a monumental stone State, was the leading producer in value (191,689 cubic feet, valued at $596,757). Massachusetts, with 291,370 cubic feet, valued at $495,156, was the second State in value, followed by Maine, with 144,240 cubic feet, valued at $425,363. Maine has made continuous gains in value in 1916 (2 per cent) and 1917 (55 per cent), whereas Massachusetts in the same years has lost 17 per cent and 19 per cent, respectively. In 1917 a considerable quantity of Maine granite was used in Government buildings at Annapolis, Md. New Hampshire, California, Georgia, Rhode Island, and Minnesota sold dressed granite in excess of $100,000 each in 1917. Of these Georgia made gains in both 1916 and 1917, its value for 1917 nearly doubling that of 1915, and Rhode Island more than tripled its value for 1916. The production of the other States named decreased from 10 to 50 per cent in value.

MONUMENTAL STONE.

The only product whose output increased in value in 1917 was monumental stone (7.8 per cent), although the quantity produced decreased 6.6 per cent. This class of stone represented 5 per cent of the total quantity of granite quarried and 37 per cent of the total value.

The following States are the principal producers of monumental granite. In 1917 their output represented 86 per cent of the quantity and 90 per cent of the value of the monumental granite.

Monumental granite produced in certain States in 1917.

State.	Quantity (cubic feet).	Value.	Average price per cubic foot.
Vermont	1,620,464	$2,200,509	$1.36
Minnesota	264,194	803,370	3.04
Wisconsin	115,255	538,370	4.67
Massachusetts	366,738	480,568	1.31
North Carolina	190,737	393,021	2.06
New Hampshire	156,378	252,522	1.61
Rhode Island [a]	105,323	158,702	1.51
Connecticut	55,199	114,786	2.08
Colorado	44,030	104,241	2.36

[a] Rough only.

The price per cubic foot, as shown above, differs greatly, according to the form in which the stone is sold as well as on the grade of the stone. More than 90 per cent of the output of both Vermont and Massachusetts is sold rough, whereas most of the stone produced in Minnesota, Wisconsin, and North Carolina is sold dressed. The output of North Carolina, chiefly stone for mausoleum work, heretofore classified as building stone, has been transferred to monumental stone, the class in which it more properly belongs.

PAVING BLOCKS.

Production.—Granite paving blocks valued at $2,319,598 and numbering 40,224,951 were sold in 1917. The quantity of paving blocks produced represented a decrease of 12 per cent, compared with 1916, which in turn showed a decrease of more than 4 per cent, compared with 1915. The value of 1917, however, owing to increase in price was only 0.5 per cent less than that in 1916, which was practically the same as that of 1915. The average price per thousand during these three years was $48.85 in 1915, $50.73 in 1916, and $57.67 in 1917, the last being the highest price ever recorded. These figures do not include sales of "durax" blocks.

Sales were reported from 18 States in both 1916 and 1917, South Carolina replacing Delaware in 1917. Three States, Connecticut, Massachusetts, and Vermont, showed increase in quantity in 1917. Maine showed a decrease of less than 1 per cent. The largest decreases were 90 per cent in California, 50 per cent in Georgia, 44 per cent in Virginia, and 38 per cent in Rhode Island.

Wisconsin continued to be the leading State in quantity of paving blocks sold, in spite of a considerable decrease, and was closely followed by Maine, which led in value of sales. Massachusetts, which ranked fourth in 1916, was third in 1917, displacing New Hampshire. Minnesota's sales were only 40,107 blocks more than for Vermont, but their value was more than twice as much. The number of blocks made directly by producers in Vermont was not very large, but the sales of manufacturers who purchased rough blocks of Vermont granite are included, as their inclusion more truly represents the condition of the paving industry. In some granite districts of other States blocks were made from rough stock sold by quarry companies to paving-block cutters, and the sales of these were included in the State totals; but in no other State was the number of these blocks so great as in Vermont.

Granite paving blocks sold in 1916 and 1917.

State.	1916			1917		
	Number of blocks.	Value.	Average per thousand.	Number of blocks.	Value.	Average per thousand.
California	556,000	$17,963	$32.31	(a)	(a)	$38.46
Connecticut	371,278	17,975	48.41	458,683	$24,921	54.33
Delaware	(a)	(a)	39.00			
Georgia	3,168,927	105,350	33.24	1,570,680	70,797	45.07
Maine	8,823,252	430,753	48.82	8,781,816	569,300	64.83
Maryland	512,242	32,646	63.73	(a)	(a)	65.98
Massachusetts	5,404,377	287,640	53.22	6,277,073	365,874	58.29
Minnesota	1,292,386	85,106	65.85	1,231,869	86,875	70.52
Missouri	698,611	37,094	53.96	460,260	26,538	57.66
New Hampshire	5,486,815	247,177	45.05	4,873,413	213,099	43.73
New York	(a)	(a)	35.39	(a)	(a)	68.78
North Carolina	4,376,383	200,851	45.89	4,032,200	204,690	50.76
Pennsylvania	(a)	(a)	52.00	(a)	(a)	57.70
Rhode Island	530,853	35,027	59.98	330,393	21,142	63.99
South Carolina				(a)	(a)	40.00
Vermont	1,147,449	41,966	36.57	1,191,762	38,781	32.54
Virginia	449,000	19,115	42.57	250,765	10,530	41.99
Wisconsin	11,005,538	685,622	62.30	8,834,922	564,466	63.89
Undistributed	2,138,134	87,457		1,931,115	122,585	
	45,961,245	2,331,742	50.73	40,224,951	2,319,598	57.67
Percentage of decrease in 1917				12.4	0.5	

[a] Included in undistributed.

The average price per thousand ranged from about $33 in Vermont to $70 in Minnesota. New Hampshire, Vermont, and Virginia showed decrease in average price per thousand of $1.32, $4.03 and $0.58, respectively, in 1917. The other States showed increase, which ranged from $1.59 in Wisconsin to $11.83 in Georgia and $16.01 in Maine. Notwithstanding the large increase in the average price in Georgia, the controlling factor in production in 1917 as in 1916 was apparently the ease with which the blocks could be prepared. Thus the average price in New Hampshire ($44) and in Georgia ($45), where easily worked granite blocks are abundantly produced, presented a contrast to that in Massachusetts ($58), where some of the granites are hard to shape, and with the average price in Wisconsin ($64) and in Minnesota ($70), where the granites are tough.

The New England States, which supplied the same general markets, sold 21,913,140 blocks, more than half the total, valued at $1,233,117, in 1917, compared with 21,764,024 blocks, valued at $1,060,538, in 1916, a gain of 149,116 blocks and of $172,579. This small gain in quantity was made in spite of the obstacles that beset the industry. Although a few producers reported general conditions better than in 1916, most of the larger ones, who reached distant as well as local markets, complained of shortage of labor and of transportation facilities, both by rail and water. It was also stated that some municipal improvement undertakings were postponed. Failure to make a more marked gain in 1917 was due to the abnormal conditions resulting from the war rather than to competition with other paving materials, although this factor also was of some influence. Paving blocks were shipped to many points in New England; also to New York, New Jersey, and eastern Pennsylvania.

In New York granite paving blocks were made in the Thousand Islands district, which is favorably situated with respect to markets in New York and along the Great Lakes. A large number of blocks were sold by two companies in 1917 but not so large as in 1916. The high price of blocks in 1917, caused by the high cost of operation and the increased cost of laying pavements, diminished to some extent the demand. Furthermore, the shortage of labor, boats, and cars made it difficult to supply the demand that existed. Owing to these conditions one company that was active in 1916 did not operate in 1917.

Pennsylvania and Maryland, supplying near-by though large markets, each showed a decrease of approximately 50 per cent in quantity sold. This large decrease was attributed principally to postponement of municipal improvements that had been planned.

The four Southern States, Virginia, North Carolina, South Carolina, and Georgia, showed sales of about 6,000,000 blocks (nearly one-sixth of the country's total), valued at nearly $300,000 (about one-eighth of the total), in 1917, compared with 7,994,310 blocks, valued at $325,316, in 1916. The decrease in 1917 was 25 per cent in quantity but only 10 per cent in value. These States as a group supplied markets not only in the Southeastern States but in the Middle Atlantic and eastern Central States. The decline in sales was attributed to the high selling price and to a general curtailment of pavement laying, only absolutely necessary work being done. The price, however, was not sufficient to offset the increase in the cost of operation. Shortage of labor, fuel, and cars, as well as railroad embargoes, also reduced the output. Replacement of granite by other paving materials for all but the heaviest traffic was reported by one producer in a district where large quantities of rubble granite paving had been laid with results far below those obtained by laying well-trimmed blocks according to improved specifications.

The decline in sales in Wisconsin amounted to nearly 20 per cent in quantity and 18 per cent in value, the average price not increasing so greatly as in the districts already considered. This State supplied all its own cities as well as some cities along the Great Lakes and west of Mississippi River. The decline was attributed to the high cost of labor and supplies and to shortage of transportation facilities.

Minnesota and Missouri, both of which showed notable decline in quantity and value, supplied markets within their own borders.

This review shows that the decline in the sales of granite paving blocks in the eastern half of the country, which includes the principal markets, was due to temporary conditions caused by the war, which curtailed a normally increasing demand. Even in New England, where there was a slight increase in quantity, the conditions as a whole were below normal. In many cities, however, particularly in the Atlantic States, the increase in heavy traffic resulting from the war will necessitate the upkeep of granite-paved streets and the repaving with granite of streets on which other pavements have hitherto been adequate. Properly paved streets in districts of heavy freight traffic are a war necessity, and therefore a reasonable demand for granite paving blocks should be expected during the war, whereas a marked increase to compensate for the present curtailment in demand must be expected when the country is again at peace.

Only in California does the granite paving block industry appear to be more than momentarily discouraging. Producers there reported practically no demand in 1917, as brick, asphalt, and cement paving were being used almost exclusively. A considerable quantity of granite paving, however, was used in Los Angeles for repair work along gutters. No shipments to any other large cities in the Pacific Coast States were reported in 1917. These cities, when the heavy traffic around their freight terminals and in their principal business streets is considered, appear to offer a potential market for granite paving, provided the durability of granite pavements laid in accordance with the latest improved specifications can be adequately demonstrated.

Shipments.—Producers in 1917 reported for the first time the cities to which their output was shipped. The quantity shipped to each city was not stated, but the data supplied gives a good general idea of the distribution of the output in 1917. New York, Philadelphia, and Chicago were the leading cities, each with a probable consumption of more than 3,000,000 blocks. Newark, N. J., and perhaps Boston and Cleveland also consumed approximately 2,000,000 blocks each. Milwaukee, Brooklyn, Detroit, St. Louis, and Akron, Ohio, may each have consumed 1,000,000 or more blocks. Cities that may have consumed 500,000 blocks or more are Worcester, Mass., Jersey City and Elizabeth, N. J., Yonkers and Albany, N. Y., East St. Louis, Ill., Minneapolis and St. Paul (together), Minn., and Kansas City, Mo. Cities in Massachusetts, excluding Boston and Worcester, probably consumed together between 2,500,000 and 3,000,000 blocks, and cities in New Jersey not mentioned above consumed 1,000,000 or more blocks. Georgia, Pennsylvania (excluding Philadelphia), Rhode Island, and Virginia were probably next in order, and were followed by New York, Ohio, and Indiana, and small quantities (probably less than 250,000 blocks) were consumed in Kentucky, Connecticut, Vermont, New Hampshire, Maine, Tennessee, and North Carolina.

The population of the smallest city named above is 80,000. Within the same general region there are 25 or 30 other cities, whose large population and whose industries would indicate that they are favorable markets for granite paving blocks. The presence of several large cities in Texas raises the question why paving blocks are not supplied to them from quarries in Texas and Oklahoma. One obstacle is the present unfavorable transportation facilities and the resulting high cost of marketing.

Sizes of granite paving blocks.—As the specifications for granite pavements have gradually been improved, a call has arisen for standardizing the size of granite blocks. Certain local standards are now recognized, but even these differ. Accordingly producers were requested to state the different sizes of blocks sold by them in 1917. No less than eleven kinds were reported by trade names, and some of these varied within moderate limits even within the same State. A reasonable degree of variation should certainly be allowed for such a product; nevertheless the amount of variation reported is an argument in favor of standardization.

The kinds and sizes reported are as follows:

Sizes of granite blocks, in inches.

Name and producing State.	Width.	Depth.	Length.
Standard blocks:			
New Hampshire, Georgia, and Massachusetts	$3\frac{1}{2}$–$4\frac{1}{2}$	$4\frac{3}{4}$–$5\frac{1}{4}$	8 –12
Connecticut	$3\frac{1}{2}$–$4\frac{1}{2}$	7 –8	8 –12
North Carolina	$3\frac{1}{2}$–$4\frac{1}{2}$	5 –$5\frac{1}{2}$	8 –12
Georgia	4	5	11
	4	5	10
Virginia	$3\frac{1}{2}$–$4\frac{1}{2}$	6 –7	6 – 8
Hassan blocks:			
New Hampshire	$3\frac{1}{2}$ $4\frac{1}{2}$	4 –$4\frac{1}{2}$	6 –12
	4 –$4\frac{1}{2}$	$3\frac{1}{2}$–$4\frac{1}{2}$	7 –12
Massachusetts	$3\frac{1}{2}$–4	4 –$4\frac{1}{2}$	$6\frac{1}{2}$–12
	4 –$4\frac{1}{2}$	4 –$4\frac{1}{2}$	$6\frac{1}{2}$–$12\frac{1}{2}$
	$3\frac{1}{2}$–$4\frac{1}{2}$	4 –$4\frac{1}{2}$	7 –12
Bronx blocks:			
New Hampshire and Massachusetts	$3\frac{1}{2}$–$4\frac{3}{4}$	$4\frac{1}{2}$–$5\frac{1}{4}$	7 –10
Manhattan special blocks:			
New Hampshire	$3\frac{1}{2}$–$4\frac{1}{2}$	$4\frac{3}{4}$–$5\frac{1}{4}$	6 –10
Philadelphia blocks:			
New Hampshire and Massachusetts	$3\frac{1}{2}$–$4\frac{1}{2}$	6 –7	9 –14
Belgian blocks:			
Used in Richmond, Va	$3\frac{1}{2}$–$4\frac{1}{2}$	6 –7	6 – 8
Rubble blocks:			
Used in Richmond, Va	3 –6	6 –7	4 –10

Names given without dimensions were "Bostons," "Worcesters," "sixes," and "culls," the last name probably including blocks of smaller dimensions than those given above, but greater than those of the "durax" blocks discussed in the next paragraph. Dimensions reported under no trade name varied with the same general limits as those listed above, two additional varieties being reported from Connecticut, seven from Maine, three from Vermont, seven from New Hampshire, ten from Massachusetts, two each from Pennsylvania and Maryland, eight from North Carolina, five from Wisconsin, two from Minnesota, and three from Missouri.

Durax blocks.—Durax blocks were produced in seven States in 1917—Maine, Maryland, New York, North Carolina, Pennsylvania, South Carolina, and Wisconsin. Three companies in North Carolina and one in each of the other States reported sales. The estimated quantity sold was 19,004 short tons and the reported value was $115,717. As some producers reported the number of blocks sold and others reported tons and as the sizes of the blocks differ, it was thought best to record the total quantity in tons, the average weight of a block, according to available evidence, being placed at $2\frac{3}{4}$ pounds. According to this estimate the average number of blocks to a ton was 727, and the average price $6.08 a ton or $8.36 a thousand.

The reported sizes of durax blocks, in inches, were as follows, all being cubes except the "irregular" blocks made in North Carolina:

Maryland, $2\frac{1}{2}$–$3\frac{1}{2}$; New York, 4; North Carolina, $2\frac{3}{4}$–$3\frac{1}{2}$, $3\frac{1}{4}$–4, $2\frac{3}{4}$–$3\frac{1}{4}$ ("irregular"); South Carolina, $2\frac{3}{4}$–$4\frac{1}{2}$, $3\frac{1}{4}$–4; Wisconsin, 3, 4.

In Pennsylvania the average size of a cube was about $3\frac{1}{2}$ inches, or 108 blocks to a cubic yard. No dimensions were reported from Maine. The sizes of durax, as of the larger blocks, varied to conform to specifications in different cities.

Durax blocks were shipped in 1917 to New York and Port Chester, N. Y.; Paterson and Passaic, N. J.; Baltimore, Md.; Washington,

D. C.; Norfolk, Va.; several cities in North Carolina; Cleveland, Columbus, and Dayton, Ohio; Detroit, Mich.; and St. Louis, Mo. Some companies reported sales exclusively to street-railway companies.

The advantages of durax blocks that have been reported by producers to establish them as durable and economical paving material are, in addition to the qualities that are common to large blocks, the distribution of the load over the entire surface of the block, thus preventing tilting, the reduced cost of cutting the blocks, particularly those cut by machine, and the reduced cost both of transporting and of handling the stone. The small size of each block tends to reduce surface irregularities and resulting noise to a minimum, and the great number of joints affords increased foothold. The "irregular" block, reported from North Carolina, has two slightly converging instead of parallel sides, which allow the blocks to be laid in concentric interlocking segments. These, it is claimed, can be laid more rapidly than the more familiar straight courses. Durax blocks have been used in many of the large cities of Europe and South America and are reported to have given general satisfaction.

As already noted the demands of the war are likely to require the repaving of streets to withstand heavier traffic than formerly. Where the traffic is not so extremely heavy as to require the large block, the durax block may serve the purpose excellently. In the Atlantic and Gulf Coastal Plain region, where military highways may be constructed, where road materials adequate for withstanding frequent heavy traffic are very scarce, and where suitable materials must be shipped in from considerable distances, durax paving is worthy of careful consideration.

RUBBLE AND RIPRAP.

Granite used for rubble decreased 85,288 short tons (34 per cent) in quantity and $54,363 (21 per cent) in value, and granite for riprap 1,188,458 short tons (54 per cent) in quantity and $409,379 (40 per cent) in value. This class of stone varies greatly in production from year to year according to the amount of river and harbor work done by the State and Federal Governments. In 1916 California, Connecticut, Delaware, North Carolina, and Virginia were the States showing greatest production for this purpose. In 1917 California decreased more than 50 per cent, North Carolina about 30 per cent, and Virginia and Connecticut reported practically no output of rubble; Massachusetts showed a greatly increased production, and Arizona, Delaware, New York, and Texas were considerable producers, although operations were confined to not more than two localities in each State.

CURBING AND FLAGGING.

Granite for curbing decreased 600,817 linear feet (30 per cent) in quantity and $129,317 (15 per cent) in value in 1917, as compared with 1916, following an increase of 19 per cent in value in 1916 over 1915. Georgia, the leading State in 1916, decreased in value $110,437 (49 per cent), and ranked third in 1917, being exceeded by Massachusetts, which showed an increase of $7,194 (4 per cent), and North Carolina, which showed an increase of $35,818 (28 per cent). A small output of flagging is included with curbing.

CRUSHED STONE.

Crushed granite represented 17 per cent of the value of the total granite output in 1917, and 20 per cent in 1916. There was a decrease of 1,658,279 short tons (35 per cent) in quantity and $842,796 (23 per cent) in value in 1917. According to uses the crushed granite sold for road metal amounted to 1,176,557 short tons, valued at $1,001,076; 478,667 short tons, valued at $269,218, for railroad ballast; and 1,409,902 short tons, valued at $1,430,326, for concrete. There was a decrease for each product in 1917 in both quantity and value, but railroad ballast showed the greatest decrease, 59 per cent in quantity and 54 per cent in value. All the States that reported production for this purpose in 1917 decreased in output except Virginia. The total average price of crushed granite in 1917 was 88 cents a ton, which was 13 cents more than in 1916.

BASALT AND RELATED ROCKS (TRAP ROCK).

The well-known group of road-building rocks which includes basalt, diabase, and some other dark igneous rocks that are very similar in mineral composition and physical properties furnished 9 per cent of the value of all the stone produced in the United States in 1917.

In 1916 this group included a quantity of light volcanic rock quarried principally in California and Massachusetts, which in 1917 has been reclassified under the heading "miscellaneous." In the following tables is shown the production of basalt and related rocks (trap rock) for 1916 and 1917. The table of classification by uses gives for the first time the quantity as well as the value of the different products.

Basalt and related rocks (trap rock) sold in 1916 and 1917, classified by uses.

	1916		1917	
	Quantity.	Value.	Quantity.	Value.
Building stone .... cubic feet..	853,000	$64,277	912,447	$39,200
Approximate equivalent in short tons...	76,770	....	82,120	....
Paving blocks .... number....	1,500,695	57,618	1,450,500	52,755
Approximate equivalent in short tons...	16,500	....	16,320	....
Rubble .... do....	258,660	186,491	326,974	328,561
Riprap .... do....	a 838,349	796,048	565,583	506,616
Crushed stone .... do....	9,008,374	6,539,008	8,067,582	6,600,957
Other .... do....	a 35,000	22,855	a 45,000	42,796
Total (quantities approximate, in short tons)	10,233,640	7,666,297	9,103,580	7,570,885

a Estimated.

Value of basalt and related rocks (trap rock) sold in the United States in 1916 and 1917.

State or Territory.	Building.	Riprap and rubble.	Paving.	Crushed stone.			Other.	Total.
				Road metal.	Railroad ballast.	Concrete.		
1916.								
Arkansas	(a)	(a)		(a)	(a)	(a)		$185,360
California		$28,300	$34,694	$294,846	$74,996	$503,038	$2,266	938,140
Colorado			(a)	(a)				(a)
Connecticut [b]	$13,453			333,228	45,856	395,064		788,661
Hawaii	(a)	(a)		72,673		151,132	4,830	381,771
Idaho						(a)		(a)
Massachusetts	18,178			425,363	9,600	192,453	1,450	647,044
Michigan		(a)		37,475	(a)	9,715	847	83,072
Minnesota	(a)	(a)		19,200		107,034		130,803
New Jersey	6,538	9,721	7,685	796,929	165,339	295,005	12,000	1,293,217
New York [b]				414,200	45,200	492,700		956,100
Oregon	5,564	56,882		156,414	8,787	68,522		303,909
Pennsylvania	4,987	11,468	(a)	452,558	357,277	212,002	722	1,041,203
Texas				(a)	(a)	(a)		(a)
Washington [b]		680,996		71,210				754,831
Wisconsin				(a)	(a)	(a)		(a)
Undistributed	15,557	195,172	15,239	118,528	54,265	158,399	740	162,126
	64,277	982,539	57,618	3,192,624	761,320	2,585,064	22,855	7,666,297
1917.								
Arkansas	(a)	(a)		(a)	(a)	(a)	(a)	(a)
California	(a)	206,536	27,074	219,542	(a)	656,134		1,150,248
Colorado						(a)		(a)
Connecticut	25,362		4,387	480,109	119,597	337,865	7,000	974,320
Hawaii	(a)	227,267		(a)		165,665	(a)	483,453
Massachusetts	(a)			379,275	10,885	138,302	(a)	535,437
Michigan		(a)		64,098		(a)		70,197
Minnesota	3,731			6,770	(a)	(a)		141,380
New Jersey	(a)	3,408	6,377	823,832	149,206	385,697	(a)	1,372,956
New York				191,675	33,000	447,775	12,100	684,550
Oregon [b]		115,921		95,449	(a)	103,081	(a)	327,770
Pennsylvania	6,009	9,262		530,287	397,616	223,290	12,200	1,178,664
Texas [b]		(a)		(a)	(a)	(a)		(a)
Washington [b]		258,777		36,054		28,583		328,331
Wisconsin				(a)	(a)	(a)		(a)
Undistributed	4,098	14,006	14,917	296,997	112,155	168,018	11,496	323,579
	39,200	835,177	52,755	3,124,088	822,459	2,654,410	42,796	7,570,885

[a] Included in "Undistributed."
[b] Small values not enumerated included in "Undistributed."

The total value of the basalt produced in 1917 was $7,570,885, which was $95,412, or 1.2 per cent, less than in 1916, and the value in 1916 declined 10 per cent ($822,925) from that in 1915. The quantity of this stone produced decreased from 10,233,640 short tons in 1916 to 9,103,580 short tons in 1917, a decrease of about 11 per cent. Most of the stone of this class now quarried is crushed for use as road metal and in concrete, and in small part for railroad ballast. In 1917 this crushed stone represented 89 per cent of the quantity and 87 per cent of the value of the basalt and related rocks sold in the United States, and 20 per cent of the quantity and 22 per cent of the value of the total crushed stone sold.

The sales of the 8,067,582 short tons of crushed stone, valued at $6,600,957, classified according to use, were divided as follows: Road metal, 3,751,396 short tons, valued at $3,124,088; concrete 3,296,711 short tons, valued at $2,654,410; railroad ballast 1,019,475 short tons, valued at $822,459. There was a decrease of 940,792 short tons (10 per cent) in total quantity, but a small increase, $61,949 (1 per cent), in the total value of crushed basalt and related rocks in 1917. The average price per ton in 1917 was 82 cents, 9 cents more than in 1916. Road metal showed the largest decrease in quantity, 516,604 tons (12 per cent). The quantity of concrete decreased 341,705 short tons (9 per cent). The value of road metal, however, decreased $68,536 (2 per cent), and that of concrete increased $69,346 (3 per cent). Railroad ballast decreased in quantity 82,483 short tons (7 per cent) and increased in value $61,139 (8 per cent).

The principal States producing this kind of crushed stone, named in order according to rank of value of output, were New Jersey (road metal and concrete); Pennsylvania (road metal and railroad ballast); Connecticut (road metal and concrete); California (concrete). Each of these States produced more than 1,000,000 short tons, valued at more than $900,000. New Jersey, Pennsylvania, and California each decreased in quantity and increased in value of output during 1917; Connecticut showed increase in both quantity and value. In 1916 New York was included in this group, ranking third, but a large decrease in both quantity and value in 1917 reduced this State to fifth in rank. Continued decrease may be expected from New York as the Palisades Park Commission has taken over all the principal quarries and is gradually closing them.

A considerable quantity of stone of this class is used in rubble and riprap work, including jetties and breakwaters. In 1917 the quantity sold for these uses was 892,557 short tons, valued at $835,177; in 1916, 1,097,000 short tons, valued at $982,539, a decrease of more than 22 per cent in quantity and 15 per cent in value. The decrease was due entirely to diminished production in the State of Washington, where the decrease in output in 1917 followed a large decrease in 1916.

The basalt and related rock sold as building stone consists almost entirely of rough stone used for foundation work. The product increased in quantity and decreased in value in 1917, the output being 912,447 cubic feet, valued at $39,200, as against 853,000 cubic feet, valued at $64,277, in 1916.

Paving blocks of diabase and basalt decreased in both quantity (3 per cent) and value (8 per cent) in 1917. This decrease followed one of 51 per cent in quantity and 61 per cent in value in 1916. California, the principal producing State, showed a small increase in quantity, but a decrease in value in 1917. The average price per thousand was $36.37 in 1917, a decrease of $2.02.

Paving blocks of basalt and related rocks (trap rock) sold in the United States in 1916 and 1917.

State.	1916		1917	
	Number.	Value.	Number.	Value.
California	797,000	$34,694	862,220	$27,074
Colorado	(a)	(a)		
Connecticut	(a)	(a)	133,460	4,387
New Jersey	301,260	7,685	46,720	6,377
Oregon	(a)	(a)	(a)	(a)
Pennsylvania	(a)	(a)		
Washington	(a)	(a)	(a)	(a)
Undistributed	402,435	15,239	408,100	14,917
	1,500,695	57,618	1,450,500	52,755
Average price per thousand		38.39		36.37

a Included in "Undistributed."

The value of stone used for "other purposes" includes in Hawaii some stone used for monumental work and curbing, and vesicular basalt quarried in Washington, for use in paper-making machinery.

Of the 15 States that produced basalt and related rocks 9 showed an increase in value in 1917. The principal gains were made by Hawaii (27 per cent), for rubble and riprap used in constructing the Government dry dock at Pearl Harbor and for the Hilo breakwater; Connecticut (24 per cent), for concrete and railroad ballast; California (23 per cent), for riprap, rubble, and concrete; and Pennsylvania (13 per cent), for total crushed stone.

The principal losses were recorded by Washington (57 per cent, following a loss of 48 per cent in 1916), and New York (28 per cent), for road metal. The apparent decrease of 20 per cent in Massachusetts was due to a revision in classification, which involved the transfer of the value of a quantity of light volcanic rocks that had been formerly included with basalt and diabase to a "miscellaneous" group of rocks, used for road metal and concrete.

Very few statements were made by the quarrymen regarding the demand for basalt in 1917. Practically all reported that the cost of operation was higher and that labor conditions were bad. Nearly all had great difficulty in getting and retaining help, in spite of high wages. Fuel was scarce and expensive. The price of stone advanced but not enough to cover the increased cost of operation. Shortage of cars prevented shipments and caused quarries to shut down. In Hawaii prices of stone advanced 20 to 30 per cent during October, November, and December. Fuel oil, which formerly cost $1.50 a barrel, could not be purchased at all and coal advanced from $10 to $28 a ton. In Oregon railroad ballast, which sold for 65 cents a cubic yard in 1916, advanced to 90 cents during the last half of 1917. Neither fuel oil nor coal could be obtained in sufficient quantity and wood was difficult to obtain, and the demand for stone was small and intermittent. In Michigan the quarrymen reported that the demand was good, but that operating conditions and car service were bad and production was therefore limited. There were 215 operators in the United States in 1917 as against 237 in 1916.

Value of basalt and related rocks (trap rock) sold in the United States, 1913–1917.

State or Territory.	1913	1914	1915	1916	1917
Arkansas	(a)	$233,987	$147,442	$185,360	(b)
California	$2,132,245	1,589,821	1,136,589	938,140	$1,150,248
Colorado			(b)	(b)	(b)
Connecticut	713,323	549,156	698,744	788,661	974,320
Hawaii	249,390	88,417	195,500	381,771	483,453
Idaho				(b)	
Massachusetts	1,194,068	691,330	632,989	647,044	535,437
Michigan	92,201	34,406	105,855	83,072	70,197
Minnesota	147,806	77,338	80,640	130,863	141,380
New Jersey	1,359,931	1,164,529	1,281,545	1,293,217	1,372,956
New York	1,077,690	895,147	762,370	956,100	684,550
Oregon	316,007	397,824	739,380	303,909	327,770
Pennsylvania	1,218,918	1,076,001	1,101,778	1,041,203	1,178,664
Texas		(a)	(b)	(b)	(b)
Washington	632,915	1,068,042	1,452,869	754,831	328,331
Wisconsin	(a)	(a)	(b)	(b)	(b)
Undistributed			153,521	162,126	323,579
	9,134,494	7,865,998	8,489,222	7,666,297	7,570,885

a Included under granite. b Included in "Undistributed."

MARBLE.

PRODUCTION.

The value of marble sold in the United States in 1917 was $6,330,387, a decrease of 10 per cent ($702,784) from the value in 1916 and the lowest annual value for output of marble since 1904. The quantity produced in 1917 was about 3,627,750 cubic feet (310,130 short tons), as against about 4,795,000 cubic feet (409,970 tons) in 1916, a decrease of 24 per cent. The quantity produced in 1917 included a small quantity of serpentine, as shown in a later paragraph, but no "onyx marble."

Marble sold in the United States in 1916 and 1917, by uses.

	1916		1917	
	Quantity.	Value.	Quantity.	Value.
Building stone:				
Rough—				
Exterior .... cubic feet..	559,577	$640,656	238,151	$307,120
Interior .... do....	1,041,079	1,576,658	584,450	1,040,157
Dressed—				
Exterior .... do....	276,793	817,576	290,342	779,248
Interior .... do....	389,120	1,709,716	357,850	1,576,038
Total exterior .... do....	836,370	1,458,232	528,493	1,086,368
Total interior .... do....	1,430,199	3,286,374	942,300	2,616,195
Total building stone	2,266,569	4,744,606	1,470,793	3,702,563
Monumental stone:				
Rough .... cubic feet..	743,640	1,094,205	380,714	939,825
Dressed .... do....	197,441	985,205	304,844	1,457,892
Total monumental stone	941,081	2,079,410	685,558	2,397,717
Other uses .... short tons..	136,217	209,155	125,764	230,107
Total	136,217	209,155	125,764	230,107
Totals:				
Cubic feet	3,207,650	6,824,016	2,156,351	6,100,280
Short tons	136,217	209,155	125,764	230,107
Estimated grand totals:				
Cubic feet	4,795,000	7,033,171	3,627,750	6,330,387
Short tons	409,970	....	310,130	....

Of the marble sold in 1917, 2,156,351 cubic feet (about 184,370 tons), valued at $6,100,280, was building and monumental marble—a decrease of 33 per cent in quantity and 11 per cent in value compared with 1916. The average price of this stone per cubic foot was $2.83 in 1917 and $2.13 in 1916.

The marble sold for use as flux, terrazzo and mosaic work, and ornamental stone, and the pulverized marble sold for use in agriculture and in manufactures amounted to 125,764 tons, valued at $230,107. The marble sold for these purposes in 1916 amounted to 136,217 short tons, valued at $209,155.

PRODUCTION BY STATES.

The number of operators in 1917 was 69, which was 11 less than in 1916. These operators were distributed among 19 States. The value of the output of Vermont represented nearly 48 per cent of the total, that of Georgia 17 per cent, and that of Tennessee 14 per cent, the product of the three largest producing States thus representing 79 per cent of the value. As there are only a small number of producers in many States, it is not possible to show the production by States without revealing individual production. The figures in the following table, however, are itemized as far as they can be without disclosing confidential reports from producers. Although increase in value is shown in only three of the States listed separately, four others—Alabama, New Mexico, North Carolina, and Utah—also reported increase.

PRODUCTION BY USES.

The total value of marble sold in 1917 for use as building stone ($3,702,563) was 22 per cent less than that sold in 1916, and the total quantity (1,470,793 cubic feet) was 35 per cent less. Exterior building stone, which represented 36 per cent of the total quantity of building stone, decreased 37 per cent in quantity and 25 per cent in value; stone for interior work, which represented 64 per cent of the total quantity, decreased 34 per cent in quantity and 20 per cent in value. Marble sold dressed for use in the exterior of buildings was the only building stone product that showed increase in quantity (13,549 cubic feet) in 1917; but the value of this product decreased $38,328 (4.7 per cent). The general average price of marble sold as building stone (rough and dressed) in 1917 was $2.52 per cubic foot; the average value of exterior stone was $2.05 and of interior stone $2.77. Vermont and Tennessee produced more than 56 per cent of the quantity of marble quarried for use as building stone, each State reporting over 390,000 cubic feet. Vermont's output was nearly equally divided between exterior and interior stone, whereas 97 per cent of Tennessee's product was interior building stone. About 37 per cent of the Vermont and over 50 per cent of the Tennessee marble was sold as rough stone. Georgia and Missouri were the next largest producers of building marble, the quantity produced in each State exceeding 100,000 cubic feet.

The value of the marble produced for monumental use in 1917, including rough and dressed stone, increased $318,307 (15 per cent) over that in 1916. The quantity, however, decreased 255,523 cubic feet (27 per cent). The average price per cubic foot was $3.50 in 1917, which was $1.29 more than in 1916. There was a large increase in the quantity of dressed monumental stone sold in 1917—107,403 cubic feet (54 per cent), but a decrease of 362,926 cubic feet (49 per cent) in the quantity of rough stone. Vermont produced more than 55 per cent (377,418 cubic feet), and Georgia more than 25 per cent of the country's output of monumental marble. Missouri, New York, and Tennessee rank next in this product.

Marble for ornamental and "other uses" declined in quantity but increased in value in 1917, as it did in 1916. Marble for "other uses" includes rough stone sold to lime burners, to carbonic acid factories, to pulp mills, and to blast furnaces; crushed stone for road metal and terrazzo; small cubes for mosaics; and finished stone for electrical apparatus and ornamental purposes. The stone sold for flux to blast furnaces amounted to 18,932 long tons, valued at $15,072, and for terrazzo to 17,551 short tons, valued at $51,218. In 1916 the stone sold for terrazzo was 24,340 short tons, valued at $83,466.

Value of marble sold in the United States, 1913–1917.

State or Territory.	1913	1914	1915	1916	1917
Alabama	(a)	$370,766	(a)	(a)	(a)
Alaska	(a)	(a)	(a)	(a)	(a)
Arkansas	(a)	(a)	(a)	(a)	(a)
California	$72,768	70,451	$47,976	$62,397	$109,504
Colorado	(a)	(a)	(a)	(a)	(a)
Georgia	1,101,997	1,190,742	973,605	903,343	1,073,783
Kentucky	....	(a)	(a)	....	....
Maryland	(a)	(a)	(a)	(b)	(b)
Massachusetts	276,819	206,883	223,203	154,090	118,808
Missouri	(b)	(a)	122,238	156,942	227,520
New Mexico	(a)	(a)	(a)	(a)	(a)
New York	252,982	248,787	202,843	268,391	249,180
North Carolina	(a)	(a)	(a)	(a)	(a)
Oregon	(a)	....	(a)	....	....
Pennsylvania	(a)	(a)	60,819	c 107,212	c 36,442
South Carolina	....	....	(a)	(a)	....
Tennessee	1,416,952	1,253,549	959,037	1,000,266	884,684
Texas	....	(a)	(a)	(a)	(a)
Utah	(a)	(a)	(a)	(a)	(a)
Vermont	3,513,405	3,490,971	2,792,764	3,062,743	3,024,315
Virginia	(a)	(a)	(a)	....	(a)
Washington	(a)	(a)	....	(a)	(a)
Undistributed	1,235,967	1,289,263	1,533,540	1,317,787	606,151
	7,870,890	8,121,412	6,916,025	7,033,171	6,330,387

a Included in "Undistributed." b Included in Pennsylvania. c Includes Maryland.

Alabama, whose output increased 16 per cent in value in 1917, ranked fourth among the marble-producing States in that year, whereas it ranked seventh in 1916. The two producing localities were Gantts Quarry and a quarry about 2½ miles from Sylacauga in Talladega County. Most of this marble is used as interior building stone, and this product increased in both quantity and value in 1917. Some stone, however, was sold for terrazzo and some for riprap and fluxing.

The sales of Alaskan marble, which have been reported since 1904 and formerly showed an almost steady increase in value, fell off considerably in 1917. Prohibitive freight rates, scarcity of ships, and lack of labor were reported by producers in this region. The stone produced is sold rough for interior building.

The marble quarried in Arkansas at Batesville, Independence County, is sold for monumental and for exterior building stone. It decreased in 1917 in both quantity and value.

The value of the marketed production of marble in California in 1917 ($109,504) was greater than that in any year since 1907. California marble is marketed generally as interior building stone, but a considerable quantity from Inyo County was sold in 1917 for the manufacture of carbonic acid gas.

The closing of the quarries of the Colorado Yule Marble Co. in 1916 practically removed Colorado from the list of marble-producing States, but some of the stock of this company on hand was sold in 1917. Operations at the quarry near Villa Grove, Saguache County, which were reported in 1916, were suspended on account of the conditions caused by the war.

An increase of $170,440 (about 19 per cent) in the value of its marble output in 1917 caused Georgia to pass Tennessee and to take second rank among the marble-producing States. The quantity of marble sold by the cubic foot, however, decreased 362,537 cubic feet (5 per cent), so that Georgia continued to rank third in the quantity of marble sold. In 1916, most of the stone that was sold by the cubic foot left the producer rough, whereas in 1917 quarrying and milling were carried on together to a greater extent, and the higher value was due largely to the greater proportion of finished stone sold directly by the producer. Preparations are being made at the quarry center in Pickens County to crush and pulverize the waste stone and market it for agricultural and industrial uses. The rough stone is carefully sorted according to color and chemical purity, and the pulverized product is carefully sized. One grade made from pure white marble consists entirely of grains finer than 300 mesh. This material is sold for rubber, paint, and putty filler and other uses that are commonly supplied by ordinary whiting.

Maryland and Pennsylvania both showed a decrease in quantity and value of output in 1917. In Maryland new quarries were opened near Cockeysville and old ones were abandoned. Serpentine was quarried at Cardiff, Md., and Easton, Pa. The marble quarries at King of Prussia, Pa., were idle. Business conditions were reported as very discouraging, labor was scarce and poor, and all supplies and costs had materially increased. Better demand was reported for crushed marble products than for regular monumental and building stone.

Marble sold in Massachusetts in 1917 reached a lower value than in any year since 1901. The decrease was about 23 per cent ($35,282) and followed a decrease of $69,113 in 1916. There was also a decrease an quantity in 1917. Business was reported to be bad, and the quarries were closed during part of the working year.

In Michigan the Verde Antique Marble Co., at Ishpeming, which operated its quarry part of the time in both 1916 and 1917, reported that no product had yet been marketed, owing to the noncompletion of the railroad spur to the quarry. It was hoped that this spur would be completed in July, 1918.

The marble marketed in Missouri in 1917 (204,517 cubic feet, valued at $227,520), showed a substantial gain over that in 1916, although the average price decreased 80 cents—from $1.91 in 1916 to $1.11 in 1917. Though some of this marble was sold as dressed stone in 1917, the greater part, and considerably more than in 1916, was sold rough for both monumental and building stone, a fact that lowered the average price. The marbles of this State are quarried in the Phenix and Carthage districts. The Carthage stone is also sold as limestone, and a full statement of production for this district for 1916 and 1917 may be found under limestone on pages 659–660 of this report. The use of "Napoleon gray" marble from the Phenix quarries as a floor tiling has enabled the company to use a large quantity of small blocks which were formerly waste.

In New Mexico the usual small amount of marble for monumental work was quarried at Alamogordo.

The American Carrara Marble Co., which has been developing a marble property at Carrara, Nye County, Nev., for several years, reported that the quarry was idle in 1917, owing to the shutting off of power, but was being operated in 1918.

Both the total quantity and total value of the marble quarried in New York decreased in 1917. The decrease in value for 1917 of $19,211 (7 per cent) reduces the total value for the year ($249,180) to practically the same amount as for 1914. The decrease in quantity was proportionately more than the decrease in value. The average price per cubic foot of stone for monumental and building stone in

1917 was $2.40, which was 65 cents more than in 1916, and the price per ton for other stone increased $1.25—from $1.19 in 1916 to $2.44 in 1917. One producer of crushed marble reported that the selling price increased 20 per cent over 1916 and 40 per cent over 1915, owing to the higher cost of labor and fuel.

The stone quarried at Regal, Cherokee County, N. C., was mostly sold for monumental work, and in 1917 increased about 4 per cent in value but decreased about 37 per cent in quantity.

The value of the marble produced in Tennessee in 1917 ($884,684) was the lowest since 1911 ($700,229). The total value for 1917 decreased $115,582 (11.5 per cent) and reduced the rank of the State from second in 1916 to third in 1917. The quantity sold in 1917 (425,332 cubic feet) was only 10,204 cubic feet more than that in 1911. The State, however, in spite of a decrease of 138,277 cubic feet (nearly 25 per cent) of stone sold, still maintained its position as second in rank according to quantity. The average price was $2.08 per cubic foot in 1917—31 cents more than in 1916. The greater part of the Tennessee marble is sold for interior building work, although monumental stone and exterior building stone is also sold. The condition of the trade in the State was reported to have been very bad in 1917 on account of the lack of fuel and the shortage of steel for construction work on the more expensive buildings which use large quantities of marble for interior decoration.

There was but one company in active operation in Texas in 1917, the Vermont Marble Co., at San Saba. The production of this marble which is sold for rough interior building work, decreased somewhat in 1917.

The only commercial operations for marble in Utah in 1917 were those of the Mount Nebo Marble Co. at its quarry near Thistle Mountain, in Utah County, and represented mostly dressed stone for interior building together with a small output of terrazzo. The product increased in value in 1917 over that of 1916. The "onyx marble" quarry of this company at Low, Tooele County, was idle in 1917.

Vermont's production represented about 23 per cent of the total quantity of marble quarried in the United States in 1917, and 48 per cent of the total value, both quantity and value continuing to exceed those of any other State by a wide margin. The total marketed production of the State for 1917 decreased about 11 per cent in quantity and a little more than 1 per cent in value and followed a decrease of 7 per cent in quantity and about 10 per cent in value in 1916. With the exception of 1915, the figures were less than those for any year since 1903. The marketed production in 1917 was as follows:

Marble sold in Vermont in 1917.

	Quantity.	Value.
Monumental:		
Rough.........cubic feet..	217,988	$611,976
Dressed.........do....	159,430	878,796
Building:		
Rough, exterior.........do....	40,791	44,828
Dressed, exterior.........do....	179,906	438,945
Rough, interior.........do....	119,123	328,224
Dressed, interior.........do....	95,950	699,800
Other.........do....	19,350	21,746
	832,538	3,024,315

The black marble quarries at Harrisonburg, Va., were operated by The Tompkins-Kiel Marble Co., of New York City. Considerable development work has been done on this property, but great difficulty was reported in making shipment of the stone in 1917 on account of lack of transportation and embargoes.

In Washington the usual small quantities of marble was quarried for local monumental work in 1917.

The table below showing the marble sold in the principal producing States exhibits the usual great differences in ratio of quantity to value—differences due to the diverse uses of the stone and to the fact that much of the marble in some States, particularly Vermont, was sold in the finished condition by the producers, whereas that in other States was sold rough.

Marble sold in the principal producing States in 1916 and 1917.

	1916			1917		
	Quantity.	Value.	Average price.	Quantity.	Value.	Average price.
California:						
Short tons	10,360	$14,800	$1.43	30,300	$54,600	$1.80
Cubic feet	21,909	47,597	2.17	21,888	54,904	2.51
		62,397			109,504	
Georgia:						
Short tons	22,000	47,000	2.13	26,289	38,783	1.48
Cubic feet	702,537	856,343	1.22	340,000	1,035,000	3.40
		903,343			1,073,783	
Massachusetts:						
Short tons	16,103	24,864	1.54	14,706	25,675	1.75
Cubic feet	67,735	129,226	2.06	46,783	93,133	1.99
		154,090			118,808	
Missouri:						
Cubic feet	143,141	156,942	1.91	204,517	227,520	1.11
		156,942			227,520	
New York:						
Short tons	50,146	59,566	1.19	14,812	36,198	2.44
Cubic feet	119,311	208,825	1.75	88,655	212,982	2.40
		268,391			249,180	
Tennessee:						
Short tons				1,066	1,280	1.20
Cubic feet	563,609	1,000,266	1.77	425,332	883,404	2.08
		1,000,266			884,684	
Vermont:						
Short tons	6,900	4,385	.63			
Cubic feet	935,321	3,058,358	3.27	832,538	3,024,315	3.67
		3,062,743			3,024,315	

SERPENTINE (VERDE ANTIQUE).

The serpentine classed as marble in this report is that variety which is used as building or ornamental stone instead of marble.

No serpentine was sold rough for use as exterior building stone either in 1916 or in 1917. The output in 1917 was valued at $194,916, which was $45,129 more than in 1916 and only $9,276 less than in

1915. Sales in 1917 were reported from Vermont, Pennsylvania, Massachusetts, California, and Maryland, the States being here named according to value of output, one producer reporting from each State.

Serpentine (verde antique) sold in the United States in 1916 and 1917.

	1916		1917	
	Quantity.	Value.	Quantity.	Value.
Cubic feet	28,709	$124,072	35,371	$179,085
Square feet	8,179	18,223	8,064	10,424
Short tons	3,437	7,492	1,815	5,407
	....	149,787	....	194,916

LIMESTONE.

GENERAL STATISTICS.

The value of the limestone produced in the United States in 1917 increased $4,953,780 (12 per cent), but the quantity decreased about 3,753,500 short tons (5.5 per cent). The total output for 1917 was 63,481,500 short tons, valued at $46,263,379, and represented 76 per cent of the quantity and 56 per cent of the value of all stone quarried in the United States in that year. The average price was 73 cents a short ton in 1917, which was 11 cents more than in 1916.

The following table shows the production of limestone in 1916 and 1917 according to uses. In this table the quantities produced are published for the first time, and in order to make possible a statement of the total quantity some of the other units are reduced to short tons.

Limestone produced in the United States in 1916 and 1917, by uses.

Use.	1916		1917	
	Quantity.	Value.	Quantity.	Value.
Building stone ... cubic feet	[a] 11,070,230	$4,588,205	[a] 8,481,510	$4,115,366
Approximate equivalent in short tons	930,000	....	712,130	....
Paving blocks ... number	[a] 300,000	14,237	[a] 138,720	7,273
Approximate equivalent in short tons	3,100	....	1,400	....
Curbing ... linear feet	[a] 190,230	79,338	[a] 118,940	51,972
Approximate equivalent in short tons	10,600	....	6,600	....
Flagging ... square feet	[a] 70,000	10,411	[a] 63,130	8,327
Approximate equivalent in short tons	2,000	....	1,700	....
Rubble ... short tons	[a] 326,000	297,772	277,376	270,327
Riprap ... do	[a] 1,600,000	1,357,457	1,007,357	854,884
Crushed stone ... do	32,184,036	17,715,434	26,646,642	17,541,098
Fluxing stone ... long tons	23,623,508	13,946,882	25,574,146	18,679,213
Equivalent in short tons	26,458,329	....	28,643,044	....
Alkali works ... short tons	2,836,557	966,262	3,124,026	1,417,898
Sugar factories ... do	369,028	369,694	530,612	666,138
Glassworks ... do	193,028	181,322	293,152	344,479
Paper mills ... do	80,338	58,785	101,305	95,582
Agriculture ... do	1,043,876	1,109,208	1,040,248	1,352,397
Lime burners ... do	130,729	81,473	59,387	31,736
Other uses [b] ... do	[a] 1,067,380	533,119	[a] 1,036,565	826,689
Total (quantities approximate, in short tons)	67,235,000	41,309,599	63,481,500	46,263,379

[a] Partly estimated.

[b] Includes stone sold as a filler for asphalt, paint, rubber, soap, and other material; stone sold for the manufacture of basic magnesium carbonate; stone sold to alcohol works and calcium carbide works; dolomite sold for use in making refractory products; stone sold for chicken grit and other products.

The production of limestone for use in the manufacturing industries was greater both in quantity and in value in 1917, but the increase in quantity for this use was not sufficient to offset the large decrease in building, riprap, and crushed stone, although the increase in the price of all products brought the total value up to an amount greater than that in 1916.

Value of limestone sold in the United States in 1916 and 1917.

1916.

	Rough building.	Dressed building.	Paving and flagging.	Curbing.	Rubble.	Riprap.	Flux.
Alabama	(a)	(a)				$17,969	$807,344
Arizona						(a)	41,426
Arkansas					(a)	4,233	(a)
California	$325						86,921
Colorado	(a)						332,187
Connecticut							(a)
Florida	(a)	(a)					
Georgia					(a)		(a)
Hawaii							
Idaho	(a)						(a)
Illinois	11,278	(a)	(a)	(a)	$34,603	297,971	427,058
Indiana	870,686	$2,532,535	$3,888	$51,400	16,473	23,976	132,145
Iowa	9,422	(a)	9,140	(a)	11,104	82,155	3,407
Kansas	34,759	25,996	3,580		7,685	44,183	(a)
Kentucky	87,320	49,071	(a)	2,993	(a)	36,525	41,807
Louisiana						(a)	
Maryland	3,569						79,565
Massachusetts							
Michigan	5,633				(a)	(a)	1,207,326
Minnesota	34,064	72,517			12,750	44,710	
Missouri	34,891	430,562	1,844	904	139,539	367,484	49,227
Montana	3,312		(a)	(a)	(a)	(a)	206,153
Nebraska	(a)				8,600	74,027	(a)
New Jersey	(a)					(a)	178,266
New Mexico							
New York	50,053	9,439	(a)	1,121	1,575	4,869	405,774
North Carolina							(a)
Ohio	38,963	(a)		(a)	3,223	63,110	1,636,991
Oklahoma	(a)	(a)	(a)		(a)	14,737	
Oregon							(a)
Pennsylvania	44,946	(a)	1,364		(a)	4,824	6,768,374
Rhode Island							(a)
South Dakota						(a)	
Tennessee	606	(a)			1,575	59,299	65,352
Texas	21,529	8,304		(a)	2,776	33,002	44,947
Utah	(a)	(a)				(a)	167,888
Vermont	(a)				(a)		(a)
Virginia	1,200	(a)			863	(a)	189,339
Washington							14,813
West Virginia	(a)				(a)		966,031
Wisconsin	23,076	2,250	1,127	22,378	52,009	78,202	77,988
Wyoming	(a)						
Undistributed	20,139	151,760	3,705	542	4,997	106,181	16,553
	1,305,771	3,282,434	24,648	79,338	297,772	1,357,457	13,946,882

a Included in "Undistributed."

Value of limestone sold in the United States in 1916 and 1917—Continued.

1916—Continued.

	Crushed stone.			Sugar factories.	Glass factories.	Agriculture.	Other.	Total.
	Road metal.	Railroad ballast.	Concrete.					
Alabama	$1,198	(a)	$41,321	(a)		(a)	$1,977	$917,559
Arizona			(a)					98,877
Arkansas	(a)	(a)	(a)		(a)	(a)	608	64,809
California	(a)	(a)	(a)	$92,380	(a)	$8,188	14,814	277,521
Colorado				73.922			565	406,974
Connecticut	(a)					(a)		(a)
Florida	139,474	(a)	153,795			36,836	(a)	479,837
Georgia	(a)		(a)			(a)	7,500	82,799
Hawaii						(a)		(a)
Idaho				(a)			(a)	27,721
Illinois	815,779	$390,311	1,228,833	(a)	$10,861	135,908	6,109	3,362,751
Indiana	810,719	73,078	86,359	(a)	(a)	32,588	9,527	4,657,813
Iowa	11,374	76,929	342,082	(a)		9,630	(a)	561,015
Kansas	64,329	143,763	281,744			1,448	42,106	599,995
Kentucky	638,977	355,564	52,054		(a)	35,477	4,999	1,315,702
Louisiana	(a)	(a)	(a)			(a)		(a)
Maryland	63,298	22,779	52,799			(a)	372	223,182
Massachusetts						(a)		(a)
Michigan	420,467	57,950	155,084	41,709		11,088	489,958	2,389,763
Minnesota	8,729	10,799	260,344	1,000		835	22,194	467,942
Missouri	235,625	65,525	582,818	2,830	38,481	6,063	34,626	1,990,419
Montana	6,151	(a)	9,291	9,204				237,923
Nebraska	(a)	(a)	290,103	13,834			(a)	405,867
New Jersey	26,967		7,977			(a)	(a)	245,019
New Mexico		(a)						(a)
New York	903,350	494,858	687,540			164,237	312,470	3,035,786
North Carolina	(a)		(a)			65,101		75,418
Ohio	1,597,284	612,336	817,158		35,643	54,591	467,620	5,337,085
Oklahoma	21,110	336,484	134,827		(a)	(a)	5,381	516,230
Oregon				(a)	(a)	(a)		(a)
Pennsylvania	450,402	111,202	466,557		74,990	129,574	115,219	8,167,639
Rhode Island						(a)	(a)	(a)
South Dakota	(a)		(a)	(a)				19,435
Tennessee	311,739	124,514	96,165			64,910	28,249	752,649
Texas	34,505	26,669	285,440		(a)	(a)	2,210	459,918
Utah	(a)		(a)	48,974			(a)	249,998
Vermont	(a)		(a)			54,535	(a)	68,098
Virginia	230,970	424,957	85,056			81,166	14,905	1,062,247
Washington						5,282	(a)	30,338
West Virginia	180,555	177,333	51,530			74,865	779	1,452,393
Wisconsin	369,725	35,472	389,623			10,360	26,901	1,089,111
Wyoming				(a)				(a)
Undistributed	74,257	110,224	139,303	85,841	21,347	126,526	30,550	179,766
	7,416,984	3,650,647	6,647,803	[b]369,694	[c]181,322	1,109,208	1,639,639	41,309,599

a Included in "Undistributed."
b Value of 369,028 short tons of stone.
c Value of 193,028 short tons of stone.

Value of limestone sold in the United States, 1916 and 1917.

1917.

State.	Rough building.	Dressed building.	Paving and flagging.	Curbing.	Rubble.	Riprap.	Flux.
Alabama	(a)				(a)	$4,052	$1,159,035
Arizona						(a)	111,329
Arkansas					(a)	3,056	(a)
California	(a)						84,414
Colorado			(a)		(a)		387,184
Connecticut							(a)
Florida	$31,902	$103,557					
Georgia							7,244
Idaho					(a)		(a)
Illinois	7,128	(a)			$67,052	148,314	434,447
Indiana	1,633,731	1,640,872	$6,400	$33,980	4,402	23,373	158,476
Iowa	12,601	(a)	(a)	(a)	5,226	54,772	18,895
Kansas	12,469	2,160			3,138	27,536	(a)
Kentucky	112,267			1,328	6,648	25,513	44,826
Louisiana						(a)	
Maine							
Maryland	2,599						107,156
Massachusetts							(a)
Michigan	(a)				(a)	(a)	1,633,965
Minnesota	18,461	96,474			10,070	17,904	(a)
Mississippi							
Missouri	72,465	169,582	1,512	(a)	83,467	266,829	71,148
Montana	(a)		(a)		(a)	(a)	183,538
Nebraska					(a)	63,560	(a)
Nevada							(a)
New Jersey							327,226
New Mexico						(a)	
New York	35,305	4,850			494	32,956	426,858
North Carolina							(a)
Ohio	11,226	(a)			6,363	16,549	2,524,564
Oklahoma		2,250			871	4,939	
Oregon							(a)
Pennsylvania	54,207	(a)			(a)	3,637	8,790,058
Rhode Island							(a)
South Dakota						(a)	
Tennessee	2,106	(a)			(a)	31,781	111,141
Texas	21,660			(a)	(a)	5,208	70,548
Utah	(a)					(a)	170,332
Vermont					(a)		(a)
Virginia	(a)				(a)	(a)	287,942
Washington							43,126
West Virginia							1,409,364
Wisconsin	15,230	250	5,215	15,212	77,285	75,231	80,667
Wyoming							
Undistributed	40,529	11,485	2,473	1,452	5,311	49,674	35,730
	2,083,886	2,031,480	15,600	51,972	[b]270,327	[c]854,884	18,679,213

[a] Included in "Undistributed."
[b] Value of 277,376 short tons of stone.
[c] Value of 1,007,357 short tons of stone.

Value of limestone sold in the United States, 1916 and 1917—Continued.

1917—Continued.

State.	Road making.	Railroad ballast.	Concrete.	Sugar factories.	Glass factories.	Paper mills.	Agriculture.	Other.	Total.
Alabama	$14,170		$54,368	(a)			$8,428	(a)	$1,278,908
Arizona			(a)						140,674
Arkansas	(a)	(a)	(a)				(a)		84,654
California	(a)	(a)	34,704	$167,535	(a)		17,929	$43,067	364,066
Colorado				144,125				(a)	532,539
Connecticut	(a)						(a)		(a)
Florida	135,161	$84,580	83,517				19,265	36,586	494,568
Georgia	(a)		(a)			(a)	58,348	8,150	155,172
Idaho				(a)					37,942
Illinois	631,869	342,224	1,494,237		(a)		126,870	6,057	3,279,737
Indiana	684,289	115,721	50,654	(a)	(a)		39,403	11,104	4,449,809
Iowa	44,744	5,771	339,622	(a)		(a)	24,584	1,936	519,933
Kansas	125,057	137,274	292,202				(a)	72,774	673,706
Kentucky	366,887	338,996	95,537				22,362	(a)	1,022,317
Louisiana		(a)	(a)				(a)		(a)
Maine						(a)			(a)
Maryland	139,734	12,165	45,915				(a)	(a)	307,679
Massachusetts							(a)		68,392
Michigan	344,970	90,560	244,648	37,004		$24,097	58,148	884,889	3,320,895
Minnesota	12,062	(a)	195,108	(a)			(a)	30,728	385,728
Mississippi							(a)		(a)
Missouri	198,419	102,906	605,734	2,491	$48,510		8,631	47,170	1,679,677
Montana	(a)	(a)	27,440	(a)					224,986
Nebraska	24,886	18,292	348,173	12,312				(a)	475,507
Nevada		(a)		(a)					31,625
New Jersey	20,379		9,128				(a)	18,336	413,477
New Mexico		(a)	(a)						(a)
New York	796,013	472,908	1,012,315			11,853	152,394	567,928	3,513,874
North Carolina	(a)		10,631				95,288		109,719
Ohio	1,177,796	489,626	714,010	(a)	74,584	(a)	93,133	280,629	5,400,578
Oklahoma	21,361	324,871	218,472		(a)		(a)	(a)	575,165
Oregon				(a)			(a)		4,939
Pennsylvania	424,053	114,650	574,885		109,862	(a)	261,396	234,449	10,589,524
Rhode Island							(a)		(a)
South Dakota	(a)		(a)	36,154					46,130
Tennessee	237,569	156,169	123,590				87,738		750,639
Texas	32,186	49,552	298,088		(a)		(a)	2,872	485,389
Utah			(a)	(a)				(a)	242,707
Vermont	3,388	(a)	5,088			(a)	26,894		45,869
Virginia	422,090	353,547	135,657			(a)	46,489	(a)	1,263,284
Washington						(a)	5,587		59,529
West Virginia	116,783	86,872	115,361		(a)		5,430	348	1,788,528
Wisconsin	368,508	(a)	492,995			6,953	23,608	11,043	1,172,567
Wyoming				130,497					130,497
Undistributed	77,883	97,811	104,267	136,020	111,523	52,679	170,472	18,257	142,450
	6,420,257	3,394,495	7,726,346	[b]666,138	[c]344,479	[d]95,582	1,352,397	2,276,323	46,263,379

[a] Included in "Undistributed."
[b] Value of 530,612 short tons of stone.
[c] Value of 293,152 short tons of stone.
[d] Value of 101,305 short tons of stone.

The figures in the foregoing tables represent only the quantity and value of limestone sold or used as such by the producers. In addition large quantities of limestone are used in the manufacture of Portland cement and lime and a small quantity is used in the manufacture of natural cement. As these products are largely manufactured by the companies quarrying the stone, and as the values of the manufactured products are given in other chapters of Mineral Resources, the quantity and value of the raw material is excluded from the preceding tables of this chapter to avoid duplication.

Limestone used in certain industries in 1915, 1916, and 1917, in short tons.

	1915	1916	1917
Portland cement (including limestone and some "cement rock")	24,095,355	[a]23,323,220	24,640,230
Natural cement (cement rock)	153,060	158,054	102,260
Lime	7,179,358	7,685,723	7,194,000
	31,427,773	[a]31,166,997	31,936,490

[a] Revised.

Thus the total quantity of limestone used for all purposes in 1917 amounted to more than 95,000,000 short tons.

Closely associated with limestone in commercial usage as well as in chemical consumption and mode of occurrence is calcareous marl. A rough estimate of the quantity of marl used in manufacturing Portland cement in 1917 is 1,060,000 short tons. No data for estimating the cost of production are available. In addition about 73,900 short tons of marl, valued at $165,223, were produced and used in agriculture.

PRODUCTION BY STATES.

Forty-four States produced limestone in 1917, two more than in 1916. In 1916 Hawaii reported pulverized limestone sold for agriculture but none in 1917. In 1917 Maine, which reported no output in 1916, reported a small quantity of stone sold to paper mills. Mississippi for the first time reported a small output of limestone, which was pulverized stone for use in agriculture and was crushed at the State penitentiary at Waynesboro, Wayne County, and at Okolona, Chickasaw County. Nebraska for the first time reported stone shipped for furnace flux, sugar manufacture, and other minor uses, from Sloan, Clark County, and from Ludwig and Mason, Lyon County.

Of the total producing States 33 increased in value of output. Washington, Rhode Island, Oregon, South Dakota, Wyoming, Massachusetts, and New Mexico, which rank among the States that produce smaller quantities of limestone, reported gains of 100 to 508 per cent. The increase in Washington and Rhode Island was in stone for fluxing; in Wyoming, South Dakota, and Oregon, in stone for sugar factories; in New Mexico, for crushed stone; and in Massachusetts, in ground limestone for agriculture. The other States that increased in output reported gains ranging from 1 per cent in Ohio to 88 per cent in Georgia. The most conspicuous gain was in Pennsylvania, $2,421,885 (30 per cent). This follows a gain in 1916 of more than $1,800,000 and in 1915 of more than $1,000,000. Michigan increased more than $370,000 in 1915, more than $500,000 in 1916, and $931,132 (38 per cent) in 1917. Many of the States reported record values in 1917, and 12 States, one State more (Alabama) than in 1916, had outputs valued in excess of $1,000,000. The decreased output shown by 11 of the 44 States ranged from less than 1 per cent in Tennessee to 33 per cent in Vermont.

States whose product was valued in excess of $2,000,000 were (named in order of rank) Pennsylvania, Ohio, Indiana, New York, Michigan, and Illinois. In 1916 Illinois followed Indiana. Pennsylvania, New York, Michigan, and Ohio showed gains respectively of 30 per cent, 16 per cent, 39 per cent, and 1 per cent; Illinois decreased 2 per cent and Indiana 4 per cent. Pennsylvania's value in 1917 was nearly 23 per cent of the total, as against 20 per cent in 1916, 18 per cent in 1915, and 16 per cent in 1914. Over four-fifths of the value of Pennsylvania's output was for furnace flux and the greater part of the remaining value was for crushed stone. The total number of active operators in 1917 was 1,465, which was 218 less than in 1916. Many small quarries that supply local markets were entirely closed during 1917, owing to lack of demand, scarcity of labor, and high wages, as well as to increased cost of supplies and substitution of cheaper material.

Value of limestone produced and sold in the United States, 1913 to 1917.

State.	1913	1914	1915	1916	1917
Alabama	$812,664	$787,214	$426,266	$917,559	$1,278,908
Arizona	6,328	(a)	9,800	98,877	140,674
Arkansas	52,220	47,390	32,917	64,809	84,654
California	323,287	286,273	338,179	277,521	364,066
Colorado	428,736	340,059	337,899	406,974	532,539
Connecticut	(a)	(a)	26,246	(a)	(a)
Florida	156,589	343,779	354,673	479,837	494,568
Georgia	83,899	89,216	86,254	82,799	155,172
Hawaii	....	....	(a)	(a)	....
Idaho	18,569	28,032	(a)	27,721	37,942
Illinois	4,112,172	2,861,340	2,864,103	3,362,751	3,279,737
Indiana	4,649,597	4,115,557	4,204,092	4,657,813	4,449,809
Iowa	803,682	537,362	535,656	561,015	519,933
Kansas	824,005	598,302	535,240	599,995	673,706
Kentucky	1,069,034	1,196,046	993,388	1,315,702	1,022,317
Louisiana	(a)	(a)	(a)	(a)	(a)
Maine	(a)	(a)	....	....	(a)
Maryland	282,241	204,376	180,723	223,182	307,679
Massachusetts	(a)	(a)	(a)	(a)	68,392
Michigan	1,408,708	1,457,961	1,828,766	2,389,763	3,320,895
Minnesota	636,620	489,849	395,763	467,942	385,728
Mississippi	....	....	....	....	(a)
Missouri	2,486,020	2,160,958	1,927,534	1,990,419	1,679,677
Montana	260,915	207,821	228,637	237,923	224,986
Nebraska	326,287	302,862	320,341	405,867	475,507
Nevada	....	....	....	....	31,625
New Jersey	280,680	240,937	159,549	245,019	413,477
New Mexico	148,266	....	(a)	(a)	(a)
New York	3,539,043	3,157,617	3,018,871	3,035,786	3,513,874
North Carolina	67,132	58,754	82,672	75,418	109,719
Ohio	4,945,310	4,131,917	4,405,590	5,337,085	5,400,578
Oklahoma	246,912	237,044	398,636	516,230	575,165
Oregon	(a)	(a)	(a)	(a)	4,939
Pennsylvania	6,189,145	5,270,458	6,367,446	8,167,639	10,589,524
Rhode Island	(a)	(a)	(a)	(a)	(a)
South Carolina	....	....	(a)	....	....
South Dakota	4,098	12,488	17,485	19,435	46,130
Tennessee	643,586	678,068	855,245	752,649	750,639
Texas	590,289	549,567	492,255	459,918	485,389
Utah	368,007	303,081	196,271	249,998	242,707
Vermont	17,715	24,049	49,405	68,098	45,869
Virginia	598,032	1,194,261	1,534,545	1,062,247	1,263,284
Washington	62,913	10,008	11,550	30,338	59,529
West Virginia	1,046,625	778,749	922,766	1,452,393	1,788,528
Wisconsin	1,017,135	1,007,106	894,158	1,089,111	1,172,567
Wyoming	108,234	50,500	(a)	(a)	130,497
Undistributed	130,734	134,254	196,945	179,766	142,450
	38,745,429	33,894,155	35,229,866	41,309,599	46,263,379

[a] Included in "Undistributed."

BUILDING STONE.

The limestone sold for use as building stone, which in 1917 represented 1 per cent of the total quantity and 8 per cent of the total value, amounted to 8,481,510 cubic feet, valued at $4,115,366—an average price of 50 cents a cubic foot. This amount was a decrease of 2,588,720 cubic feet (23 per cent) in quantity, $472,839 (10 per cent) in value, and 8 cents in average price per cubic foot from 1916. The value was divided about equally between rough and rough sawed stone and dressed stone. The principal districts in which building limestone is produced are the Bloomington-Bedford district, in Lawrence and Monroe counties, Ind.; the Carthage district, in Jasper County, Mo.; and the Bowling Green district, in Warren County, Ky. The industry in these sections is given in detail below.

INDIANA.

Production.—The total value of Indiana oolitic limestone sold in 1917 was $3,384,110, a decrease of $96,415, or nearly 3 per cent, compared with 1916. This value, however, was greater than that for any other preceding year except 1912, as is shown in the following table:

Bedford oolitic limestone quarried and sold in Lawrence and Monroe counties, Ind., 1908–1917.

Year.	Lawrence County.		Monroe County.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1908	[a]5,199,996	$1,498,822	[a]3,147,097	$880,218	[a]8,347,093	$2,379,040
	[b]93,085	42,150	[b]8,260	1,719	[b]101,705	43,869
1909	[a]6,441,483	1,678,195	[a]2,970,388	801,436	[a]9,411,871	2,479,631
	[b]145,672	71,637	[b]106,600	56,925	[b]252,272	128,562
1910	[a]5,778,660	1,841,233	[a]3,960,148	1,265,287	[a]9,738,808	3,106,520
	[b]131,590	75,906	[b]70,655	44,224	[b]202,245	120,130
1911	[a]6,612,988	2,171,148	[a]2,915,444	859,580	[a]9,528,442	3,030,728
	[b]53,242	27,842	[b]50,914	45,112	[b]104,156	72,954
1912	[a]7,066,496	2,622,648	[a]3,375,808	824,594	[a]10,442,304	3,447,242
	[b]71,124	37,894	[b]76,532	60,629	[b]147,656	98,523
1913	[a]5,737,303	2,095,461	[a]3,273,369	992,286	[a]9,010,672	3,087,747
	[b]91,034	50,092	[b]67,035	41,508	[b]158,069	91,600
1914	[a]5,249,651	1,920,904	[a]2,679,355	750,311	[a]7,929,006	2,671,215
	[b]83,590	30,384	[b]21,860	17,010	[b]105,450	47,394
1915	[a]6,143,282	2,102,814	[a]2,541,931	830,613	[a]8,685,213	2,933,427
	[b]114,547	64,491	[b]34,032	20,253	[b]148,579	84,744
1916	[a]5,940,055	2,519,690	[a]2,605,479	873,886	[a]8,545,534	3,393,576
	[b]187,270	69,546	[b]24,966	17,403	[b]212,236	86,949
1917	[a]5,020,533	2,530,607	[a]1,754,141	730,500	[a]6,774,674	3,261,107
	[b]164,586	88,935	[b]45,740	34,068	[b]210,326	123,003

[a] Cubic feet. [b] Short tons.

Almost the entire value in 1917, as in previous years, was represented by building stone, as shown in the accompanying table which differs from that heretofore published in the volume "Mineral Resources of the United States" in that it includes rough sawed stone with rough blocks, the figures for 1916 being readjusted on this basis. The prices per cubic foot for 1916 are therefore distinctly higher in this revised table, that for rough stone increasing from 21 to 23 cents and that for dressed stone from 59 to 75 cents. As the rough sawing of soft stone is merely equivalent to the splitting of large blocks of granite into smaller blocks and is only the first of several steps necessary to convert rough into finished stone, this revision more truthfully represents the condition of the industry. The value of Indiana oolitic limestone used for building has represented large percentages of the total value of limestone for building in the United States in recent years—69 per cent in 1913 and 1914, 72 per cent in 1915, and 74 per cent in 1916. The percentages of the value of this limestone included in the total value of all kinds of building stone in the United States was 15 per cent in 1914, 19 per cent in 1915, and 23 per cent in 1916. These increasing percentages and the decrease in sales reported for 1917 indicate greater decreases in the total value both of all limestones and of all other kinds of stone sold for building in the United States in 1917, as may be surmised from the curtailment in building for all except war purposes. An estimated decrease of 30 per cent or more in total quantity and of 8 to 10 per cent in value will probably not prove excessive.

Limestone produced in the Bedford-Bloomington (Lawrence and Monroe counties) district, Ind., in 1916 and 1917.

County.	Rough blocks and rough sawed.		Dressed.		Total.		Other.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
1916.									
	Cu. ft.		*Cu. ft.*		*Cu. ft.*		*Short tons.*		
Lawrence	3,690,973	$831,219	2,249,082	$1,688,471	5,940,055	$2,519,690	187,270	$69,546	$2,589,236
Monroe	2,165,591	536,836	439,888	337,050	2,605,479	873,886	24,966	17,403	891,289
	5,856,564	1,368,055	2,688,970	2,025,521	8,545,534	3,393,576	212,236	86,949	3,480,525
Average price		0.23		0.75		0.40		0.41	
1917.									
Lawrence	3,578,058	$1,169,768	1,442,475	$1,360,839	5,020,533	$2,530,607	164,586	$88,935	$2,619,542
Monroe	1,432,821	461,529	321,320	268,971	1,754,141	730,500	45,740	34,068	764,568
	5,010,879	1,631,297	1,763,795	1,629,810	6,774,674	3,261,107	210,326	123,003	3,384,110
Average price		0.31		0.92		0.47		0.58	
Percentage of increase (+) or decrease (−)	−14.4	+19.2	−34.4	−19.5	−20.7	−3.9	−0.9	+41.4	−2.8

The total quantity of Bedford building stone sold in 1917 was 6,774,674 cubic feet, valued at $3,261,107, a decrease compared with 1916 of 21 per cent in quantity and nearly 4 per cent in value, the average price increasing from 40 to 47 cents a cubic foot. Rough blocks and rough sawed stone amounted to 5,010,879 cubic feet, valued at $1,631,297, in 1917, a decrease of about 14 per cent in quantity but an increase of 19 per cent in value, the price per cubic foot rising from 23 to 31 cents. Dressed or manufactured stone amounting to 1,763,795 cubic feet, valued at $1,629,810, decreased 34 per cent in quantity and nearly 20 per cent in value, although the price per cubic foot increased from 75 to 92 cents.

The quarry companies almost unanimously reported that business conditions were much poorer in 1917 than in 1916, especially in the last half of the year. A few companies reported decreases of 30 to 50 per cent in sales; and one company failed to show a profit for the first time in 17 years. Selling prices were advanced from 5 to 26 per cent, but cost of operation advanced much more, wages advancing about 20 per cent, fuel as much as 100 per cent, and different supplies from 10 to 300 per cent. Increase in thickness of overburden also seriously affected the cost of quarrying. Mill operators who bought their rough stone reported similar decreases in sales and increase in cost of labor and supplies, including rough stone, but nearly all of them reported that their selling prices were no better than in 1916, and some even reported lower prices. A few mills were closed awaiting revival of demand, and no new developments of consequence were reported.

The quantity and value of finished stone sold by mill operators in the Bedford-Bloomington district who buy their rough stock were reported for the first time for 1917 and amounted to 1,471,101 cubic feet, valued at $1,788,405, or $1.22 a cubic foot. These figures include a small quantity of monumental stone reported by two companies. The total value of the combined quarry and milling industry in 1917 was $5,172,515 and was probably second only to the value of the combined granite quarrying and milling industry in the Barre district of Vermont, which in 1917 was $8,316,600.

Shipments.—Shipments by quarrying and milling companies to different States, shown for the first time in the accompanying table, were made to 43 States and to Canada.

Shipments of Indiana oolitic limestone to different States and Canada in 1917.

	By milling companies.	By quarry companies.	Total.
	Cubic feet.	*Cubic feet.*	*Cubic feet.*
Canada	2,700	147,538	150,238
Alabama	1,218	22,266	23,484
Arkansas	525	2,784	3,309
California		864	864
Colorado	2,241	9,258	11,499
Connecticut	3,887	27,008	30,895
Delaware	1,158	2,491	3,649
District of Columbia	98,989	71,835	170,824
Florida	7,541	1,304	8,845
Georgia	7,495	34,716	42,211
Illinois	96,319	737,599	833,918
Indiana	130,688	2,952,611	3,083,299
Iowa	38,165	151,117	189,282
Kansas	8,033	19,801	27,834
Kentucky	2,886	14,488	17,374
Louisiana	17,280	22,584	39,864
Maine		1,617	1,617
Maryland	6,580	8,923	15,503
Massachusetts	6,723	87,016	93,739
Michigan	110,118	336,952	447,070
Minnesota	13,275	73,349	86,624
Mississippi		320	320
Missouri	63,064	43,801	106,865
Montana		2,119	2,119
Nebraska	34,080	111,858	145,938
New Hampshire	802	15,090	15,892
New Jersey	8,120	77,582	85,702
New Mexico		1,492	1,492
New York	133,405	711,570	844,975
North Carolina	62,971	18,312	81,283
North Dakota	5,400	13,642	19,042
Ohio	257,216	236,294	493,510
Oklahoma	8,531	45,863	54,394
Oregon		57,448	57,448
Pennsylvania	217,700	310,121	527,821
Rhode Island	2,700	43,242	45,942
South Carolina	6,127	17,502	23,629
South Dakota	13,660	12,093	25,753
Tennessee	1,350	21,045	22,395
Texas	37,784	11,747	49,531
Virginia	11,841	30,413	42,254
West Virginia	31,381	26,487	57,868
Wisconsin	18,212	245,111	263,323
Wyoming	936	41	977
	1,471,101	6,779,314	8,250,415

The six States to which no shipments were reported were, with the exception of Vermont, in the far West, and none except Washington have a population much if any in excess of 500,000. The large shipments reported as made by Indiana, the leading State, are accounted for in part by duplication, stone that was sold by quarry companies to mill companies in the Bedford-Bloomington district being counted twice. Even after the total quantity shipped by milling companies was deducted, however, Indiana retained the lead by a large margin and was the only State making shipments whose total quantity exceeded 1,000,000 cubic feet. New York was second with 844,975 cubic feet, and Illinois was a close third with 833,918 cubic feet. Pennsylvania was the only other State whose shipments exceeded 500,000 cubic feet in quantity. States that exceeded 100,000 cubic feet in quantity were, in order of rank, Ohio, Michigan, Wisconsin, Iowa, District of Columbia, Nebraska, and Missouri. Canada also exceeded this quantity.

Minor products.—Crushed stone, mostly for road metal, came largely from the Mitchell limestone, which overlies the oolitic stone, and amounted in 1917 to 93,086 short tons, valued at $62,698, and fluxing stone amounted to 47,439 short tons, valued at $10,163. These, with smaller quantities of riprap and stone sold to sugar factories, glass factories, and for agricultural use, reached a total of 210,326 short tons, valued at $123,003, a decrease in quantity of 0.9 per cent but an increase in value of 41 per cent, the average price per ton rising from 41 to 58 cents.

MISSOURI.

Missouri, which ranks second to Indiana in the production of limestone for building and which showed gains of 17 and 25 per cent, respectively, in 1915 and 1916, had a sharp decline in value of output in 1917. This decrease was due to decline in sales in the Carthage district, Jasper County, which has furnished 65 to 75 per cent of the limestone for building sold in the State in recent years. The decrease, which was caused by curtailment of building operations due to the war, began in the spring of the year, and has since reached a point where erection of permanent high-grade buildings by private interests is now practically at a standstill. Selling prices increased slightly in 1917, but were not sufficient to offset the increased cost of production.

The total value of the limestone and marble sold in the Carthage district in 1917, as shown in the accompanying table, was $392,443, representing a decrease of 28 per cent compared with 1916 and of 5 per cent compared with 1915 but exceeding the total of any other year. The output of building stone, the principal product, amounted in 1917 to 313,904 cubic feet, valued at $302,411, a decrease of 36 per cent in quantity and 39 per cent in value compared with 1916. The quantity of building stone sold in 1917 was less than in any of the nine preceding years except 1914; the value in 1917, however, was exceeded in only four years, 1909, 1910, 1915, and 1916.

Of the total quantity of building stone sold in 1917, 219,940 cubic feet, valued at $150,350, was rough, and 93,964 cubic feet, valued at $142,061, was dressed or manufactured stone. The proportion of stone dressed by the producers increased greatly in 1915 and 1916, owing largely to the quantity required for the new State capitol of Missouri. The proportion of dressed stone sold in 1917, though less than in the two preceding years, was greater than in earlier years.

The production of monumental stone in 1917 amounted to 49,819 cubic feet, valued at $58,809, an increase of 97 per cent in quantity and 167 per cent in value compared with 1916, the first year in which figures for monumental stone were separately recorded This increase was in keeping with the conditions of the monumental-stone trade throughout the country and reflected the continuation of the prosperity for a large part of the country which was so conspicuous in 1916. All the monumental stone was sold rough by the producers.

Of the minor products of the Carthage quarries in 1917, flagging amounted to 8,228 square feet, valued at $1,387, a decrease of 18 per cent, and rubble to 1,139 short tons, valued at $1,030, a decrease of 61 per cent. Stone for sugar factories, amounting to 3,169 short tons, valued at $1,491, is included in the table under "Other stone," and other important items under this heading are stone for glass factories, fluxing stone, crushed stone for concrete, and pulverized stone for agriculture. The total value of these products, valued at $31,223 in 1917, increased 56 per cent as compared with 1916.

Limestone and marble sold at Carthage, Jasper County, Mo., in 1908–1917.

Year.	Number of producers.	Building stone (rough and dressed).		Monumental stone[a] (rough).		Curbing.	Flagging.	Rubble.	Other stone.[b]	Total value.
		Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.					
1908	8	431,576	$280,249	....	....	$5,238	$3,602	$2,682	$17,826	$309,597
1909	8	481,274	334,715	....	....	1,263	6,232	3,791	24,001	370,002
1910	10	502,161	347,244	....	....	1,767	7,229	2,945	23,571	382,756
1911	9	427,974	293,470	....	....	2,427	2,431	2,596	23,865	324,789
1912	8	404,685	268,930	....	....	670	2,878	4,885	28,087	305,450
1913	7	346,421	236,524	....	....	....	2,367	1,500	18,564	258,955
1914	7	280,046	206,554	....	....	....	2,883	1,951	21,426	232,814
1915	7	367,950	384,959	....	....	(c)	2,614	[c] 1,220	25,471	414,264
1916	7	426,408	497,357	25,232	$22,054	(c)	1,684	2,675	20,029	543,799
1917	7	313,904	302,411	49,819	58,809	....	1,387	1,030	28,806	392,443
Average price 1917	....	....	$0.96	....	$1.18	....	....	....	....	....
Percentage of increase or decrease	....	−35.8	−39.2	+97.4	+166.6	....	−17.6	−61.4	+55.9	−27.8

[a] Prior to 1916 included under "Other stone."
[b] Includes stone used for monumental work prior to 1916, crushed stone, stone sold to glass factories, blast furnaces, sugar factories, etc.
[c] Curbing included in flagging; rubble includes riprap.

KENTUCKY.

The quantity of limestone sold in the Bowling Green district, Warren County, Ky., in 1917 for use in building operations was 201,582 cubic feet, valued at $107,279, or 53 cents a cubic foot, a decrease of 55,126 cubic feet, or 21 per cent, in quantity and of $12,421, or 10 per cent, in value compared with 1916, but an increase over both 1914 and 1915. Only four companies reported sales, a a smaller number than in former years, and many of the sales in 1917 were made under contract entered into late in 1916, when building activity was at its height. The output in 1917 included rough stone and rough sawed stone. No sales of finished stone were reported.

Other products of the Bowling Green district in 1917, consisting mainly of flux and crushed stone, amounted to 22,537 short tons, valued at $20,240, or 90 cents a ton. The output of crushed stone decreased considerably, whereas that of flux increased, and the total value of stone other than building increased $3,747, or 23 per cent.

Statistics of the limestone industry in Warren County, compiled by the United States Geological Survey, are given in the following table:

Limestone sold in Warren County, Ky., 1909–1917.

Year.	Rough building.		Dressed building.		Crushed stone.		Other.[a]	Total value.
	Quantity (cubic feet).	Value.	Quantity (cubic feet.)	Value.	Quantity (short tons).	Value.		
1909	203,120	$60,936	74,482	$62,989	46,725	$22,013	$33,704	$179,642
1910	204,602	56,141	90,100	57,350	108,183	47,532	5,584	166,607
1911	134,291	45,792	103,220	76,589	57,720	25,921	250	148,552
1912	148,711	51,638	114,308	100,774	38,495	17,563	1,890	171,965
1913	110,576	36,388	95,915	74,250	37,972	20,476	2,045	133,159
1914	104,895	36,043	80,427	60,292	39,906	22,344	....	118,679
1915	125,112	41,693	60,641	46,424	17,859	8,339	300	96,756
1916	193,843	71,197	62,865	48,503	10,750	5,133	11,360	136,193
1917	[c] 201,582	107,279	([c])	....	22,537	20,240	([b])	127,519
Average price	....	$0.53	....	....	....	$0.90	....	....

[a] Includes curbing, flagging, fluxing, and monumental stone.
[b] Mainly fluxing stone included with crushed stone.
[c] Prior to 1917 rough sawed stone was grouped with dressed stone. In 1917 rough sawed and rough stone were grouped together.

OTHER STATES.

A considerable quantity of building limestone is also quarried at Rockwood, Franklin County, Ala.; near Miami in Dade County, Fla.; and at Kasota, Le Sueur County, and Mankato, Blue Earth County, Minn. The output of Alabama and Florida is confined to one company in each State, a fact that makes it impossible to publish figures. In Minnesota, the output of the two districts amounted to 97,002 cubic feet, valued at $112,469, in 1917, and 100,610 cubic feet, valued at $91,323, in 1916, a decrease in quantity but an increase in value in 1917.

OTHER USES.

PAVING, CURBING, AND FLAGGING.

Limestone sold for paving, curbing, and flagging forms an almost negligible part of the total output of limestone. Each of these products decreased in both quantity and value in 1917.

RUBBLE.

The output of limestone for rubble, which has decreased continuously for the last eight years, decreased 5 per cent in quantity and 9 per cent in value in 1917. The principal producing States are Missouri, Wisconsin, and Illinois. Missouri decreased but Wisconsin and Illinois showed an increase in value of output.

RIPRAP.

Limestone for riprap showed a decrease in value of $502,573 (37 per cent) in 1917. Missouri, Illinois, and Wisconsin were the principal producing States. Practically all the States producing riprap showed decrease in output, the most notable decrease being in Illinois, Kansas, Minnesota, Missouri, Ohio, Texas, and Virginia. The only notable increase was in New York.

CRUSHED STONE.

The output of crushed limestone in 1917 showed a decrease of 17 per cent (5,537,394 short tons) in quantity and less than 1 per cent ($174,336) in value from that of 1916. The average price per ton was 66 cents, which was 11 cents more than in 1916. Of the total decrease nearly 72 per cent (3,972,352 short tons) was in crushed stone for road making, a little over 1 per cent (56,274 short tons) in concrete, and about 27 per cent (1,508,768 short tons) in railroad ballast.

Crushed limestone sold in the United States in 1916 and 1917, by uses.

	1916		1917	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Road metal	13,245,634	$7,416,984	9,273,282	$6,420,257
Railroad ballast	8,088,673	3,650,647	6,579,905	3,394,495
Concrete	10,849,729	6,647,803	10,793,455	7,726,346
	32,184,036	17,715,434	26,646,642	17,541,098

The only increase in 1917 was in the value of stone sold for concrete, which showed also the least decrease in quantity of production. Road metal had the largest decrease in quantity (30 per cent) and in value (13 per cent). The decrease in 1917 followed a decrease in 1916 of 9 per cent in both quantity and value.

The table below gives the output of crushed limestone in 1917 in the States that produced more than 175,000 tons:

Crushed limestone produced in the United States in 1917.

	Quantity (short tons).	Value.
Florida	412,969	$303,258
Illinois	4,468,439	2,468,330
Indiana	1,477,941	850,664
Iowa	551,012	390,137
Kansas	678,310	554,533
Kentucky	1,364,985	801,420
Maryland	175,297	197,814
Michigan	1,327,715	680,178
Minnesota	239,387	208,610
Missouri	1,036,979	907,059
Nebraska	382,241	391,351
New York	3,334,977	2,281,236
Ohio	4,140,007	2,381,432
Oklahoma	883,406	564,704
Pennsylvania	1,055,192	1,113,588
Tennessee	920,998	517,328
Texas	600,214	379,826
Virginia	1,345,965	911,294
West Virginia	560,741	319,016
Wisconsin	1,082,058	861,873
Undistributed [a]	607,809	457,447
	26,646,642	17,541,098

[a] Alabama, Arizona, Arkansas, California, Connecticut, Georgia, Louisiana, Montana, Nevada, New Jersey, New Mexico, North Carolina, South Dakota, Utah, Vermont.

Of these States eight (Florida, Indiana, Iowa, Kentucky, Minnesota, Ohio, Tennessee, and West Virginia) decreased in both quantity and value; five (Kansas, Nebraska, Oklahoma, Texas, and Virginia) increased in both quantity and value; and seven (Illinois, Maryland, Michigan, Missouri, New York, Pennsylvania, and Wisconsin) decreased in quantity but increased in value of output in 1917.

More than half the output of Illinois went into concrete and a little less than one-fourth into road metal; in Ohio one-fourth of the output was used for railroad ballast, a little less than one-third for concrete and nearly one-half for road metal; in New York two-fifths was used for concrete and a little less than two-fifths for road metal.

FURNACE FLUX.

Though the condition of the iron trade during the first six months of 1917 indicated that a small decrease in the quantity of limestone marketed for use as furnace flux might be expected in 1917, the reports for the entire year show an increase, for the production was 25,574,146 long tons, valued at $18,679,213, a gain of 1,950,638 long tons (8 per cent) in quantity and of $4,732,331 (34 per cent) in value over 1916. These increases followed increases of 24 per cent in quantity and 44 per cent in value in 1916, and of 24 per cent in quantity and 23 per cent in value in 1915. The average price in 1917 was 73 cents a long ton, compared with 59 cents in 1916, and 51 cents in 1915. There was also sold for furnace flux 18,932 long tons of marble valued at $15,072.

Production in 1916 was reported from 33 States; in 1917 from 34 States, Nevada reporting production for the first time. In 1917, as in 1916, five States produced more than 1,000,000 long tons, Alabama rising above that figure and Illinois falling below. Five States exceeded $1,000,000 in value in 1917, whereas only three exceeded that value in 1916.

Of the 22 States whose individual production is shown in the accompanying table, 9 showed decrease in quantity but only 2 showed decrease in value. The 9 States whose quantity decreased were Pennsylvania and New York in the East, Wisconsin, Illinois, and Kentucky in the central region, and Colorado, Montana, Utah, and California in the West. Pennsylvania fell below the 10,000,000-ton mark, which it passed in 1916, but its output was still more than double that of the second State, Ohio, and nearly three times that of the third State, Michigan. The combined increase in quantity for Ohio and Michigan was nearly four times the combined decrease of Pennsylvania and New York. New York's output had also decreased in 1916. The three Central States, Wisconsin, Illinois, and Kentucky, though showing a decrease in production in 1917, were still far ahead of 1915. Only a small part of their decrease in 1917 was offset by gains in adjacent States, but their total loss was less than 10 per cent of the gains of Ohio and Michigan, which can supply the same markets in the Great Lakes region. The combined decrease of the four Western States mentioned was nearly double the gain made by other Western States, and the loss of Montana alone (208,910 long tons) was more than 50 per cent greater than this gain.

The States showing the most striking increase were Ohio, New Jersey, and Maryland in the East, Tennessee and Alabama in the South, Michigan and Indiana in the central region, and Arizona and Washington in the West. Maryland, whose output rose from less than 5,000 long tons in 1915 to more than 146,000 long tons in 1916, made a further gain of 22,256 long tons in 1917, and its value passed the $100,000 mark. West Virginia, which passed the 1,000,000-ton mark in 1916, made a further gain of 274,420 long tons in 1917 and the value of its output approximated $1,500,000. Alabama produced more than 1,000,000 long tons and the value of its product exceeded $1,000,000 for the first time. Michigan gained 542,023 long tons in 1917, continuing the steady increase in output since 1913, the year in which this industry was begun in the State. Arizona and Washington more than doubled the quantity and value of their output in 1917.

According to the Iron Trade Review the production of pig iron in the United States for the first half of 1918 was 5.6 per cent less than in the corresponding period in 1917, a reduction which indicates what may be expected of the furnace flux industry for the first half of 1918.

Furnace flux sold in the United States in 1916 and 1917.

	1916		1917	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Alabama	867,785	$807,344	1,157,818	$1,159,035
Arizona	68,069	41,426	152,877	111,329
Arkansas	(a)	(a)	(a)	(a)
California	79,607	86,921	68,015	84,414
Colorado	564,147	332,187	549,852	387,184
Connecticut	(a)	(a)	(a)	(a)
Georgia	(a)	(a)	6,385	7,244
Idaho	(a)	(a)	(a)	(a)
Illinois	1,120,175	427,058	991,879	434,447
Indiana	282,748	132,145	324,741	158,476
Iowa	4,398	3,407	18,563	18,895
Kansas	(a)	(a)	(a)	(a)
Kentucky	69,447	41,807	54,922	44,826
Maryland	146,276	79,565	168,532	107,156
Massachusetts	....	....	(a)	(a)
Michigan	3,033,155	1,207,326	3,575,178	1,633,965
Minnesota	....	....	(a)	(a)
Missouri	61,500	49,227	63,028	71,148
Montana	633,729	206,153	424,819	182,538
Nebraska	(a)	(a)	(a)	(a)
Nevada	....	....	(a)	(a)
New Jersey	289,043	178,266	368,850	327,226
New York	657,788	405,774	578,748	426,858
North Carolina	(a)	(a)	(a)	(a)
Ohio	3,281,324	1,636,991	4,432,652	2,524,564
Oregon	(a)	(a)	(a)	(a)
Pennsylvania	10,019,046	6,768,374	9,840,305	8,790,058
Rhode Island	(a)	(a)	(a)	(a)
Tennessee	113,149	65,352	155,028	111,141
Texas	60,424	44,947	84,710	70,548
Utah	292,681	167,888	278,803	170,332
Vermont	(a)	(a)	(a)	(a)
Virginia	361,598	189,339	375,469	287,942
Washington	17,582	14,813	44,045	43,126
West Virginia	1,451,700	966,031	1,726,120	1,409,364
Wisconsin	131,566	77,988	95,359	80,667
Undistributed	16,571	16,553	37,448	35,730
	23,623,508	13,946,882	25,574,146	18,679,213
Average price	....	$0.59	....	$0.73
Percentage of increase	....	....	8.2	33.9

a Included in "Undistributed."

AGRICULTURAL USE.

Since the statistics of the production of pulverized limestone for use in agriculture were first compiled in 1911 the output has steadily increased until 1917, when a slight decrease in quantity (0.3 per cent) was reported, although the value increased about 22 per cent. The output for 1917 was 1,040,248 short tons, valued at $1,352,397.

The burned lime used in agriculture in 1917 amounted to 488,297 short tons, equivalent to about 980,000 tons of limestone, and was valued at $2,475,731—a decrease of 20 per cent in quantity and an increase of 11 per cent in value. The total quantity of limestone quarried in 1917 for use by farmers was therefore about 2,000,000 tons, as compared with 2,270,000 tons in 1916. The average price of pulverized limestone in 1917 was $1.30, an increase of 24 cents. In addition to pulverized limestone and burned lime, 73,900 short tons of calcareous marl, valued at $165,223, was sold for this use.

Lime and pulverized limestone produced for use in agriculture, 1911–1917.

Year.	Lime.		Limestone.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1911	596,664	$1,714,386	174,290	$205,006
1912	604,607	1,852,530	200,000	311,702
1913	590,229	1,798,566	408,627	493,718
1914	684,348	2,139,444	615,197	688,961
1915	673,260	2,163,874	810,399	893,530
1916	613,564	2,224,058	1,043,876	1,109,208
1917	488,297	2,475,731	1,040,248	1,352,397
Average price per ton		5.07		1.30
Increase or decrease (per cent)	−20.4	+11.3	−0.3	+21.9

Ground limestone sold for agricultural purposes in 1916 and 1917.

State.	1916		1917	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama	(a)	(a)	7,218	$8,428
Arkansas	(a)	(a)	(a)	(a)
California	5,602	$8,188	7,173	17,929
Connecticut	(a)	(a)	(a)	(a)
Florida	29,450	36,836	9,428	19,265
Georgia	(a)	(a)	32,537	58,348
Hawaii	(a)	(a)		
Illinois	203,829	135,908	179,848	126,870
Indiana	39,596	32,588	46,100	39,403
Iowa	17,526	9,630	45,387	24,584
Kansas	1,870	1,448	(a)	(a)
Kentucky	34,645	35,477	25,723	22,362
Louisiana	(a)	(a)	(a)	(a)
Maryland	(a)	(a)	(a)	(a)
Massachusetts	(a)	(a)	(a)	(a)
Michigan	30,543	11,088	62,027	58,148
Minnesota	1,412	835	(a)	(a)
Mississippi			(a)	(a)
Missouri	5,946	6,063	5,992	8,631
New Jersey	(a)	(a)	(a)	(a)
New York	102,608	164,237	82,000	152,394
North Carolina	46,032	65,101	67,415	95,288
Ohio	55,236	54,591	66,341	93,133
Oklahoma	(a)	(a)	(a)	(a)
Oregon	(a)	(a)	(a)	(a)
Pennsylvania	73,301	129,574	138,323	261,396
Rhode Island	(a)	(a)	(a)	(a)
Tennessee	66,854	64,910	60,237	87,738
Texas	(a)	(a)	(a)	(a)
Vermont	27,489	54,535	15,031	26,894
Virginia	131,703	81,166	40,580	46,489
Washington	1,881	5,282	2,764	5,587
West Virginia	47,709	74,865	4,782	5,430
Wisconsin	11,920	10,360	15,090	23,608
Undistributed	108,724	126,526	126,252	170,472
	1,043,876	1,109,208	1,040,248	1,352,397

[a] Included in "Undistributed."

Illinois was the leading State in quantity of output of ground limestone, but Pennsylvania, the next in quantity, stood first in value. The output of Pennsylvania showed increase and that of Illinois decrease in both quantity and value. At many quarries pulverized limestone is a by-product, but at others it is the principal output. In some parts of the country, particularly in California, Kentucky, Virginia, and Wisconsin, where the farmers recognize the value of this product, they pulverize limestone on a community plan, which is promoted by State or county officials

SUGAR FACTORIES.

The quantity of limestone sold to sugar factories showed a decided increase in 1917 over 1916—from 369,028 short tons, valued at $369,694, to 530,612 short tons, valued at $666,138. The burned lime sold for this use increased from 21,923 short tons, valued at $118,572 in 1916, to 47,546 short tons, valued at $381,746 in 1917, making the total value of the limestone products sold for this purpose $488,266 in 1916 and $1,047,884 in 1917. Of the total quantity of the lime burned for use at sugar factories 70 per cent (33,614 tons) was produced in California. California also furnished the largest quantity of limestone for this purpose—124,070 short tons, valued at $167,535—but was closely followed by Colorado, which produced 117,554 short tons, valued at $144,125, and by Wyoming, which produced 96,288 short tons, valued at $130,497.

GLASSWORKS.

The limestone sold to glassworks in 1917 amounted to 293,152 short tons, valued at $344,479, an increase of 100,124 tons in quantity and $163,157 in value. The burned lime sold for this purpose amounted to 60,624 tons, valued at $316,280, making a total of $660,759 for the value of limestone used in glass making. Pennsylvania, Ohio, and Missouri furnished about 70 per cent of the stone and Ohio more than half of the lime.

ALKALI WORKS.

The limestone used in making alkali amounted to 3,124,026 short tons, valued at $1,417,898, an increase of 287,469 short tons, and of $451,636. There was also a considerable quantity of lime used for this purpose. This large increase was due to the increased manufacture of chemicals called for by the war. Michigan furnished 68 per cent of the stone for this purpose, and large quantities were also quarried in New York, Virginia, and Kansas.

LIME BURNERS.

The stone sold to manufacturers of lime in 1917 amounted to 59,387 short tons, valued at $31,736, a decrease of 54 per cent (71,342 tons) in quantity and 60 per cent ($49,737) in value.

PAPER MILLS.

The limestone sold to paper manufacturers in 1917 amounted to 101,305 short tons, valued at $95,582, a gain of 25 per cent in quantity and 62 per cent in value over 1916, when the figures were 80,338 short tons, valued at $58,785. The lime burned and sold for this purpose was 355,768 short tons, valued at $2,008,423, in 1917 and 353,187 short tons, valued at $1,461,412, in 1916. Pennsylvania and Michigan furnish more than one-half of the stone sold to the paper mills, and Pennsylvania, Maine, Massachusetts, New York, Tennessee, Indiana, Vermont, West Virginia, Wisconsin, and Missouri furnish also considerable quantities of lime for this purpose.

WHITING.

The quantity of limestone pulverized and used as a substitute for whiting and chalk increased considerably in 1916 and 1917. In 1916 the rough stone sold for the manufacture of whiting was 24,722 short tons, valued at $47,435, and in 1917 it was 34,983 short tons, valued at $75,326, an increase in 1917 of 41 per cent in quantity and 59 per cent in value. Fourteen companies reported production of whiting in 1917 and the States represented were California, Georgia, Illinois, Iowa, Michigan, Missouri, Ohio, and Utah.

Most of the whiting used in this country has been manufactured from English chalk, whose imports are included in the following table compiled from figures furnished by the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Chalk, etc., imported for consumption, 1915–1917.

	1915		1916		1917	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Chalk, crude, not precipitated, or otherwise manufactured (duty free)..........tons..	111,501	$79,950	133,188	$112,671	129,711	$126,60
Ground or bolted (duty 0.1 cent a pound) ....pounds..	75,018	486	....	....	1,195,955	6,241
Precipitated, for medicinal purposes (duty 25 per cent)........................	....	42,420	....	27,713	....	29,980
Forms of cubes, blocks, sticks, dishes, or otherwise, including tailor's, billiards, etc. (duty 25 per cent)........	....	4,592	....	4,096	....	6,563
French, cut, powdered, washed, or pulverized (duty 15 per cent)............	....	129	....	628	....	222
Manufactured, not elsewhere specified (duty 25 per cent)................	....	160	....	249	....	340
Whiting and Paris white, dry (duty 0.1 cent a pound)..................pounds..	3,493,308	12,774	2,308,726	9,952	4,054,622	22,485
Whiting and Paris white, ground in oil or putty (duty 15 per cent)........pounds..	16,402	395	28,334	972	37,230	2,879

The principal features of this table are the marked increase in quantity of ground or bolted chalk and of whiting and Paris white in 1917. This increase, which presumably built up considerable reserve stocks, may explain why there were no complaints of shortage by consumers after the shipping situation became acute late in 1917 and in 1918.

MISCELLANEOUS LIMESTONE.

Of limestone sold for miscellaneous purposes in 1917 the most important products reported were 232,421 short tons of dolomite, valued at $171,257, used for lining furnaces and making patent refractory products[1]; 39,498 short tons of limestone, valued at $125,648, used as asphalt filler; 12,030 short tons, valued at $8,818,

[1] Dolomite quarried and "dead burned" by the producer for refractory uses in 1917 amounted to 223,300 short tons, valued at $2,376,633.

used in the manufacture of mineral wool; and 73,214 short tons of dolomite, valued at $89,189, used in the manufacture of basic magnesium carbonate. Other products reported either by individual producers or in quantities too small for segregation were stone sold for chicken grit, roofing gravel, stucco and terrazzo work, and filter stone, and stone sold to chemical works making powder, carbolic acid, calcium carbide, and other products.

LITHOGRAPHIC STONE.

In a statement made to the United States Geological Survey the Kentucky Lithographic Stone Co., whose quarry is at Brandenburg, Ky., reported sales of 5,832 pounds of lighographic stone in 1917—considerably less than was sold in 1916. The decrease was due largely to obstacles which kept the quarry idle for six months. The shipments in 1917 were made to the same points as in 1916—Boston, New York, Cleveland, and less distant cities.

The continued demand from the same markets and the fact that the demand in 1917 exceeded the company's ability to supply it were encouraging in spite of the obstacles that attend the development of a new industry. The main difficulty has been the handling and disposing of a large quantity of limestone that lies above and between the three beds of lithographic stone. Plans made to build a spur track to the quarry from the Louisville, Henderson & St. Louis Railway have been delayed by difficulties in obtaining a right of way. In consequence of these unfavorable conditions of transportation the quarry was not operated continuously. The track is now reported to be under construction, and when it is completed the company will use it to ship a large quantity of by-product stone, in the form of crushed stone, furnace flux, pulverized agricultural stone, chicken grit, and other products. A crusher and a pulverizer are installed and even under the poor conditions that prevailed in 1917 small quantities of these products and of honestones were marketed. The present demand for crushed stone, flux, and agricultural stone should call for sufficient quarrying to insure a large supply of lithographic stone as soon as adequate means of transportation are provided.

SANDSTONE.

GENERAL STATISTICS.

The sandstone marketed in the United States in 1917 amounted to about 3,867,600 short tons, valued at $5,512,421—a decrease in value of 1.6 per cent from that for 1916, which was in turn a decrease of 8 per cent from that for 1915. Except in 1909, 1913, and 1914, the value of the sandstone sold has shown a decrease each year since 1903. The decrease in quantity for 1917 was about 806,600 short tons (17 per cent). In 1917 the sandstone sold represented 6.7 per cent of the total value of stone sold and 4 per cent of the total quantity.

The three leading States, which contributed more than 66 per cent of the total value of sandstone, were Pennsylvania ($1,794,919), Ohio ($1,086,027), and New York ($760,582). Pennsylvania and New York reported increase in value in 1917. The increase for Pennsylvania was mainly in the value of ganister, as except for a small increase in crushed stone for concrete, all other sandstone products showed a decrease. Ohio's principal sandstone products were building stone, curbing, and flagging, the output of all of which decreased in 1917. In New York increase in value was reported for rough building stone, paving, curbing, and flagging, and decrease for dressed building stone and crushed stone. The States reporting a production of sandstone numbered 35, of which 24 showed decreased output. The decrease was general for all uses of stone. The increase in Wisconsin was in quartzite (ganister) used in the manufacture of refractory brick. Colorado's increase was in building stone and ganister. The considerable increase in North Carolina was due to the quarrying of a large quantity of stone in Burke and McDowell counties near Bridgewater for the construction of a dam. The most noticeable decreases were in Minnesota (building and crushed stone) and in Texas (riprap and crushed stone). An apparent decrease in building stone and crushed stone for concrete in New Jersey was due to the reclassification of argillite under "miscellaneous stone." The number of quarries reporting operation in 1917 was 356, compared with 436 in 1916.

Value of sandstone (including quartzite and bluestone) produced and sold in the United States, 1913–1917.

State.	1913	1914	1915	1916	1917
Alabama	$151,111	$161,773	$30,432	$20,995	$17,098
Arizona	88,391	23,760	9,625	(a)	(a)
Arkansas	89,395	79,358	54,747	95,398	66,183
California	139,486	277,657	336,629	422,225	232,379
Colorado	96,964	97,029	52,487	53,902	90,646
Connecticut	(a)	(a)	(a)	(a)	(a)
Florida	(a)				
Georgia	(a)				
Idaho	20,111	22,837	10,302	47,061	56,702
Illinois	28,781	72,738	43,307	40,343	42,304
Indiana	(a)	(a)	(a)		
Iowa	1,612	1,319	(a)	(a)	(a)
Kansas	1,602	2,274	(a)	3,495	(a)
Kentucky	81,171	60,926	70,164	114,136	96,117
Maryland	16,435	8,128	11,038	6,003	(a)
Massachusetts	404,817	428,926	353,662	318,982	216,500
Michigan	19,224	(a)	(a)	21,449	(a)
Minnesota	315,149	210,099	173,995	186,179	81,717
Missouri	10,195	3,588	10,104	14,991	6,862
Montana	51,081	(a)	6,346	(a)	(a)
Nebraska	(a)	(a)	(a)	(a)	(a)
New Jersey	69,584	53,394	63.964	46,035	6,758
New Mexico	66,700	412,845	296,809	18,330	(a)
New York	[b] 1,568,952	[b] 1,475,231	[b] 1,000,523	[b] 714,558	[b] 760,582
North Carolina	(a)	(a)	27,544	(a)	228,048
Ohio	1,316,028	1,523,796	1,411,333	1,274,181	1,086,027
Oklahoma	1,010	1,934	2,525	24,229	5,096
Oregon	(a)	(a)	(a)	(a)	(a)
Pennsylvania	[b] 1,359,533	[b] 1,140,182	1,253,994	[b] 1,318,239	[b] 1,794,919
South Dakota	163,165	126,413	119,225	163,735	116,785
Tennessee	(a)	(a)	(a)	(a)	(a)
Texas	58,750	197,800	73,128	85,940	(a)
Utah	23,965	67,578	27,267	27,207	25,021
Virginia	(a)	150,469	178,775	66,217	34,058
Washington	560,468	450,436	(a)	(a)	(a)
West Virginia	146,698	142,459	124,929	48,416	52,543
Wisconsin	213,229	167,595	180,198	188,791	291,241
Wyoming	(a)	11,831	10,840	(a)	(a)
Undistributed	185,358	129,433	141,908	282,741	204,835
	7,248,965	7,501,808	6,095,800	5,603,778	5,512,421

[a] Included in "Undistributed." [b] Includes bluestone.

There have been excluded from the production of sandstone in 1917 quantities of mica schist quarried in Pennsylvania and used as furnace lining, of slate and conglomerate quarried in Massachusetts and used as crushed stone and building stone, and of argillite quarried in New Jersey and Pennsylvania and used as crushed stone. The approximate quantity of the output of sandstone is shown for the first time. The usual unit of measurement for the different products is given and the quantities reported are then reduced to estimated equivalents in short tons in order to show the approximate total quantity.

Sandstone sold in the United States in 1916 and 1917, by uses.

	1916		1917	
	Quantity.	Value.	Quantity.	Value.
Building stone.........cubic feet..	[a] 3,803,190	$1,316,287	[a] 2,579,750	$1,043,226
Approximate equivalent in short tons......	(311,860)		(211,540)	
Paving blocks.........number..	[a] 7,300,000	327,264	[a] 7,093,500	352,808
Approximate equivalent in short tons......	(73,000)		(70,940)	
Curbing.........linear feet..	[a] 2,417,000	702,902	[a] 2,177,560	651,564
Approximate equivalent in short tons......	(124,470)		(112,300)	
Flagging.........square feet..	[a] 3,050,000	389,859	[a] 2,963,980	348,000
Approximate equivalent in short tons......	(75,000)		(71,630)	
Crushed stone.........short tons..	2,159,866	1,664,694	1,520,981	1,400,705
Riprap.........do....	[a] 670,000	488,874	342,485	263,464
Rubble.........do....	[a] 200,000	86,938	146,584	65,667
Ganister.........do....	859,956	529,805	1,301,177	1,350,500
Other.........do....	[a b] 200,000	97,155	[a] 90,000	36,487
Total (quantities approximate, in short tons).........	4,674,200	5,603,778	3,867,640	5,512,421

[a] Partly estimated.
[b] Includes 33,236 short tons of mica schist valued at $47,304, used for furnace lining and included under "Miscellaneous" in 1917.

Value of sandstone (including quartzite and bluestone) produced and sold in the United States in 1916 and 1917.

1916.

State.	Rough building.	Dressed building.	Ganister.	Paving.	Curbing.	Flagging.	Rubble.	Riprap.	Crushed stone. Road metal.	Crushed stone. Railroad ballast.	Crushed stone. Concrete.	Other.	Total.
Alabama	(a)		(a)				(a)	(a)					$20,995
Arizona												(a)	(a)
Arkansas	(a)	(a)		(a)		(a)		(a)	(a)	(a)	$14,071	(a)	95,398
California	$7,079							$108,532	$137,814	$23,145	145,655		422,225
Colorado	3,790	$2,842	(a)	$10,678	$1,003	$986	$5,323	2,022		(a)	(a)	(a)	53,902
Connecticut	(a)	(a)					(a)	(a)				(a)	(a)
Idaho	(a)	(a)					(a)					(a)	47,061
Illinois	(a)		(a)						(a)	(a)			40,343
Iowa	(a)											(a)	(a)
Kansas	(a)			(a)	(a)	(a)					600		3,495
Kentucky	4,721	61,045						40,599	(a)		(a)	(a)	114,136
Maryland	(a)		(a)				(a)		(a)		(a)		6,003
Massachusetts	58,328	(a)					(a)		53,600		190,914	(a)	318,982
Michigan	(a)	(a)					(a)	(a)	(a)		(a)		21,449
Minnesota	(a)	(a)		(a)	(a)		(a)		(a)		66,698	(a)	186,179
Missouri	(a)	(a)					(a)	(a)				(a)	14,991
Montana	(a)	(a)											5,362
Nebraska	(a)	(a)						(a)				(a)	(a)
New Jersey	28,239	3,475		(a)			(a)	(a)	(a)		(a)	(a)	46,035
New Mexico							(a)	(a)			16,860		18,330
New York	35,955	149,016		131,430	221,060	37,987	(a)	1,392	70,008	10,397	44,150	$12,825	714,558
North Carolina										(a)	(a)	(a)	(a)
Ohio	126,626	369,091	(a)		375,690	308,516	9,016	63,685	7,275		(a)	8,391	1,274,181
Oklahoma	(a)	(a)		(a)			(a)				(a)	(a)	24,229
Oregon								(a)					(a)
Pennsylvania	102,398	114,827	$410,541	78,237	86,061	41,829	25,033	18,801	160,090	107,548	115,438	57,436	1,318,239
South Dakota	2,127	(a)	(a)	(a)			(a)	5,117	(a)		124,914	(a)	163,735
Tennessee												(a)	(a)
Texas							(a)	62,850	(a)		(a)		85,940
Utah	(a)	(a)		(a)			(a)						27,207
Virginia									53,800	(a)			66,217
Washington	(a)	(a)		(a)			(a)	(a)					(a)
West Virginia	4,448	3,939		(a)	(a)	(a)	3,910	(a)	8,655	(a)	17,356	(a)	48,416
Wisconsin	8,551	21,683	79,643	23,266	(a)	(a)	5,924	8,714	30,729		9,897	(a)	188,791
Wyoming	(a)	(a)						(a)			(a)		(a)
Undistributed	65,659	142,448	39,621	83,653	19,088	541	37,732	177,162	107,732	39,045	108,303	18,503	282,741
	447,921	868,366	529,805	327,264	702,902	389,859	86,938	488,874	629,703	180,135	854,856	97,155	5,603,778

[a] Included in "Undistributed."

Value of sandstone (including quartzite and bluestone) produced and sold in the United States in 1916 and 1917—Continued.

1917.

State.	Rough building.	Dressed building.	Ganister.	Paving.	Curbing.	Flagging.	Rubble.	Riprap.	Crushed stone.			Other.	Total.
									Road metal.	Railroad ballast.	Concrete.		
Alabama	(a)	(a)	(a)				(a)	(a)					$17,098
Arizona	(a)							(a)					(a)
Arkansas	(a)							(a)	(a)	$4,266	(a)	(a)	66,183
California	$8,000						(a)	(a)	$61,575		$144,377	(a)	232,379
Colorado	14,534	$25,967	$32,137	(a)	$2,216	$654	$3,071	(a)			(a)		90,646
Connecticut	(a)	(a)					(a)	(a)				(a)	(a)
Idaho	(a)	(a)					(a)					(a)	56,702
Illinois	(a)		(a)						(a)				42,304
Iowa							(a)					(a)	(a)
Kansas	(a)					(a)	(a)						(a)
Kentucky	(a)	51,615					3,541	$19,985	(a)	(a)	(a)		96,117
Maryland	(a)		(a)						(a)		(a)		(a)
Massachusetts		(a)							(a)		154,500		216,500
Michigan	(a)	(a)					(a)	(a)					(a)
Minnesota	(a)	(a)		(a)	(a)	(a)	(a)		(a)		15,150		81,717
Missouri	(a)	(a)					(a)	(a)				(a)	6,862
Montana	(a)	(a)											(a)
Nebraska	(a)						(a)						(a)
New Jersey	(a)							(a)					6,758
New Mexico							(a)						(a)
New York	38,209	102,346	(a)	$171,566	275,254	46,783	(a)	8,491	(a)	21,413	47,007	$5,445	760,582
North Carolina	(a)	(a)					(a)			(a)	(a)		228,048
Ohio	92,691	342,462	(a)		305,581	274,150	5,719	49,302	(a)	(a)	(a)	4,356	1,086,027
Oklahoma	311	(a)					(a)				(a)		5,096
Oregon								(a)					(a)
Pennsylvania	57,080	100,507	1,114,696	73,087	59,321	26,187	24,151	16,498	85,522	94,928	121,897	21,045	1,794,919
South Dakota	(a)	(a)	(a)	14,375			(a)	1,604	(a)		85,433	(a)	116,785
Tennessee			(a)										(a)
Texas								(a)		(a)	(a)	(a)	(a)
Utah	(a)			(a)	(a)								25,021
Virginia									(a)	(a)			34,058
Washington		(a)					(a)	(a)					(a)
West Virginia	8,761	(a)	(a)		(a)		4,756	(a)	15,910		14,709		52,543
Wisconsin	28,260	(a)	167,385	44,711			2,147	2,950	25,402		(a)	608	291,241
Wyoming							(a)	(a)			(a)		(a)
Undistributed	46,792	125,691	36,282	49,069	9,192	226	22,282	164,634	210,286	27,472	270,858	5,033	204,835
	294,638	748,588	1,350,500	352,808	651,564	348,000	[b]65,667	[c]263,464	398,695	148,079	853,931	36,487	5,512,421

[a] Included in "Undistributed."

[b] Value of 145,584 short tons of stone.

[c] Value of 342,485 short tons of stone.

BUILDING STONE.

The value of sandstone for use in building decreased $273,061 (20 per cent) in 1917, 7 per cent in 1916, and 22 per cent in 1915. The quantity decreased 1,223,440 cubic feet (32 per cent) in 1917. Rough building stone, valued at $294,638, decreased 34 per cent and dressed stone, valued at $748,588, decreased about 14 per cent. The total production in 1917 was 2,579,750 cubic feet, valued at $1,043,226. The three principal producing States were Ohio, Pennsylvania, and New York, whose outputs were valued at $435,153, $157,587, and $140,555, respectively. These States represented 70 per cent of the total value of building stone and had an average decrease in value of 17 per cent in 1917. The only notable increases in building stone were in Colorado and Wisconsin and were due to increased activity in the quarries at Stone City, Pueblo County, Colo., and at Port Wing, Bayfield County, and Dunnville, Douglas County, Wis. An apparent decrease in Massachusetts was occasioned by the reclassification of some conglomerate used as building stone with the group of "miscellaneous stone" and by decreased operations at East Long Meadow.

PAVING BLOCKS.

The value of the sandstone sold for paving blocks ($352,808) increased 7.8 per cent, and this was the only sandstone product other than ganister that increased in value in 1917. The quantity, however, decreased 2.8 per cent. Sandstone paving blocks were produced in 7 States in 1917, compared with 13 in 1916. New York, Pennsylvania, and Wisconsin were the leading producers. New York's output, valued at $171,566, was an increase of 30 per cent; Wisconsin's, valued at $44,711, an increase of 92 per cent; and Pennsylvania's valued at $73,087, a decrease of 6.4 per cent. Colorado, Minnesota, South Dakota, and Utah, the other States producing sandstone paving blocks in 1917, decreased in value. The principal quarrying districts for sandstone paving blocks are Sandstone, Pine County, Minn.; Medina and vicinity, Orleans County, N. Y.; Dell Rapids and Sioux Falls, S. Dak.; and Sauk County, Wis.

CURBING AND FLAGGING.

Curbing and flagging are two sandstone products that have shown continued decrease for several years, owing to competition with concrete. The value of curbing in 1917 was $651,564, a decrease of $51,338 (7 per cent) which followed a decrease of $187,562 (22 per cent) in 1916. Ohio, New York, and Pennsylvania were the only important producing States. The value for New York ($275,254) was the only one showing an increase. The value for Ohio ($305,581) is nearly one-half of the total value of sandstone curbing. The greater part of the curbing sold in New York and Pennsylvania was, as usual, bluestone. The total quantity of curbing (2,177,560 linear feet) decreased 10 per cent.

The value of flagging decreased to $348,000, or 11 per cent. Ohio produced flagging valued at $274,150, about 80 per cent of the total value and a decrease of 11 per cent. New York showed a slight increase—from $37,987 in 1916 to $46,783 in 1917—and Pennsylvania, the only other producing State, decreased to $26,187 (about 37 per cent). The total quantity of the sandstone sold for flagging in 1917 was about 2,963,980 square feet, a decrease of nearly 3 per cent.

RUBBLE AND RIPRAP.

The sandstone sold for rubble and for riprap in 1917 decreased in both quantity and value; in 1916 there was a decrease in value of rubble and an increase in value of riprap. Pennsylvania, the leading State in production of rubble, decreased in output in 1917, as did practically all the other producing States. Large decreases in riprap in California and Oregon and minor ones in the other States caused a decrease of 50 per cent in quantity and 46 per cent in value in 1917.

CRUSHED STONE.

Crushed sandstone in 1917, for the third year in succession, decreased in sales—30 per cent in quantity and 16 per cent in value. The largest decrease was in crushed stone for road metal, which declined about 45 per cent in quantity and 36 per cent in value.

Crushed sandstone sold in the United States in 1917.

	Quantity (short tons).	Value.
Road metal	450,478	$398,695
Concrete	829,724	853,931
Railroad ballast	240,779	148,079
	1,520,981	1,400,705

A little more than one-fourth of the quantity sold was quarried in Pennsylvania—389,043 short tons, valued at $302,347. California stood second with 269,903 short tons, valued at $205,952; and Massachusetts third, with 167,000 short tons, valued at $211,500. The output of crushed sandstone in Massachusetts in 1917 as reported does not include conglomerate and slate, which are now classified with "miscellaneous stone," as is the argillite quarried in Pennsylvania and New Jersey.

GANISTER.

The demand for ganister, or quartzite, used in making silica brick and for lining furnaces, which was brought into prominence in 1915 by the unusual demand for refractory material for use in the war industries, continued its remarkable growth in 1917. This product represented about one-third of the total quantity of sandstone quarried and more than one-fourth of the total value. The total quantity sold in 1917 amounted to 1,301,177 short tons, valued at $1,350,500, an average price of $1.04 a ton. This was an increase of 441,221 tons, or about 51 per cent, in quantity and of $820,695, or 155 per cent, in value compared with 1916, when the average price was only 62 cents a ton. The increase in 1916 over 1915 was 50 per cent in quantity and 58 per cent in value. The marked advance in price in 1917 was due mainly to increased cost of production.

Pennsylvania, with 26 plants, continued to furnish the bulk of the output in 1917—1,001,630 short tons, valued at $1,114,696, or $1.10 a ton, an increase of 49 per cent in quantity and 171 per cent in value compared with 1916, when the average price was 61 cents a ton. Railroad embargoes and shortage of cars have delayed shipments during the first part of 1918, but the price per ton is reported to have been as high as $1.50. More than four-fifths of Pennsylvania's production in 1917 came from 7 plants in Huntington County and 6 in Blair County, the remainder being distributed among 13 other plants in 10 counties. A small quantity of the output of one company in 1917 was sold to electrometallurgical companies, presumably for making ferrosilicon.

Wisconsin, with 5 plants in operation, ranked second, with sales of 222,086 short tons, valued at $167,385 in 1917, a gain of 84,509, or 61 per cent, in quantity and of $87,742, or 110 per cent, in value, compared with 1916. The average price per ton advanced from 57 to 75 cents. Three producers in Colorado sold 35,254 short tons, valued at $32,137, and 1 company each in Alabama, Illinois, Maryland, New York, Ohio, South Dakota, Tennessee, and West Virginia reported production in 1917.

BLUESTONE.

The production of bluestone quarried in New York and Pennsylvania is included in sandstone, but on account of the local importance of the stone the figures are also given separately. The value in 1917 showed a continuation of the decrease that has been steady since 1911 and was the smallest recorded value since statistics of bluestone have been collected by the Survey.

The total value of bluestone sold in 1917 was $427,896—$82,115 less than in 1916. Of this value 80 per cent ($334,071) was represented by the stone quarried in New York, which showed a decrease of 11 per cent. The value of the bluestone quarried in Pennsylvania decreased 30 per cent. More than 80 per cent of the total value was about equally divided between stone sold for building purposes and for curbstone, and about 18 per cent was represented by stone sold for flagstone.

Value of bluestone produced and sold in the United States, 1910–1917.

Year.	Value.	Year.	Value.
1910	$1,535,187	1914	$1,086,699
1911	1,876,473	1915	641,446
1912	1,505,763	1916	510,011
1913	1,280,862	1917	427,896

Value of bluestone produced and sold in New York and Pennsylvania in 1916 and 1917.

State.	Building stone.	Flagging.	Curbing.	Crushed stone.	Other uses.	Total value.
1916.						
New York	$168,834	$37,487	$132,486	$27,767	$10,271	$376,845
Pennsylvania	31,060	41,729	48,415	4,290	7,672	133,166
	199,894	79,216	180,901	32,057	17,943	510,011
1917.						
New York	130,056	45,778	150,025	(a)	8,212	334,071
Pennsylvania	40,266	25,901	26,408		1,250	93,825
	170,322	71,679	176,433	(a)	9,462	427,896

a Included in "Other uses."

MISCELLANEOUS STONE.

In former reports on the stone industry, small quantities of certain different kinds of stone were included for convenience with the more common kinds of stone to which they were most nearly related. As the marketed quantities of some of these varieties gradually increased, however, they tended to make more and more misleading the total figures for the groups heretofore recognized. They have therefore been segregated into "a miscellaneous" group, whose marketed production in 1917 is shown in the following table:

Value of miscellaneous varieties of stone sold in the United States in 1917.

State.	Building value.	Crushed stone.						Other value.	Total value.
		Road metal.		Railroad ballast.		Concrete.			
		Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.		
Arizona	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	$37,627
California	(a)	145,489	$108,765	56,907	$18,867	102,239	$62,416	$20,704	210,812
Colorado	(a)							(a)	(a)
Florida		(a)	(a)	(a)	(a)			(a)	(a)
Massachusetts	$6,934	128,508	134,106			94,675	100,610	(a)	241,775
Michigan		(a)	(a)						(a)
Missouri		(a)	(a)						(a)
New Hampshire	(a)					(a)	(a)	(a)	(a)
New Jersey	(a)	(a)	(a)			(a)	(a)	(a)	(a)
New York		(a)	(a)	(a)	(a)	(a)	(a)		(a)
North Carolina				(a)	(a)	(a)	(a)		(a)
Oklahoma		(a)	(a)	(a)	(a)				(a)
Oregon	(a)			(a)	(a)			(a)	(a)
Pennsylvania	12,880	72,091	67,066	(a)	(a)	16,354	16,471	86,086	183,803
Rhode Island		16,403	20,154			(a)	(a)	(a)	38,554
South Dakota		(a)	(a)			(a)	(a)	(a)	(a)
Undistributed	21,451	89,352	116,353	229,310	141,305	33,718	36,016	23,458	281,071
	41,265	451,843	446,444	286,217	160,172	246,986	215,513	130,248	993,642

[a] Included in "Undistributed."

This group included the following kinds of stone in 1917:

Light-colored volcanic rocks (Massachusetts, North Carolina, South Dakota, Colorado, Arizona, California, Oregon); conglomerate and grit (Massachusetts, New York); slate and argillite (Massachusetts, New Jersey, Pennsylvania); chert and cherty limestone or "flint rock" (Florida, Missouri, Oklahoma); taconite or "iron ore rock" (Michigan); mica schist (New Hampshire, Rhode Island, Pennsylvania).

Light-colored volcanic rocks.—The light-colored volcanic rocks include principally rhyolite, trachyte, and andesite (chiefly lava flows) and related tuffs, or consolidated volcanic ash. Other rocks that would be included in this subgroup are dacite, phonolite, and some basaltic tuffs of light color. Any one of these rocks, except the tuffs, whether in flows or dikes, may be locally termed porphyry, if it contains distinct crystals scattered through a relatively fine grained or dense groundmass. These rocks differ considerably in physical properties, according to differences in their mode of origin and subsequent alteration. Some, particularly rhyolites, which are quarries to a considerable extent for crushed stone in eastern Massachusetts, at one place in North Carolina, and in certain parts of California, are hard and of flinty character; others, quarried mainly for local use as building stone in Colorado, South Dakota, and States west of the Rocky Mountains, are comparatively soft and in some places have been called sandstones, owing to their general resemblance to sandstone when placed in buildings, and, as regards the tuffs, to their mode of occurrence. In some regions soft light volcanic tuff, called "trass," has been quarried for such refractory uses as fireplaces, stove linings, and chimneys.

Conglomerate.—Conglomerate, or "puddingstone," is quarried in the vicinity of Boston, Mass., and formerly supplied a considerable local demand for building stone; but for several years it has been quarried mainly for crushed stone. Conglomerate is also quarried near Otisville, Orange County, N. Y.

Slate and argillite.—A massive slate with no indication of true slaty cleavage has also supplied former demands for building stone and present demands for crushed stone in the vicinity of Boston. At present it is quarried at Somerville and Watertown, Mass. Argillite, which supplies a considerable quantity of crushed stone in New Jersey and eastern Pennsylvania, is a shale hardened through the influence of intruding masses of igneous rock into a dark-gray to black stone, which rather closely resembles diabase or basalt (trap rock) in appearance and physical properties.

Chert and cherty limestone.—Cherty limestone, or flint rock, also lumps of chert or flint left by the weathering of these limestones are crushed for road metal and railroad ballast in Florida, Missouri, and Oklahoma.

Taconite.—Taconite, or "iron ore rock," is a cherty or jaspery rock closely associated with iron ores in the Lake Superior region. In some places it is calcareous and in others quartzitic. Small quantities of this rock have been taken from the waste dumps of mines in Michigan and crushed for road metal.

Mica schist.—Mica schist is one of the commonest metamorphic rock and consists essentially of mica and quartz, with which may be associated certain other minerals, such as garnet and staurolite. Owing to its marked foliation, its softness, and its generally unattractive appearance, it has not been greatly used as structural stone or as paving or crushed stone, although some is quarried for foundation work in Pennsylvania. It was once quarried near Bolton, Conn., for use as flagstone, but it was too soft to withstand the wear upon it in places of much travel.

The mica, to which the softness of mica schist is due, however, successfully withstands a very high temperature, and as the stone can be readily cut into blocks of the desired shape, mica schist has therefore been used considerably as furnace lining. The mica schist quarried for this use is found in eastern Pennsylvania, at places conveniently near the metallurgical plants in which it is required. The quantity of mica schist produced for this purpose in 1917 was 39,975 short tons, an increase of 6,739 tons, or 20 per cent, over 1916. The value of the output in 1917 was $85,986, an increase of $38,682, or nearly 82 per cent. The greater increase in value was due to a rise in price from $1.42 to $2.15 a ton, which largely represents the increased cost of production.

CRUSHED STONE.

GENERAL STATISTICS.

The total sales of crushed stone in the United States in 1917 amounted to 40,285,377 short tons, valued at $29,065,509. Of this quantity, 66 per cent represents limestone, 20 per cent basalt and related rocks (trap rock), nearly 8 per cent granite, nearly 4 per cent sandstone, and a little more than 2 per cent miscellaneous rocks, including argillite, light volcanic and other rocks formerly classed with granite, sandstone, and basalt and related rocks (trap rock).

Crushed stone represented 48 per cent of the quantity and 35 per cent of the value of all the stone quarried in 1917. The average price per short ton at the crusher was 72 cents in 1917, 11 cents more than in 1916.

The quantity of crushed stone sold in 1917 was 7,790,204 short tons, or 16 per cent less than that sold in 1916, which in turn was about 2 per cent less than in 1915. The value of the crushed stone sold was $397,043, or about 1 per cent less than the value in 1916, which was 1 per cent more than the value in 1915.

Crushed stone is used principally for road metal, railroad ballast, and concrete. The concrete is used in building roads, curbing, stucco, and other construction work. The largest decrease in quantity in 1917 was in stone used for road metal (24 per cent), and the smallest in concrete (6 per cent). Railroad ballast decreased 19 per cent. Concrete was the only use for which an increase in value was given (8.5 per cent), and this was not enough to offset in the total value the decrease of 8 per cent for road metal and 7 per cent for railroad ballast. The only increase in quantity was in basalt and related rocks (trap rock) sold for concrete, and the only increases in value were in basalt and related rocks (trap rock) for railroad ballast and concrete and in limestone for concrete. Crushed granite, the sales of which in 1917 amounted to 3,065,126 short tons, valued at $2,700,620, decreased largely in both quantity and value—1,658,179 short tons (35 per cent) and $842,796 (24 per cent). Basalt and related rocks, the sales of which as crushed stone amounted to 8,067,582 short tons, valued at $6,600,957, decreased 14 per cent in quantity but increased about 1 per cent in value. Sandstone, of which 1,520,981 short tons, valued at $1,400,705, was sold, decreased 29 per cent in quantity and 15 per cent in value. Limestone, of which 26,646,642 short tons, valued at $17,541,098, was sold, decreased 17 per cent (5,537,394 short tons) in quantity but only 1 per cent ($174,336) in value.

PRODUCTION BY STATES.

Crushed stone was produced in 47 States in 1917—one more than in 1916, the District of Columbia and Nevada entering as new producers and Idaho dropping out. Of the States whose production is shown separately in the accompanying table, 11 increased and 19 decreased in both quantity and value of output, 5 decreased in quantity but increased in value, and 2 showed increase in quantity but decrease in value. Fourteen States produced more than 1,000,000 tons each of crushed stone. Three of these States—Connecticut, Massachusetts, and Michigan—increased in both quantity and value. Illinois, New York, and Ohio, with outputs of 4,528,572, 4,293,831 and 4,156,321 short tons, respectively, were the largest producers (representing 32 per cent of the total). In 1916 Ohio produced 6,361,570 short tons, Illinois 5,508,854 short tons, and New York 5,127,483 short tons, and the decreases in 1917 were therefore about 17 per cent each for New York and Illinois and 35 per cent for Ohio. Ohio's decrease in quantity was 41 per cent in stone for road material, 30 per cent in stone for railroad ballast, and 27 per cent in stone for concrete. The decrease in Illinois and New York was principally in crushed stone for road metal, and the stone sold for concrete in these States increased slightly.

Labor difficulties, embargoes on shipping, and increased cost of operation affected the crushed-stone industry in 1917. State and county work on roads was suspended in many places, and railroad improvement was confined largely to necessary repairs. The use of concrete in many large Government contracts retarded the normal decrease in stone for this purpose for 1917. All producers reported increase in prices due to higher cost of materials and labor.

A considerable quantity of sand, gravel, "chats," or tailings from the zinc mines in Missouri and Kansas, chert, slag, and waste from iron mines is used for road metal, railroad ballast, concrete, roofing gravel, and other uses supplied mainly by ordinary crushed stone. According to H. A. Buehler, State geologist of Missouri, the quantity of "chats" shipped from the zinc mines in 1917 amounted to 1,426,716 short tons, a decrease of 1,464,254 short tons (50 per cent). The quantity sold for railroad ballast (1,010,620 short tons) decreased 55 per cent, and that sold for other purposes (416,096 short tons) 33 per cent. The gravel sold in 1917 for the same uses as crushed stone amounted to 25,312,820 short tons, valued at $11,764,812, a decrease of 22 per cent in quantity, but an increase of 13 per cent in value. Railroads also reported the production for their own use of 10,260,999 short tons of sand and gravel, valued at $1,743,377.

Further details of the crushed-stone industry in the United States are shown in the following tables:

Total crushed stone sold in the United States 1908–1917.

Year.	Quantity (short tons).	Value.
1908	33,271,202	$20,262,012
1909	39,215,575	24,078,780
1910	46,308,672	27,264,535
1911	47,866,937	28,426,375
1912	48,502,501	28,592,536
1913	52,318,965	31,677,871
1914	49,364,476	30,161,766
1915	49,008,709	29,173,488
1916	48,075,581	29,462,552
1917	40,285,377	29,065,509

Crushed stone produced and sold in the United States in 1916 and 1917, by kinds of stone.

	Road metal.		Railroad ballast.		Concrete.		Total.		Average price per ton.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	
1916.									
Granite	1,478,235	$1,179,956	1,158,518	$581,339	2,086,552	$1,782,121	4,723,305	$3,543,416	$0.75
Basalt and related rocks (trap rock)	4,268,000	3,192,624	1,101,958	761,320	3,638,416	2,585,064	9,008,374	6,539,008	.73
Limestone	13,245,634	7,416,984	8,088,673	3,650,647	10,849,729	6,647,803	32,184,036	17,715,434	.55
Sandstone	832,893	629,703	305,866	180,135	1,021,107	854,856	2,159,866	1,664,694	.77
	19,824,762	12,419,267	10,655,015	5,173,441	17,595,804	11,869,844	48,075,581	29,462,552	
Average price per ton		$0.63		$0.49		$0.67		$0.61	
1917.									
Granite	1,176,557	1,001,076	478,667	269,218	1,409,902	1,430,326	3,065,126	2,700,620	.88
Basalt and related rocks (trap rock)	3,751,396	3,124,088	1,019,475	822,459	3,296,711	2,654,410	8,067,582	6,600,957	.82
Limestone	9,273,282	6,420,257	6,579,905	3,394,495	10,793,455	7,726,346	26,646,642	17,541,098	.66
Sandstone	450,478	398,695	240,779	148,079	829,724	853,931	1,520,981	1,400,705	.92
Miscellaneous	451,843	446,444	286,217	160,172	246,986	215,513	985,046	822,129	.72
	15,103,556	11,390,560	8,605,043	4,794,423	16,576,778	12,880,526	40,285,377	29,065,509	
Average price per ton		$0.75		$0.56		$0.78		$0.72	
Percentage of increase or decrease for 1917.	−23.8	−8.3	−19.2	−7.3	−5.8	+8.5	−16.2	−1.3	

Crushed stone sold in the United States in 1916 and 1917, by States and Territories.

1916.

State or Territory.	Road metal. Quantity (short tons).	Road metal. Value.	Railroad ballast. Quantity (short tons).	Railroad ballast. Value.	Concrete. Quantity (short tons).	Concrete. Value.	Total. Quantity (short tons).	Total. Value.
Alabama	(a)	(a)	(a)	(a)	71,990	$41,321	74,381	$42,699
Arizona	(a)	(a)	(a)	(a)	28,679	27,001	105,243	69,826
Arkansas	122,483	$90,030	156,095	$76,838	173,371	117,519	451,949	284,387
California	1,092,374	648,444	495,807	221,227	1,632,783	899,483	3,220,964	1,769,154
Colorado	(a)	(a)	(a)	(a)	25,807	27,564	31,445	31,681
Connecticut	577,127	334,207	77,950	45,856	635,667	395,064	1,290,744	775,127
Delaware	(a)	(a)	....	....	(a)	(a)	(a)	(a)
Florida	277,556	139,474	93,750	42,000	132,789	153,795	504,095	335,269
Georgia	126,344	86,780	41,589	29,028	202,165	169,301	370,098	285,109
Hawaii	69,481	72,673	....	....	111,925	151,132	181,406	223,805
Idaho	....	....	....	....	(a)	(a)	(a)	(a)
Illinois	1,952,065	852,343	991,788	392,440	2,565,001	1,228,833	5,508,854	2,473,616
Indiana	1,542,122	810,719	218,866	73,078	167,031	86,359	1,928,019	970,156
Iowa	14,201	11,374	155,669	76,929	541,093	342,082	710,963	430,385
Kansas	113,222	64,329	220,772	143,763	235,042	232,344	569,036	440,436
Kentucky	990,342	645,563	832,742	355,564	76,907	52,893	1,899,991	1,054,020
Louisiana	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Maine	4,173	3,702	(a)	(a)	(a)	(a)	13,575	11,270
Maryland	250,095	232,681	330,388	216,840	202,133	167,804	782,616	617,325
Massachusetts	588,927	565,761	13,402	10,862	493,366	480,682	1,095,695	1,057,305
Michigan	876,099	461,576	187,194	57,985	336,772	168,433	1,400,065	687,994
Minnesota	65,119	63,833	18,352	10,799	504,775	437,756	588,246	512,388
Missouri	298,418	237,030	123,445	65,525	661,516	585,428	1,083,379	887,983
Montana [b]	11,269	6,151	....	....	25,096	9,291	39,240	16,138
Nebraska	(a)	(a)	(a)	(a)	335,820	290,103	362,065	299,093
New Hampshire [b]	18,600	16,233	....	....	....	....	25,596	22,431
New Jersey	1,019,027	882,119	243,650	180,636	352,279	307,171	1,614,956	1,369,926
New Mexico [b]	....	....	....	....	17,443	16,860	101,243	75,520
New York	2,258,471	1,414,912	978,832	552,840	1,890,180	1,249,847	5,127,483	3,217,599
North Carolina	100,376	95,337	131,617	72,717	682,604	609,377	914,597	777,431
Ohio	3,166,136	1,604,559	1,510,411	612,336	1,685,023	822,158	6,361,570	3,039,053
Oklahoma	36,960	21,110	623,902	336,484	209,738	141,327	870,600	498,921
Oregon	233,703	156,414	95,514	21,031	90,542	68,522	419,759	245,967
Pennsylvania	1,517,871	1,084,698	864,222	576,154	1,109,696	825,079	3,491,789	2,485,931
Rhode Island	93,425	118,781	....	....	54,187	82,484	147,612	201,265
South Carolina	55,344	47,635	21,469	15,160	311,061	217,807	387,874	330,602
South Dakota	7,350	6,300	....	....	155,076	132,116	162,426	138,416
Tennessee	430,880	311,739	489,625	124,514	194,600	96,165	1,115,105	532,418
Texas	85,710	62,179	64,825	30,259	473,017	319,651	623,552	412,089
Utah	(a)	(a)	....	....	(a)	(a)	(a)	(a)
Vermont	7,642	5,859	....	....	7,024	8,818	14,666	14,677
Virginia	585,528	443,121	988,971	492,169	238,750	155,117	1,813,249	1,090,407
Washington	149,452	81,380	....	....	5,257	3,156	154,709	84,536
West Virginia	300,390	189,210	390,630	179,413	108,028	68,886	799,048	437,509
Wisconsin	754,379	522,368	113,754	61,112	702,505	507,638	1,570,638	1,091,118
Wyoming	....	....	....	....	(a)	(a)	(a)	(a)
Undistributed	32,101	28,643	179,784	99,882	149,066	123,477	147,100	121,570
	19,824,762	12,419,267	10,655,015	5,173,441	17,595,804	11,869,844	48,075,581	29,462,552

[a] Included in "Undistributed."
[b] Small quantities not classified included in "Undistributed."

Crushed stone sold in the United States in 1916 and 1917, by States and Territories—Continued.

1917.

State or Territory.	Road metal.		Railroad ballast.		Concrete.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama	11,400	$14,170			75,502	$54,368	86,902	$68,538
Arizona	6,466	9,350	(a)	(a)	(a)	(a)	121,631	47,146
Arkansas	252,773	213,495	123,818	$69,326	17,744	14,556	394,335	297,377
California	994,459	596,424	252,429	123,526	1,549,467	985,592	2,796,355	1,705,542
Colorado					(a)	(a)	(a)	(a)
Connecticut	865,200	480,414	158,005	119,597	394,551	339,365	1,417,756	939,376
Delaware	(a)	(a)			(a)	(a)	40,966	53,863
District of Columbia	(a)	(a)			(a)	(a)	(a)	(a)
Florida	247,697	196,161	214,522	173,857	57,811	83,517	520,030	453,535
Georgia	62,816	51,554	21,921	16,483	128,391	134,289	213,128	202,326
Hawaii					129,126	165,665	214,007	254,747
Illinois	1,155,749	664,887	745,901	342,224	2,626,922	1,494,237	4,528,572	2,501,348
Indiana	1,136,653	684,289	262,647	115,721	78,641	50,654	1,477,941	850,664
Iowa	43,262	44,744	8,529	5,771	499,221	339,622	551,012	390,137
Kansas	165,861	125,057	213,645	137,274	298,804	292,202	678,310	554,533
Kentucky	522,685	384,887	701,881	339,085	164,070	95,926	1,388,636	819,898
Louisiana			(a)	(a)	(a)	(a)	(a)	(a)
Maine	(a)	(a)			(a)	(a)	(a)	(a)
Maryland	384,102	405,017	100,889	65,756	264,790	233,611	749,781	704,384
Massachusetts	603,793	647,535	10,949	10,885	494,818	532,001	1,109,560	1,190,421
Michigan	794,812	433,473	182,375	90,560	422,965	250,122	1,400,152	774,155
Minnesota	43,831	44,978	13,472	11,290	390,040	351,855	447,343	408,123
Missouri	254,648	210,826	170,362	102,906	626,295	605,734	1,051,305	919,466
Montana	(a)	(a)	(a)	(a)	39,004	27,440	45,462	30,917
Nebraska	34,398	24,886	23,339	18,292	324,504	348,173	382,241	391,351
Nevada			(a)	(a)			(a)	(a)
New Hampshire	33,660	35,152			4,577	4,984	38,237	40,136
New Jersey	893,335	886,882	178,085	149,206	403,395	408,770	1,474,815	1,444,858
New Mexico			(a)	(a)	(a)	(a)	(a)	(a)
New York	1,503,914	1,038,461	825,653	538,671	1,964,264	1,524,551	4,293,831	3,101,683
North Carolina	110,568	113,654	76,348	51,962	475,268	565,605	662,184	731,221
Ohio	1,869,282	1,182,796	1,053,710	490,436	1,233,329	717,010	4,156,321	2,390,242
Oklahoma	33,042	26,327	568,012	327,621	324,040	236,133	925,094	590,081
Oregon	124,820	95,449	35,958	7,677	121,954	103,081	282,732	206,207
Pennsylvania	985,651	1,138,900	791,338	611,494	1,069,492	943,245	2,846,481	2,693,639
Rhode Island	40,261	56,788			21,500	29,275	61,761	86,063
South Carolina	5,494	5,100	(a)	(a)	223,222	287,541	241,224	301,295
South Dakota	16,161	12,284			100,766	93,489	116,927	105,773
Tennessee	295,332	237,569	428,233	156,169	197,433	123,590	920,998	517,328
Texas	62,636	49,875	168,904	68,202	452,423	317,785	683,963	435,862
Utah					(a)	(a)	(a)	(a)
Vermont	6,607	3,388	(a)	(a)	8,313	9,118	15,920	13,756
Virginia	562,962	544,566	822,970	432,014	273,614	187,677	1,659,546	1,164,257
Washington	58,975	36,054			41,545	33,233	100,520	69,287
West Virginia	227,816	132,693	186,982	86,872	175,883	130,070	590,681	349,635
Wisconsin	595,577	460,172	30,325	23,338	736,696	615,011	1,362,598	1,098,521
Wyoming					(a)	(a)	(a)	(a)
Undistributed	96,858	102,303	233,841	108,208	166,398	151,429	236,119	167,818
	15,103,556	11,390,560	8,605,043	4,794,423	16,576,778	12,880,526	40,285,377	29,065,509

[a] Included in "Undistributed."

PETROLEUM.[1]

By John D. Northrop.

INTRODUCTION.

For the petroleum industry as well as for the other great industries and organized activities in the United States the year 1917 was a period of transition from a normal to a war basis. Because the earlier months of the war brought to the domestic petroleum industry an unprecedented demand for its products from domestic buyers and from such foreign buyers as were able to avail themselves of those products and because the satisfaction of that demand had already effected or at least initiated the readjustments necessary to a change from a peace basis to a war basis, the official recognition of a state of war on April 6, 1917, found the industry amply prepared to assume its full share in the mighty task to which all the resources of this country were then dedicated. Its equipment of refining facilities and trunk pipe lines was more than adequate for immediate demands upon them, and betterments then under construction were completed with sufficient rapidity to care for the increasing need for their services. As the declaration of the existence of a state of war with the Teutonic alliance coincided with the emergence of the domestic petroleum industry from a period in which primary activity had been centered in the construction of refineries and pipe lines, the effect of that declaration was most immediate and most pronounced on the producing branch of the industry. To the period of increased requirements for crude oil then normally due and in fact well under way it brought an imperative demand for production that the utmost efforts of the operators were unable to satisfy except by requisition from the surface reserves of oil accumulated in the period of overproduction in 1914 and 1915. The fact that these reserves were large and that they were readily available to satisfy emergency requirements in excess of current production served as a stabilizing influence on the entire industry that, despite abrupt and entirely justified advances in the prices of crude oil at the wells, assured the consuming public an unrestricted supply of petroleum products at only relatively slight advances over prewar prices.

Despite the influence of these reserves in adjusting the balance between current production and current demand, too much credit can not be accorded to the producing branch of the industry for its prompt acknowledgement of the responsibilities devolving upon it and for the highly creditable results it accomplished in the face

[1] The statistical tables in this chapter are the work of Miss A. B. Coons and Miss M. N. Schellenger, statistical clerks, United States Geological Survey, except the tables relating to imports and exports, which were compiled from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce, by J. A. Dorsey, also of the Survey.

of decidedly adverse conditions. These results and the adverse conditions under which they were obtained are described in detail in the text and tables of this report, which is designed as a record primarily of the producing branch of the domestic petroleum industry, though it includes brief notes on the trend of the petroleum industry in foreign countries so far as conditions can be ascertained or inferred. The present chapter is the thirty-sixth in the series of statistical records of the petroleum industry issued by the Geological Survey since its organization in 1879.

General conditions.—As already stated the year 1917 is destined to be recorded in the annals of the petroleum industry as one in which interest was centered primarily in efforts to increase the production of petroleum. Efforts were directed to this end in response to advancing prices for crude oil at the wells predicated on a steadily growing discrepancy between oil in sight and consumers' demand. Although production was materially increased and a new record of output was established, the facts remain that the rate of increase of production in 1917 was appreciably less than the rate of increase of consumers' demand in the same period and that at the end of 1917 surface reserves of crude oil in the United States were being depleted more generally and more rapidly than at the beginning of the year. The fact that despite repeated advances in the price of crude oil the number of new wells completed in 1917 was 1,500 less than in 1916 indicates clearly that the price of oil was a factor of subordinate importance in determining the economic limits of drilling operations in that year. The reasons for the anomaly thus indicated are several, among which, however, the more important and general were the difficulty encountered by the average oil operator in obtaining necessary supplies of drilling materials, including the prime essential, casing, at prices he thought he could afford; the scarcity, high cost, and unrest of labor; the lack of confidence in the stability of the petroleum market; and the uncertainties of pending tax legislation. Other deterrents, such as temporary shortage of water for drilling, absence of adequate marketing facilities for crude oil, scarcity of promising territory, strikes and labor disputes, litigation, and governmental delay in providing for the opening of the reserved oil lands of the public domain, complicated the situation locally, and tended to discourage the investment of capital in so hazardous an enterprise as the quest of petroleum.

Prices.—The record levels attained and firmly held by prices of crude petroleum at the wells in all fields constitute one of the salient features of the crude-oil industry in 1917. The ascending scale of prices inherited from 1916 continued throughout 1917 with numerous advances that affected every grade of oil produced in the country. Slight temporary retrograde movements in the quotations on Mercer Black oil in the Appalachian field and on Goose Creek oil in the Gulf field are exceptions, caused by local conditions, which merely proved the general rule that all revisions of price in 1917 were upward.

Significant developments.—Significant results of oil-field activity in 1917 include the opening in Towanda Township, Butler County, Kans., of a prolific extension of the Eldorado field; the opening in Caddo Parish, La., of a prolific extension of the old Caddo field: the opening in eastern Kentucky of several new areas of promise for moderate production of oil; and the discovery of new and important pools of oil in Brazoria, Eastland, Coleman, and Brown counties, Tex.; in Hot Springs County, Wyo.; and in Los Angeles County, Cal. Of these discoveries the most significant, as indicating the trend of development in the immediate future, are those in north-central Texas, which, because of their areal distribution, their depth, their large initial capacity, and the high grade of the oil they disclose, rank as discoveries not only of individual pools of much promise but of a new and potentially valuable oil region.

Although legislation providing for the leasing of lands in the petroleum reserves of the public domain was pending before both branches of Congress throughout 1917, no substantial progress was made during the year in the enactment of such legislation into law.

PRODUCTION.

The quantity of petroleum actually brought to the surface in the oil fields of the United States in 1917 is not susceptible of accurate determination from the data it is possible to obtain from the oil producers by the system on which the Geological Survey is forced to depend. The incomplete data at hand, however, permit an approximation of the actual production that is not without value in the absence of more specific data. This result is obtained by deducting from the figures showing oil marketed in 1917 the net decrease during that year in the stocks of unmarketed oil held by producers. According to the best data available this net decrease in stocks amounted to not less than 6,300,000 barrels. Deduction of this quantity from that of petroleum marketed gives a difference of 329,000,000 barrels as the approximate output of fresh oil that may be credited to the oil fields of the United States in 1917.

PETROLEUM MARKETED.

GENERAL STATEMENT.

The quantity of petroleum marketed from the oil fields of the United States in 1917, which aggregated 335,315,601 barrels of 42 gallons each, established a new record for output of petroleum in this country that is more than 11 per cent greater than the former maximum yield of 300,767,158 barrels, attained in 1916.

The average price received for this oil at the wells was \$1.56 a barrel and the total market value of the output was \$522,635,213, a gain of 46 cents in average unit price and of \$191,735,345, or 58 per cent, in gross market value, compared with 1916.

STATISTICS.

Petroleum marketed in the United States in 1916 and 1917, by months, in barrels of 42 gallons.

[Segregation by months approximate.]

Month.	1916		1917	
	Quantity.	Daily average.	Quantity.	Daily average.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*
January	23,180,388	747,754	26,333,171	849,457
February	22,733,259	783,905	23,696,107	846,290
March	25,523,378	823,335	27,979,149	902,553
April	24,024,080	800,801	27,104,844	903,495
May	26,015,903	839,223	27,616,740	890,863
June	25,539,910	851,333	27,431,228	914,374
July	25,380,269	818,718	29,079,301	938,042
August	25,206,940	813,127	29,642,662	956,215
September	25,261,015	842,034	29,670,770	989,025
October	26,747,762	862,831	30,418,432	981,240
November	25,301,342	843,378	28,716,464	957,215
December	25,852,912	833,965	27,626,733	891,185
	300,767,158	821,768	335,315,601	918,673

Petroleum marketed in the United States, 1859–1917, in barrels of 42 gallons.

Year.	Pennsylvania and New York.	Ohio.	West Virginia.	California.	Kentucky and Tennessee.	Colorado.	Indiana.	Illinois.	Kansas.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
Prior to 1908	687,425,409	366,250,105	185,039,718	201,965,825	5,276,578	8,874,285	90,127,511	28,866,683	*a* 42,357,150
1908	10,584,453	10,858,797	9,523,176	44,854,737	*e* 727,767	379,653	3,283,629	33,686,238	1,801,781
1909	10,434,300	10,632,793	10,745,092	55,471,601	*e* 639,016	310,861	2,296,086	30,898,339	1,263,764
1910	9,848,500	9,916,370	11,753,071	73,010,560	*e* 468,774	239,794	2,159,725	33,143,362	1,128,668
1911	9,200,673	8,817,112	9,795,464	81,134,391	*e* 472,458	226,926	1,695,289	31,317,038	1,278,819
1912	8,712,076	*g* 8,969,007	12,128,962	*h* 87,272,593	*e* 484,368	206,052	970,009	28,601,308	1,592,796
1913	8,865,493	8,781,468	11,567,299	97,788,525	*e* 524,568	188,799	956,095	23,893,899	2,375,029
1914	9,109,309	8,536,352	9,680,033	99,775,327	*e* 502,441	222,773	1,335,456	21,919,749	3,103,585
1915	8,726,483	7,825,326	9,264,798	86,591,535	*e* 437,274	208,475	875,758	19,041,695	3,823,487
1916	8,466,481	7,744,511	8,731,184	90,951,936	1,203,246	197,235	769,036	17,714,235	8,738,077
1917	8,612,885	7,750,540	8,379,285	93,877,549	3,100,356	121,231	759,432	15,776,860	36,536,125
	779,986,062	456,082,381	286,608,082	1,012,694,579	13,836,846	11,176,084	105,228,026	284,859,406	102,999,281

Year.	Texas.	Oklahoma.	Wyoming.	Louisiana.	Montana.	Other.	United States.	Total value.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	
Prior to 1908	117,819,991	*b* 45,084,441	*c* 85,785	27,413,511	....	*d* 21,471	1,806,608,463	$1,657,113,275
1908	11,206,464	45,798,765	*f* 17,775	5,788,874	....	*d* 15,246	178,527,355	129,079,184
1909	9,534,467	47,859,218	*f* 20,056	3,059,531	....	*d* 5,750	183,170,874	128,328,487
1910	8,899,266	52,028,718	*f* 115,430	6,841,395	....	*d* 3,615	209,557,248	127,899,688
1911	9,526,474	56,069,637	*f* 186,695	10,720,420	....	*d* 7,995	220,449,391	134,044,752
1912	11,735,057	51,427,071	1,572,306	9,263,439	....	....	222,935,044	164,213,247
1913	15,009,478	63,579,384	2,406,522	12,498,828	....	*i* 10,843	248,446,230	237,121,388
1914	20,068,184	73,631,724	3,560,375	14,309,435	....	*j* 7,792	265,762,535	214,125,215
1915	24,942,701	97,915,243	4,245,525	18,191,539	....	*j* 14,265	281,104,104	179,462,890
1916	27,644,605	107,071,715	6,234,137	15,248,138	44,917	*j* 7,705	300,767,158	330,899,868
1917	32,413,287	107,507,471	8,978,680	11,392,201	99,399	*k* 10,300	335,315,601	522,635,213
	288,799,974	747,973,387	27,423,286	134,727,311	144,316	104,982	4,252,644,003	3,824,923,207

a Includes Oklahoma in 1905 and 1906.
b Production for 1905 and 1906 included in Kansas.
c Includes Utah in 1907.
d Michigan and Missouri.
e No production recorded for Tennessee.
f Includes Utah.
g Includes Michigan.
h Includes Alaska.
i Alaska, Michigan, Missouri, and New Mexico.
j Alaska, Michigan, and Missouri.
k Alaska and Michigan.

Petroleum marketed in the United States in 1916 and 1917.

State.	Quantity.				Value.		Average price per barrel.	
	1916 (barrels).	1917 (barrels).	Increase or decrease. Barrels.	Increase or decrease. Per cent.	1916	1917	1916	1917
California	90,951,936	93,877,549	+ 2,925,613	+ 3.22	$53,702,733	$86,161,764	$0.590	$0.918
Colorado	197,235	121,231	− 76,004	− 38.53	217,139	128,100	1.100	1.057
Illinois	17,714,235	15,776,860	− 1,937,375	− 10.94	29,237,168	31,358,069	1.650	1.988
Indiana	769,036	759,432	− 9,604	− 1.25	1,207,565	1,470,548	1.570	1.936
Kansas	8,738,077	36,536,125	+27,798,048	+318.13	10,339,958	67,120,573	1.183	1.837
Kentucky	1,202,569	3,088,160	+ 1,885,591	+156.80	2,188,495	7,033,714	1.820	2.278
Louisiana	15,248,138	11,392,201	− 3,855,937	− 25.29	14,669,774	17,224,602	.962	1.600
Montana	44,917	99,399	+ 54,482	+121.29	44,019	146,272	.980	1.472
New York	874,087	879,685	+ 5,598	+ .64	2,190,195	2,850,378	2.506	3.240
Ohio	7,744,511	7,750,540	+ 6,029	+ .08	16,154,940	21,104,483	2.086	2.723
Oklahoma	107,071,715	107,507,471	+ 435,756	+ .41	128,463,805	181,646,981	1.200	1.690
Pennsylvania	7,592,394	7,733,200	+ 140,806	+ 1.85	19,149,855	25,154,290	2.522	3.253
Tennessee	677	12,196	+ 11,519	+1701.48	1,317	28,448	1.945	2.333
Texas	27,644,605	32,413,287	+ 4,768,682	+ 17.25	25,760,335	42,891,555	.932	1.323
West Virginia	8,731,184	8,379,285	− 351,899	− 4.03	21,914,080	27,246,960	2.510	3.252
Wyoming	6,234,137	8,978,680	+ 2,744,543	+ 44.01	5,644,080	11,047,876	.905	1.230
Other	[a] 7,705	[b] 10,300	+ 2,595	+ 33.68	[a] 14,410	[b] 20,600	1.870	2.000
	300,767,158	335,315,601	+34,548,443	+ 11.49	330,899,868	522,635,213	1.100	1.559

[a] Alaska, Michigan, and Missouri. [b] Alaska and Michigan.

RANK OF PRODUCING STATES.

QUANTITY.

The most significant changes in rank, based on quantity of petroleum marketed, among the oil-producing States in 1917 were the advance of Kansas from sixth place in 1916 to third in 1917, of Wyoming from tenth rank in 1916 to seventh in 1917, and of Tennessee from nineteenth rank in 1916 to sixteenth in 1917. Except for the adjustments due to these advances and to the disappearance of Missouri from the alignment in 1917, the relative positions of the States not specifically mentioned remained in 1917 the same as in 1916.

Rank of petroleum-producing States in 1916 and 1917.

State.	Quantity. 1916 Rank.	1916 Output (barrels).	1916 Percentage.	1917 Rank.	1917 Output (barrels).	1917 Percentage.
Oklahoma	1	107,071,715	35.60	1	107,507,471	32.06
California	2	90,951,936	30.24	2	93,877,549	28.00
Texas	3	27,644,605	9.19	4	32,413,287	9.67
Illinois	4	17,714,235	5.89	5	15,776,860	4.70
Louisiana	5	15,248,138	5.07	6	11,392,201	3.40
Kansas	6	8,738,077	2.91	3	36,536,125	10.90
West Virginia	7	8,731,184	2.90	8	8,379,285	2.50
Ohio	8	7,744,511	2.57	9	7,750,540	2.31
Pennsylvania	9	7,592,394	2.52	10	7,733,200	2.30
Wyoming	10	6,234,137	2.07	7	8,978,680	2.68
Kentucky	11	1,202,569	.40	11	3,088,160	.92
New York	12	874,087	.29	12	879,685	.26
Indiana	13	769,036	.26	13	759,432	.23
Colorado	14	197,235	.07	14	121,231	.04
Montana	15	44,917	.02	15	99,399	.02
Alaska	16	7,705		17	10,300	.01
Missouri	17					
Michigan	18			18		
Tennessee	19	677		16	12,196	
		300,767,158	100.00	....	335,315,601	100.00

Rank of petroleum-producing States in 1916 and 1917—Continued.

State.	Value.					
	1916			1917		
	Rank.	Value.	Percentage.	Rank.	Value.	Percentage.
Oklahoma	1	$128,463,805	38.82	1	$181,646,981	34.26
California	2	53,702,733	16.23	2	86,161,764	16.49
Texas	4	25,760,335	7.78	4	42,891,555	8.21
Illinois	3	29,237,168	8.84	5	31,358,069	6.00
Louisiana	8	14,669,774	4.43	9	17,224,602	3.30
Kansas	9	10,339,958	3.13	3	67,120,573	12.84
West Virginia	5	21,914,080	6.62	6	27,246,960	5.21
Ohio	7	16,154,940	4.88	8	21,104,483	4.04
Pennsylvania	6	19,149,855	5.79	7	25,154,290	4.81
Wyoming	10	5,644,080	1.71	10	11,047,876	2.11
Kentucky	12	2,188,495	.66	11	7,033,714	1.35
New York	11	2,190,195	.66	12	2,850,378	.54
Indiana	13	1,207,565	.36	13	1,470,548	.28
Colorado	14	217,139	.07	15	128,100	.02
Montana	15	44,019		14	146,272	.03
Alaska	16			17		
Missouri	17	14,410	.02		20,600	.01
Michigan	18			18		
Tennessee	19	1,317		16	28,448	
		330,899,868	100.00	....	522,635,213	100.00

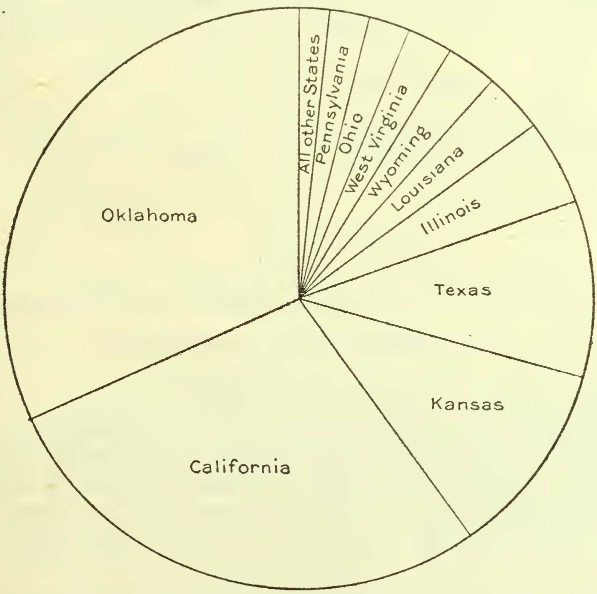

FIGURE 16.—Distribution, by States, of petroleum marketed in the United States in 1917.

The accompanying figure shows graphically the relative importance of the several States as contributors to the petroleum marketed in the United States in 1917.

VALUE.

Significant changes in rank based on the value of the petroleum marketed in 1917 included the advance of Kansas from ninth to third place, the advance of Kentucky from twelfth to eleventh place by exchange with New York, the advance of Montana from fifteenth to fourteenth place by exchange with Colorado, the advance of

Tennessee from nineteenth to sixteenth place, the retirement of Illinois from third to fifth place, and the elimination of Missouri. Aside from the adjustments necessitated by these changes the relative alinement of the other States remained in 1917 the same as in 1916.

The participation of each oil-producing State in the gross receipts from the sales of crude oil at the wells in 1917 is shown graphically in the accompanying figure.

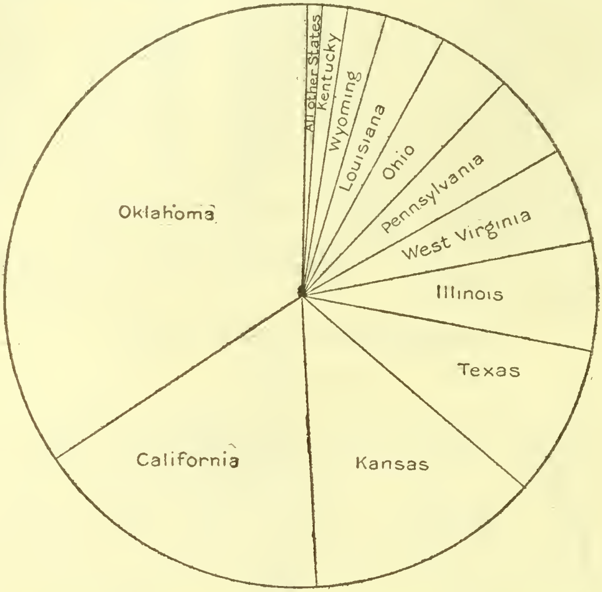

FIGURE 17.—Distribution, by States, of value of petroleum marketed in the United States in 1917.

CLASSIFICATION BY FIELDS.

GENERAL STATEMENT.

For convenience of discussion the oil pools of the United States are grouped in certain major areas or fields based originally on geographic position alone. As these fields have been extended areally, the geographic boundaries have become in many cases less distinct and the separation has come to be based more and more on fundamental differences in the type of oil produced and its adaptability to refining needs. Thus the oils of the Appalachian field are in the main of paraffin base, free from asphalt and objectionable sulphur, and they yield by ordinary refining methods high percentages of gasoline and illuminating oils—the products in greatest demand. Contrasted with them is the petroleum of the Lima-Indiana field, which contains some asphalt, though consisting chiefly of paraffin hydrocarbons, and is contaminated with sulphur compounds, which necessitate special treatment for their elimination.

Illinois oils contain varying proportions of both asphalt and paraffin and differ considerably as to specific gravity and distillation products. Sulphur is generally present, but rarely in such form as to necessitate special treatment for its removal.

Mid-Continent oils vary in composition within wide limits, ranging from asphaltic oils, poor in gasoline and illuminants, to oils in which the asphalt content is negligible and the paraffin content relatively high and which yield correspondingly high percentages of the lighter products on distillation. Sulphur is present in varying quantities in the lower grade oils, in certain of which—Healdton grade, for example—it exists in the form requiring special treatment for its elimination.

Oils from the Gulf field are characterized by relatively high percentages of asphalt and low percentages of the lighter gravity distillation products. Considerable sulphur is present, much of which, however, is in the form of sulphureted hydrogen and is easily removed by steam before refining or utilizing the oil as fuel.

Oils from Wyoming and Colorado are in the main of paraffin base, suitable for refining by ordinary methods. Heavy asphaltic oils of fuel grade are also obtained in certain of the Wyoming fields.

The California oils are generally characterized by much asphalt and little or no paraffin and by varying proportions of sulphur. The chief products are fuel oils, lamp oils, lubricants, and oil asphalt, though low percentages of naphthas may be derived from certain of the lighter oils, notably those of the Santa Maria, Sespe, and Santa Paula fields, in the southern part of the State.

PETROLEUM MARKETED.

Petroleum marketed in the United States in 1916 and 1917, by fields.

Field.	Quantity.				Value.		Average price per barrel.	
	1916 (barrels).	1917 (barrels).	Increase or decrease in 1917.					
			Barrels.	Per cent.	1916	1917	1916	1917
Appalachian	23,009,455	24,932,205	+ 1,922,750	+ 8.36	$56,689,178	$77,786,495	$2.464	$3.120
Lima-Indiana	3,905,003	3,670,293	− 234,710	− 6.01	6,117,269	7,102,326	1.567	1.935
Illinois	17,714,235	15,776,860	− 1,937,375	−10.94	29,237,[illegible]68	31,358,069	1.650	1.988
Mid-Continent	136,934,439	163,506,205	+26,571,766	+19.40	162,816,[illegible]98	282,796,124	1.189	1.730
Gulf	21,768,096	24,342,879	+ 2,574,783	+11.83	16,416,874	26,087,587	.754	1.071
California	90,951,936	93,877,549	+ 2,925,613	+ 3.22	53,702,733	86,161,764	.590	.918
Rocky Mountain	6,476,289	9,199,310	+ 2,723,021	+42.05	5,905,238	11,322,248	.912	1.231
Other fields	[a] 7,705	[b] 10,300	+ 2,595	+33.68	[a] 14,410	[b] 20,600	1.870	2.000
	300,767,158	335,315,601	+34,548,443	+11.49	330,899,868	522,635,213	1.100	1.559

[a] Alaska, Michigan, and Missouri.
[b] Alaska and Michigan.

Percentages of petroleum marketed in the several fields, 1913–1917.

Field.	1913	1914	1915	1916	1917
Appalachian	10.430	9.07	8.13	7.650	7.44
Lima-Indiana	1.930	1.90	1.52	1.298	1.09
Illinois	9.620	8.25	6.77	5.890	4.70
Mid-Continent	34.180	36.87	43.86	45.528	48.76
Gulf	3.440	4.94	7.32	7.238	7.26
California	39.356	37.54	30.81	30.240	28.00
Rocky Mountain	1.040	1.43	1.585	2.153	2.75
Other fields	.004		.005	.003	
	100.000	100.00	100.000	100.000	100.00

Petroleum marketed in the United States, 1859–1917, by fields, in barrels of 42 gallons.

Year.	Appalachian.	California.	Lima-Indiana.	Rocky Mountain.	Illinois.	Mid-Continent.	Gulf.	Other.	United States.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
Prior to 1908	947,150,206	201,965,825	386,969,115	8,960,070	28,866,683	94,651,699	138,023,394	[a] 21,471	1,806,608,463
1908	24,945,517	44,854,737	10,032,305	397,428	33,686,238	48,823,747	15,772,137	[a] 15,246	178,527,355
1909	26,535,844	55,471,601	8,211,443	330,917	30,898,339	50,833,740	10,883,240	[a] 5,750	183,170,874
1910	26,892,579	73,010,560	7,253,861	355,224	33,143,362	59,217,582	9,680,465	[a] 3,615	209,557,248
1911	23,749,832	81,134,391	6,231,164	413,621	31,317,038	66,595,477	10,999,873	[a] 7,995	220,449,391
1912	26,338,516	87,272,593	4,925,906	1,778,358	28,601,308	65,473,323	8,545,040	....	222,935,044
1913	25,921,785	97.788,525	4,773,138	2,595,321	23,893,899	84,920,225	8,542,494	[b] 10,843	248,446,230
1914	24,101,048	99,775,327	5,062,543	3,783,148	21,919,749	97,994,900	13,118,028	[c] 7,792	265,762,535
1915	22,860,048	86,591,535	4,269,591	4,454,000	19,041,695	123,294,317	20,578,653	[c] 14,265	281,104,104
1916	23,009,455	90,951,936	3,905,003	6,476,289	17,714,235	136,934,439	21,768,096	[c] 7,705	300,767,158
1917	24,932,205	93,877,549	3,670,293	9,199,310	15,776,860	163,506,205	24,342,879	[d] 10,300	335,315,601
	1,196,437,035	1,012,694,579	445,304,362	38,743,686	284,859,406	992,245,654	282,254,299	104,982	4,252,644,003

[a] Michigan and Missouri.
[b] Alaska, Michigan, Missouri, and New Mexico.
[c] Alaska, Michigan, and Missouri.
[d] Alaska and Michigan.

DELIVERIES.

Petroleum delivered to trade in 1916 and 1917, in barrels.

Field.	1916			1917		
	Refining.	Fuel.	Total.	Refining.	Fuel.	Total.
Appalachian	[a] 24,901,407	....	24,901,407	[b] 24,956,413	3,920	24,960,333
Lima-Indiana	4,730,455	[c] 4,831	4,735,286	3,843,401	9,016	3,852,417
Illinois	22,428,763	[d] 13,514	22,442,277	18,808,647	6,963	18,815,610
Mid-Continent	132,980,401	943,236	133,923,637	161,905,672	3,129,824	165,035,496
Gulf	14,085,596	5,390,504	19,476,100	19,209,191	6,063,275	25,272,466
California	65,354,107	30,787,562	96,141,669	67,966,889	36,781,719	104,748,608
Rocky Mountain } Other }	6,093,540	70,457	6,156,292	8,752,737	686,713	9,429,150
Other			7,705			10,300
	270,574,269	37,210,104	307,784,373	305,442,950	46,681,430	352,124,380

[a] Includes 45,427 barrels of lubricating oil.
[b] Includes 40,180 barrels of lubricating oil.
[c] Includes 157 barrels used for street sprinkling.
[d] Includes 652 barrels used for hog dip and street sprinkling.

STOCKS AND STORAGE.

The reserve of petroleum above ground in the United States is the working stock from which the refining industry draws its supply, and fluctuations in this reserve normally have considerable influence on the market price of crude oil. When conditions of production are such that this reserve is steadily increasing, a decline in market prices for crude petroleum may be expected. When, however, requisitions become necessary to keep the refineries operating to capacity, prices of oil in the field tend to advance and stimulate additional drilling.

This reserve is distributed among several classes of holders, the bulk, however, being in the custody of the large pipe-line companies engaged in interstate transportation of petroleum. Additional quantities are held in tanks and reservoirs in or adjacent to productive fields and at the various refineries throughout the country.

PIPE-LINE STOCKS.

The statistics tabulated below show the quantities of crude oil of various grades in the custody of the pipe-line companies of the United States at the close of business on December 31, and include also the stocks held at storage centers by important purchasing and marketing agencies other than pipe-line companies.

Stocks of all grades of petroleum at the end of 1916 and 1917, in barrels.

Grade of oil.	Held by eastern pipe lines and refineries.[a]		In pipe-line storage outside of eastern field.		Total.		Decrease.
	1916	1917	1916	1917	1916	1917	
Pennsylvania [b]	3,849,544	3,821,416	....	....	3,849,544	3,821,416	28,128
Lima	2,088,365	1,906,241	....	....	2,088,365	1,906,241	182,124
Illinois [c]	1,268,155	502,312	5,331,817	3,057,910	6,599,972	3,560,222	3,039,750
Mid-Continent	4,300,809	4,356,420	73,006,410	71,421,508	77,307,219	75,777,928	1,529,291
Gulf	....	....	9,314,401	8,384,814	9,314,401	8,384,814	929,587
California	....	....	39,398,351	28,427,292	39,398,351	28,427,292	10,971,059
Rocky Mountain	....	....	745,181	515,341	745,181	515,341	229,840
	11,506,873	10,586,389	127,796,160	111,806,865	139,303,033	122,393,254	16,909,779

[a] These pipe lines connect with the delivering lines of the Illinois, Kansas, and Oklahoma fields and receive and transfer large quantities of these western oils to the Atlantic seaboard in addition to the oil from wells directly tributary to their own systems.
[b] Includes natural lubricating oil from Pennsylvania and West Virginia.
[c] Includes some Indiana oil of Illinois grade.

REFINERY STOCKS.

Statistics compiled and published by the Bureau of Mines show that the quantity of crude oil on hand at the various petroleum refineries of the United States at the close of business on December 31, 1917, was not less than 11,638,433 barrels. A small part of this working stock is certainly duplicated in the foregoing tabulation of pipe-line stocks, owing to the fact that many refining companies which receive all or a part of their supply of crude oil through private pipe lines make no distinction in their records between pipe-line and refinery stocks of crude oil.

FIELD STORAGE.

The following table shows the quantity of unmarketed petroleum reported by the producers as held in field tanks and reservoirs at the close of business on December 31, 1916 and 1917:

Petroleum in field storage at end of 1916 and 1917.

	1916	1917
	Barrels.	*Barrels.*
Appalachian field	344,590	310,966
Lima-Indiana field	76,884	71,018
Illinois field	404,974	213,349
Mid-Continent field	32,131,000	28,448,000
Gulf field	132,746	121,001
Rocky Mountain field	217,829	294,524
California field	6,760,857	4,316,922
	40,068,880	33,775,780

SUMMARY OF WELLS DRILLED.

The following tables compiled from trade journal sources with the exception of the statistics for Alaska, California, Colorado, Michigan, Missouri, Montana, Utah, Wyoming, and miscellaneous, which are taken from reports furnished by the oil producers themselves, show in condensed form the results of activity in drilling for oil in the United States in the last two years.

Wells drilled in the United States in 1916 and 1917.

Field.	Wells completed.				Initial daily production (barrels).	
	Oil.	Gas.	Dry.	Total.	Total.	Average per well.
1916.						
Appalachian:						
Pennsylvania and New York	2,500	255	296	3,051	10,774	4.3
Southeastern and central Ohio	927	402	525	1,854	10,838	11.7
West Virginia	1,055	442	296	1,793	24,234	23.0
Kentucky	878	17	179	1,074	27,310	31.1
Tennessee	2		7	9	45	22.5
	5,362	1,116	1,303	7,781	73,201	13.7
Lima, Ohio	616	11	72	699	9,325	15.1
Indiana	160	8	98	266	3,554	22.2
	776	19	170	965	12,879	16.6
Illinois	1,107	36	318	1,461	24,789	22.4

Wells drilled in the United States in 1916 and 1917—Continued.

Field.	Wells completed.				Initial daily production (barrels).	
	Oil.	Gas.	Dry.	Total.	Total.	Average per well.
1916.						
Mid-Continent:						
Kansas	3,142	112	370	3,624	248,846	79.2
Oklahoma	6,086	377	1,120	7,583	521,895	85.8
Central and northern Texas	500	38	145	683	49,728	99.5
Northern Louisiana	324	55	141	520	54,871	169.4
	10,052	582	1,776	12,410	875,340	87.1
Gulf:						
Coastal and southern Texas	647	28	355	1,030	388,422	600.3
Coastal Louisiana	104	1	41	146	111,310	1,070.3
	751	29	396	1,176	499,732	665.4
Arkansas	....	21	11	32	....	....
California	613	....	32	645	....	....
Colorado	3	....	6	9	....	....
Missouri	....	....	3	3	....	....
Montana	6	....	1	7	....	....
Wyoming and Utah	106	....	21	127	....	....
Miscellaneous	1	....	2	3	....	....
	18,777	1,803	4,039	24,619	....	....
1917.						
Appalachian:						
Pennsylvania and New York	1,936	266	356	2,558	9,760	5.0
Southeastern and central Ohio	868	456	504	1,828	11,976	13.8
West Virginia	933	435	267	1,635	14,867	15.9
Kentucky	1,162	59	417	1,638	35,293	30.4
Tennessee	8	3	....	11	615	76.9
	4,907	1,219	1,544	7,670	72,511	14.8
Lima, Ohio	473	9	52	534	7,364	15.6
Indiana	174	9	83	266	4,914	28.2
	647	18	135	800	12,278	19.0
Illinois	488	9	149	646	10,128	22.8
Mid-Continent:						
Kansas	2,712	177	538	3,427	319,093	117.7
Oklahoma	5,027	410	1,360	6,797	365,314	72.7
Central and northern Texas	728	23	290	1,041	51,128	70.2
Northern Louisiana	302	56	99	457	59,272	196.3
	8,769	666	2,287	11,722	794,807	90.6
Gulf:						
Coastal and southern Texas	771	50	519	1,340	445,288	577.5
Central Louisiana	93	4	81	178	46,210	496.9
	864	54	600	1,518	491,498	568.9
Alaska	....	....	2	2	....	....
California	686	....	48	734	....	....
Colorado	3	....	17	20	....	....
Missouri	....	....	2	2	....	....
Montana	1	....	1	2	....	....
Miscellaneous	....	....	17	17	....	....
	16,365	1,966	4,802	23,133	....	....

PETROLEUM OPERATORS' STATISTICS.

The statistics presented in this section are those obtained directly from the oil producers themselves. The object of this investigation, in addition to providing a check on the determination of petroleum marketed, as reported by the pipe-line and other oil-transporting companies, is to procure a record of petroleum utilized in field operations and to obtain details available in no other way concerning field storage, drilling activity, and acreage held for development.

It will be noted that the statistics of wells completed as given in this section differ with respect to many States and districts from those given elsewhere in this chapter. The statistics presented here are those obtained from voluntary reports by the petroleum operators themselves and relate merely to the number of wells owned or operated by the particular companies reporting. Those published elsewhere, with the exception of the field reports for Colorado, Wyoming, Montana, Utah, California, Michigan, Missouri, Alaska, and miscellaneous, which are obtained from the statements of the operators, are compiled from various trade journals, principally the Oil City Derrick and the Oil and Gas Journal, and are published because they are consistent since the beginning of the oil industry in the United States and because they furnish in addition to the number of wells completed an approximation of the output of each well the first day of its productive life. No attempt is made to procure data on this subject from the oil producers.

Well record and acreage held by operators in the United States in 1917.

[From statistics furnished by producers.]

State.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Alabama			4				2,000	2,000
Alaska	7		2		7	151		151
Arizona			1					
Arkansas			8			7,000	49,840	56,840
California	7,784	686	48	108	8,362	192,504	156,352	348,856
Colorado	85	3	17	5	83	15,254	20,513	35,767
Florida			1					
Illinois	15,839	599	119	392	16,046	5,367	165,619	170,986
Indiana	2,535	121	34	726	1,930	2,522	64,625	67,147
Kansas	5,843	2,149	420	318	7,674	26,065	2,128,119	2,154,184
Kentucky	1,866	1,079	393	86	2,859	45,454	1,410,250	1,455,704
Louisiana	1,728	352	106	201	1,879	28,156	455,683	483,839
Michigan	28				28	15	8,000	8,015
Missouri	14		2		14		53,500	53,500
Montana	6	1	1		7		440	440
New Mexico	1		2		1	320	648,755	649,075
New York	11,200	251	4	47	11,404	34,207	65,992	100,199
Ohio	31,144	890	184	2,056	29,978	48,054	723,226	771,280
Oklahoma	31,930	3,817	778	595	35,152	49,195	1,752,001	1,801,196
Pennsylvania	58,417	1,697	182	993	58,776	310,735	856,860	1,167,595
Tennessee	3	1	16		4		44,700	44,700
Texas	5,216	1,255	562	475	5,996	47,535	1,023,474	1,071,009
Utah	5			1	4	11,700		11,700
Washington			2				3,700	3,700
West Virginia	15,918	803	103	538	16,183	176,862	1,708,093	1,884,955
Wyoming	457	225	50	59	623	18,022	92,027	110,049
	190,026	13,528	3,025	6,542	197,012	1,019,118	11,433,769	12,452,887
Total, 1916	181,221	14,820	2,783	6,017	190,025	1,168,893	8,433,769	9,252,887

Well record and acreage held by operators in the United States in 1917—Continued.

New York.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Allegany	7,794	147	....	17	7,924	18,395	35,846	54,241
Cattaraugus	3,183	104	4	20	3,267	11,312	29,248	43,560
Steuben	223	....	....	10	213	1,500	898	2,398
	11,200	251	4	47	11,404	34,207	65,992	100,199
Total, 1916	11,028	264	18	92	11,200	34,632	65,404	100,036

Pennsylvania.

Allegheny	1,750	67	21	76	1,741	4,035	86,122	90,157
Armstrong	188	25	1	8	205	1,405	2,684	4,089
Beaver	694	17	8	63	648	839	16,045	16,884
Butler	5,341	122	32	31	5,432	23,474	73,331	96,805
Clarion	1,980	57	13	29	2,008	14,630	44,600	59,230
Crawford	717	22	2	5	734	953	3,717	4,670
Elk	1,160	11	3	90	1,081	27,552	36,159	63,711
Forest	1,626	20	11	25	1,621	53,330	28,605	81,941
Greene	519	43	5	10	552	740	151,193	151,933
Jefferson	152	7	4	4	155	882	38,092	38,974
Lawrence	992	10	....	58	944	1,339	11,262	12,601
McKean	15,794	374	6	183	15,985	77,410	114,989	192,399
Mercer	332	20	2	7	345	3,798	7,638	11,436
Potter	84	....	....	11	73	1,286	622	1,908
Tioga	24	1	....	1	24	....	372	372
Venango	17,735	402	39	219	17,918	60,337	77,076	137,413
Warren	7,474	90	17	94	7,470	34,944	47,846	82,790
Washington	1,855	54	18	79	1,830	3,775	116,507	120,282
	58,417	1,342	182	993	58,766	310,735	856,860	1,167,595
Total, 1916	58,443	1,616	249	1,582	58,417	300,762	802,573	1,103,335

West Virginia.

Braxton	16	....	....	5	11	1,500	5	1,505
Brooke	283	10	2	3	290	622	6,207	6,829
Cabell	18	....	....	3	15	169	3,000	3,169
Calhoun	297	13	4	12	298	972	10,260	11,232
Clay	75	26	3	....	101	6,863	48,396	55,259
Doddridge	623	36	6	21	638	1,087	49,036	50,123
Gilmer	106	3	....	5	104	....	68,938	68,938
Hancock	347	9	3	42	314	1,212	3,709	4,921
Harrison	1,350	36	3	59	1,327	2,430	82,626	85,056
Jackson	2	....	....	....	2	....	600	600
Kanawha	879	150	5	35	994	4,833	335,418	340,251
Lewis	275	8	....	17	266	4,000	66,646	70,646
Lincoln	875	61	2	4	932	117,453	373,861	491,314
Logan	1	....	....	1	....	....	50	50
Marion	742	68	5	25	785	69	65,942	66,011
Marshall	133	4	2	6	131	24	19,554	19,578
Monongalia	714	20	1	20	714	1,580	39,766	41,346
Ohio	4	....	....	....	4	....	5	5
Pleasants	1,745	62	13	41	1,766	10,578	20,398	30,976
Putnam	1	....	....	....	1	....	380	380
Ritchie	1,976	77	14	90	1,963	1,912	91,659	93,571
Roane	1,222	85	3	11	1,296	12,463	220,864	233,327
Taylor	1	....	....	....	1	....	9,941	9,941
Tyler	1,553	27	6	29	1,551	1,027	65,763	66,790
Wayne	7	....	....	1	6	....	3,096	3,096
Wetzel	1,135	30	5	50	1,115	1,843	95,358	97,201
Wirt	524	31	17	48	507	3,169	15,357	18,526
Wood	1,014	47	9	10	1,051	3,056	11,258	14,314
	15,918	803	103	538	16,183	176,862	1,708,093	1,884,955
Total, 1916	15,366	937	156	385	15,918	372,314	2,118,282	2,490,596

Well record and acreage held by operators in the United States in 1917—Continued.

Kentucky.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed. Oil.	Completed. Dry.	Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
Adair		2	2		2		11,000	11,000
Allen	102	55	49	20	137	5,510	115,998	121,508
Barren	11	10		3	18	101	10,240	10,341
Bath	91	2	8	3	90		9,957	9,957
Boyle		1	2		1		1,200	1,200
Breathitt			3				51,000	51,000
Bullitt			5				34,000	34,000
Estill	681	594	131	28	1,247	27,269	622,775	650,044
Lloyd	21	1			22		2,825	2,825
Grayson		14	5		14		77,000	77,000
Hopkins		1		1			9,000	9,000
Jackson		4	4		4		11,300	11,300
Johnson			2					
Knott	2				2		1,250	1,250
Knox		11	11	1	10		13,632	13,632
Larue			2					
Lawrence	64	28	4	4	88		13,155	13,155
Lee	1	35	10		36	3,254	41,831	45,085
Lewis	6			6				
Lincoln		6	8		6		11,900	11,900
Logan			1					
McCreary	25	9	5	4	30	6,000	7,934	13,934
Madison	3		2	3				
Martin	1			1				
Menifee		1	2		1	80	10,012	10,092
Metcalfe	1	3	5	1	3		11,400	11,400
Morgan	27	4	4		31	1,200	2,815	4,015
Ohio	3	1			4		1,234	1,234
Powell	19	244	92	4	259	200	112,752	112,952
Pulaski			2				1,000	1,000
Rockcastle		4	3		4		26,000	26,000
Rowan	35				35		2,500	2,500
Russell			1					
Simpson		1	1		1		5,500	5,500
Warren	1	4	5	1	4		77,000	77,000
Wayne	621	29	16	3	647	1,840	90,456	92,296
Whitley	5		1		5		2,375	2,375
Wolfe	146	15	7	3	158		21,209	21,209
	1,866	1,079	393	86	2,859	45,454	1,410,250	1,455,700
Total, 1916	1,059	886	204	79	1,866	53,841	256,662	310,503

Ohio.

County.	Productive Jan. 1.	Completed. Oil.	Completed. Dry.	Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
Allen	1,094	10		247	857	533	19,023	19,556
Ashland	7		14	3	4		179	179
Athens	162	7	1	8	161	185	4,476	4,661
Auglaize	365	5	1	46	324	446	10,131	10,577
Belmont	184	5	5	6	183		30,924	30,924
Carroll	95	28	2		123	160	90,221	90,381
Columbiana	386	7	7	8	385	334	7,785	8,119
Coshocton	67	21	2	2	86	126	26,241	26,367
Cuyahoga	5	1	3	1	5		250	250
Erie	2				2		500	500
Fairfield	289	5	1	18	276		10,883	10,883
Gallia			1					
Guernsey	9				9		760	760
Hancock	3,318	41	4	351	3,008	976	31,286	32,262
Hardin	7				7		2,055	2,055
Harrison	732	20	1	107	645	350	9,987	10,337
Hocking	350	66	13	12	404		56,312	56,312
Holmes	39	8	1		47	100	19,955	20,055
Jefferson	524	30	12	17	537	1,720	20,239	21,959
Knox	13	8			21		14,865	14,865
Lawrence	16				16		383	383
Licking	96	14	1	5	105	246	23,886	24,132
Logan	2				2		25	25
Lorain	9				9	5	3,200	3,205
Lucas	451	2		39	414	1,084	6,983	8,067
Mahoning	147	11	4	10	148	145	1,640	1,785

Well record and acreage held by operators in the United States in 1917—Continued.

Ohio—Continued.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Medina	2	2			4		240	240
Meigs	10		3	2	8		900	900
Mercer	620	29	1	27	622	793	10,058	10,851
Monroe	2,535	17	5	41	2,511	3,282	39,800	43,082
Morgan	1,324	49	21	35	1,338	1,026	11,533	12,559
Muskingum	208	78	2	7	279	1,867	26,234	28,101
Noble	587	16	2	33	570	2,290	7,739	9,669
Ottawa	323	27		57	293	475	5,725	6,200
Paulding		1			1		1,800	1,800
Perry	687	69	21	64	692	4,767	56,439	61,206
Sandusky	4,028	39	2	364	3,703	5,091	36,505	41,596
Seneca	668	30		20	678	942	6,819	7,761
Shelby	17				17		360	360
Trumbull	20	2	1		22	600	8,160	8,760
Van Wert	559	7	4	258	308	571	4,889	5,460
Vinton	42	9		1	50	100	5,654	5,754
Washington	4,033	139	47	109	4,063	8,521	39,818	48,339
Wayne	65	22			87		5,919	5,919
Wood	7,047	65	2	158	6,954	11,319	62,805	74,124
	31,144	890	184	2,056	29,978	48,054	723,226	771,280
Total, 1916	30,811	1,421	301	1,088	31,144	59,199	759,615	818,734

Indiana.

County.	Productive Jan. 1.	Oil.	Dry.	Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
Adams	312			140	172	395	6,001	6,396
Allen		8	1	1	7		1,955	1,955
Blackford	39			39			2,392	2,392
Davies	3			3				
Delaware	36			1	35	450	1,663	2,113
Gibson	106	2	3	7	101		2,808	2,808
Grant	166	8		162	12	33	3,518	3,551
Green	7			2	5		80	80
Huntington	72			29	43		2,042	2,042
Jay	686	6	4	196	496	1,270	14,171	15,441
Knox		2	1		2		1,000	1,000
Madison			1				5,000	5,000
Miami	10	16	1	9	17		1,800	1,800
Pike	164	67	13	12	219	94	6,167	6,261
Randolph	40	3			43	200	2,784	2,984
Sullivan	527	9	10	12	524		7,107	7,107
Vigo	35			17	18		356	356
Wells	332			135	197	80	5,781	5,861
	2,535	121	34	726	1,930	2,522	64,625	67,147
Total, 1916	2,900	138	51	503	2,535	4,464	69,144	73,608

Illinois.

County.	Productive Jan. 1.	Oil.	Dry.	Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
Clark	2,321	161	12	50	2,432	776	16,771	17,547
Clinton	155	11	5	7	159		3,663	3,663
Coles	60			12	48	160	160	320
Crawford	7,846	173	53	163	7,856	845	78,910	79,755
Cumberland	784	25	2	30	779	13	4,753	4,766
Edgar	11	4	1		15	559	485	1,044
Hancock	1	10	2		11		155	155
Jackson			1					
Jasper	9	1		1	9		160	160
Lawrence	4,130	169	16	103	4,196	326	44,664	44,990
McDonough	367	34	2	5	396	103	5,640	5,743
Macoupin	3	3	7		6	120	5,341	5,461
Madison	2	1			3		350	350
Marion	114	6	5	15	105		1,742	1,742
Morgan	3				3	170	400	570
Tazewell	2		6	2				
Wabash	31	1	7	4	28	2,295	2,425	4,720
	15,839	599	119	392	16,046	5,367	165,619	170,986
Total, 1916	15,180	991	183	333	15,838	2,575	160,880	163,455

Well record and acreage held by operators in the United States in 1917—Continued.

Kansas.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Allen	565	100	3	48	617	2,363	15,176	17,539
Anderson		8	1		8	1,360	4,938	6,298
Atchison			2			2,812	42,000	44,812
Bourbon		3	1	2	1		2,150	2,150
Butler	816	1,060	157	21	1,855	2,620	1,191,939	1,194,559
Chautauqua	1,576	241	37	32	1,785	7,688	95,749	103,437
Coffey	26	6	3	1	31		6,712	6,712
Cowley	5	5	14		10		21,939	21,939
Douglas			6				4,200	4,200
Elk	17	56	10		73	99	5,557	5,656
Elsworth			2				3,000	3,000
Franklin	263	119	22	1	381	410	21,232	21,642
Greenwood	1	8	10		9		35,992	35,992
Labette	10	42	9	1	51		6,040	6,040
Linn		4	7	2	2	3,500	6,180	9,680
McPherson			1				20,000	20,000
Miami	263	43	18	39	267	31	20,056	20,087
Montgomery	1,538	255	49	87	1,706	2,063	475,210	477,273
Neosho	530	152	38	69	613	2,380	117,829	120,209
Sedgwick			1				5,074	5,074
Wilson	226	43	26	15	254	739	24,854	25,593
Woodson	7	4	3		11		2,292	2,292
	5,843	2,149	420	318	7,674	26,065	2,128,119	2,154,184
Total, 1916	3,673	2,354	333	184	5,843	25,185	715,818	741,003

Oklahoma.

County.	Productive Jan. 1.	Completed Oil.	Completed Dry.	Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
Beckham			1			160	35,000	35,160
Bryan			1					
Carter	1,282	467	46	11	1,738	1,778	57,975	59,753
Coal			2				6,000	6,000
Comanche	17	4	1		21	20	4,780	4,800
Cotton			1			20	550	570
Craig	15	1	4		16		887	887
Creek	5,074	507	79	78	5,503	10,882	335,287	346,169
Garfield	2	60	15		62		64,469	64,469
Garvin		13			13		1,600	1,600
Grady			3				80	80
Grant			1				800	800
Hughes			1				1,600	1,600
Jefferson	9	3	3		12	612	7,262	7,874
Kay	132	79	15	4	207	735	165,170	165,905
Kiowa	4	2	4	3	3		2,300	2,300
McIntosh	10		2		10		160	160
Marshall	3				3	20	120	140
Mayes			4				2,635	2,635
Muskogee	673	58	48	22	709	1,323	44,116	45,439
Noble		1			1		6,500	6,500
Nowata	6,941	386	53	141	7,186	5,834	146,415	152,249
Okfuskee	24	7	3	4	27		18,095	18,095
Oklahoma			6				60	60
Okmulgee	1,635	433	111	45	2,023	9,543	142,390	151,933
Osage	2,742	319	41	24	3,037	65	184,899	184,964
Pawnee	661	170	22	15	816	333	45,316	45,649
Payne	20	85	71	1	104	80	54,464	54,544
Pittsburg	1		1	1				
Pontotoc	26	20	9	8	38		7,140	7,140
Pottowatomie			2				140	140
Pushmataha			1				325	325
Rogers	2,322	77	18	27	2,372	1,467	35,848	37,315
Sequoyah			1				2,500	2,500
Stephens	3	4	4		7		15,438	15,438
Tulsa	3,792	453	129	78	4,167	5,640	139,870	145,510
Wagoner	140	55	30	10	185	1,397	63,623	65,020
Washington	6,402	613	45	123	6,892	9,286	158,187	167,473
	31,930	3,817	778	595	35,152	49,195	1,752,001	1,801,196
Total, 1916	29,131	3,686	507	887	31,930	48,362	1,394,734	1,443,096

Well record and acreage held by operators in the United States in 1917—Continued.

Texas.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Anderson			3					
Archer	12	14	12		26	37	6,512	6,549
Austin			2					
Bastrop			1					
Bell			1					
Bexar	33	6	7		39	2,070	17,317	19,387
Brazoria		9	30		9	5,461	68,458	73,919
Brown		20	2		20		5,000	5,000
Chambers			2					
Clay	375	33	30	29	379	5,323	37,183	42,506
Coleman	2	1	1		3		160	160
Colorado			1				10,000	10,000
Crockett			2				100	100
Deaf Smith			1				2,700	2,700
Delta			1					
Dimmit			1					
Duval	12	1	9	2	11	836	8,905	9,741
Fayette			2					
Fort Bend			3					
Galveston			5			250	5,306	5,556
Gonzales			1				2,500	2,500
Grayson			1					
Hardin	1,171	183	72	172	1,182	7,274	8,614	15,888
Harris	632	341	181	166	807	6,131	48,846	54,977
Jack	61		3	2	59		6,116	6,116
Jefferson	86	17	16	13	90	35	1,063	1,098
Johnson			1				10,000	10,000
Lamar			1				9,000	9,000
Lampassas			1				1,440	1,440
Lavacca			1				4,000	4,000
Liberty	5		15	1	4	5	9,269	9,274
Limestone			3					
McLennan	12		1		12		320	320
McMullen	23				23	1,301		1,301
Madison			2				11,000	11,000
Marion	31	2	1	8	25	3,143	2,146	5,289
Matagorda	35	6	9	3	38	1,374	13,752	15,126
Medina			1					
Nacogdoches	1				1		1,200	1,200
Navarro	893	37	13	33	897	145	15,087	15,232
Orange	1		3		1		176	176
Palo Pinto	99	64	22	1	162	10,000	230,283	240,283
Panola			3				52,426	52,426
Parker		1	2		1			
Refugio			1				900	900
Robertson			1					
San Patricio			1				2,500	2,500
Shackelford	18	1			19	573	52,569	53,142
Tarrant			1					
Tom Green			1				2,000	2,000
Victoria			2				9,217	9,217
Walker			1					
Washington	1				1		1,000	1,000
Wharton			1				14,000	14,000
Wichita	1,527	488	81	43	1,972	2,857	346,567	349,424
Wilbarger	35	30	2		65	620	3,607	4,227
Wilkinson	151			2	149	100	2,235	2,335
Wilson		1	1		1			
	5,216	1,255	562	475	5,996	47,535	1,023,474	1,071,009
Total, 1916	4,331	1,291	550	406	5,216	43,462	913,780	957,242

Louisiana.

Acadia	81	30	3	7	104	782	2,227	3,009
Allen			2					
Avoyelles								
Bossier		1	3		1		4,235	4,235
Caddo	1,031	208	22	98	1,141	22,807	132,982	155,789
Calcasieu	139	41	23	60	120	1,643	59,015	60,658
De Soto	157	29	13	5	181	182	117,476	117,658
Evangeline								
Grant			1					
Iberia		2	8		2	867	6,410	7,277
Jackson			1					

Well record and acreage held by operators in the United States in 1917—Continued.

Louisiana—Continued.

State.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Jefferson Davis	8		3	4	4	71	500	571
Morehouse			1					
Natchitoches			1					
Ouachita			1				2,000	2,000
Rapides			1				60,000	60,000
Red River	303	41	14	27	317	338	49,415	49,753
Sabine	1				1		2,243	2,243
St. Landry			1					
St. Martin	8		4		8	1,460	9,180	10,640
Terrebonne			1			6	10,000	10,000
Webster			2					
Winn			1					
	1,728	352	106	201	1,879	28,156	455,683	483,839
Total, 1916	1,538	437	157	247	1,728	23,621	394,253	417,874

PIPE-LINE STATISTICS.

Under this heading are included statistics furnished by pipe-line and other transporting agencies, with which are incorporated, wherever appropriate and without differentiation, supplemental data, including statistics of fuel consumed in field operations and statistics of local sales of crude petroleum by producers, concerning which the transportation companies would have no record.

APPALACHIAN OIL FIELD.

GENERAL STATEMENT.

The Appalachian field embraces all oil pools east of central Ohio and north of central Alabama, including those of New York, Pennsylvania, West Virginia, southeastern Ohio, Kentucky, Tennessee, and northern Alabama.

The formations that yield oil in this field include those of the Devonian and Carboniferous systems. The oil occurs generally along the axes and flanks of anticlines, parallel in general with the strike of the Appalachian Mountains, on minor terraces or other structures associated with them, and rarely in waterless synclines. The reservoir rocks are mainly sandstone or conglomerate layers, the most notable exception being the Big lime (Greenbrier limestone), a calcareous stratum that contains oil in West Virginia.

Returns from the oil fields of New York, Pennsylvania, eastern Ohio, West Virginia, Kentucky, and Tennessee indicate an output of 24,932,205 barrels of crude petroleum from the Appalachian field in 1917. This quantity is greater by 1,922,750 barrels, or 8 per cent, than the output of the field in 1916, and greater by about 9 per cent than that in 1915. Although the principal increase in production in 1917 was made by the newer fields in Kentucky and Tennessee, the relatively slight gains made by the older fields in New York, Pennsylvania, and eastern Ohio contributed materially to the success of the year's operations, as they were ample to offset the moderate decline in output charged to West Virginia.

The average price received at the wells for all grades of Appalachian oil marketed in 1917 was $3.12 a barrel, a gain of 66 cents, or 26 per cent, over the average in 1916. The market value of the oil sold was $77,786,495, a gain of $21,097,317, or about 37 per cent, over the market value of the output in 1916.

The market for Appalachian oil was strong throughout the year and, except for one temporary reversal affecting "Mercer Black" grade only, all revisions of price in 1917 were upward. Pennsylvania grade, the class which includes the greater part of the oil produced in the Appalachian field, opened the year at $2.85 a barrel, and advanced to $2.95 on January 5, to $3.05 on January 9, to $3.10 on April 17, to $3.25 on August 13, to $3.50 on August 20, and attained its closing price of $3.75 a barrel on December 4, the total advance during the year amounting to 90 cents a barrel and constituting a gain of about 32 per cent on the price in effect at the beginning of the year.

Activity in drilling was slightly less in 1917 than in 1916, owing to the conditions already indicated. In all 7,670 wells were completed in 1917, compared with 7,781 in 1916. Of these 4,907, or 64 per cent, were oil wells credited with an average yield of 15 barrels each the first 24 hours after completion, 1,219 were gas wells, and 1,544, an average of 1 in every 5, were failures.

PETROLEUM MARKETED.

Petroleum marketed in the Appalachian field in 1916 and 1917, in barrels.

Month.	Pennsylvania.	New York.	Southeastern Ohio.	West Virginia.	Kentucky.	Total.
1916.						
January	625,720	72,216	355,553	647,805	33,751	1,735,045
February	555,410	61,611	344,767	672,843	40,657	1,675,288
March	625,987	64,909	385,306	751,018	51,323	1,878,543
April	662,241	79,439	371,192	674,056	65,545	1,852,473
May	701,435	80,140	401,866	765,938	86,102	2,035,481
June	658,195	78,586	422,673	737,701	81,409	1,978,564
July	641,148	76,489	389,532	704,071	94,001	1,905,241
August	663,901	76,552	409,467	749,881	134,432	2,034,233
September	609,754	72,946	376,239	706,416	143,093	1,908,448
October	638,244	73,056	388,561	783,475	162,060	2,045,396
November	605,049	68,351	386,229	786,723	157,685	2,004,037
December	605,310	69,792	377,159	751,257	153,188	1,956,706
	7,592,394	874,087	4,608,544	8,731,184	[a] 1,203,246	23,009,455

Month.	Pennsylvania.	New York.	Southeastern Ohio.	West Virginia.	Kentucky.	Tennessee.	Total.
1917.							
January	641,092	74,332	389,402	700,840	154,378	....	1,960,044
February	555,525	59,615	352,102	617,115	139,417	797	1,724,571
March	712,735	81,305	415,850	731,373	174,299	1,127	2,116,689
April	672,875	71,511	398,347	669,982	165,331	....	1,978,046
May	711,358	81,371	430,389	739,808	240,024	1,138	2,204,088
June	686,789	80,232	412,722	684,290	266,328	380	2,130,741
July	670,550	75,270	424,766	684,461	318,776	374	2,174,197
August	665,484	76,836	434,381	704,155	320,529	927	2,202,312
September	610,115	71,247	394,632	702,030	330,626	3,960	2,112,610
October	645,981	74,836	429,751	760,430	352,481	1,650	2,265,129
November	608,631	67,106	401,629	700,231	339,783	1,307	2,118,687
December	552,065	66,024	355,708	684,570	286,188	536	1,945,091
	7,733,200	879,685	4,839,679	8,379,285	3,088,160	12,196	24,932,205

[a] Includes 677 barrels from Tennessee.

Petroleum marketed in the Appalachian field since 1859.

Year.	Quantity (barrels).	Percentage of total production.	Increase or decrease.		Value.	Yearly average price per barrel.
			Barrels.	Per cent.		
1859	2,000	100.00			$32,000	$16.000
1860	500,000	100.00	+ 498,000	+24,900.00	4,800,000	9.590
1861	2,113,609	100.00	+1,613,609	+ 322.72	1,035,668	.490
1862	3,056,690	100.00	+ 943,081	+ 44.62	3,209,525	1.050
1863	2,611,309	100.00	− 445,381	− 14.57	8,225,663	3.150
1864	2,116,109	100.00	− 495,200	− 18.96	20,896,576	8.060
1865	2,497,700	100.00	+ 381,591	+ 18.03	16,459,853	6.590
1866	3,597,700	100.00	+1,100,000	+ 44.04	13,455,398	3.740
1867	3,347,300	100.00	− 250,400	− 6.96	8,066,993	2.410
1868	3,646,117	100.00	+ 298,817	+ 8.93	13,217,174	3.625
1869	4,215,000	100.00	+ 568,883	+ 15.60	23,730,450	5.638
1870	5,260,745	100.00	+1,045,745	+ 24.81	20,503,754	3.860
1871	5,205,234	100.00	− 55,511	− 1.06	22,591,180	4.340
1872	6,293,194	100.00	+1,087,960	+ 20.90	21,440,503	3.640
1873	9,893,786	100.00	+3,600,592	+ 57.21	18,100,464	1.830
1874	10,926,945	100.00	+1,033,159	+ 10.44	12,647,527	1.170
1875	8,787,514	100.00	−2,139,431	− 19.58	7,368,133	1.350
1876	9,120,669	99.87	+ 333,155	+ 3.79	22,952,822	2.563
1877	13,337,363	99.90	+4,216,694	+ 46.23	31,756,066	2.420
1878	15,381,641	99.90	+2,044,278	+ 15.33	18,009,346	1.190
1879	19,894,288	99.90	+4,512,647	+ 29.34	17,164,836	.859
1880	26,245,571	99.85	+6,351,283	+ 31.93	24,506,963	.945
1881	27,561,376	99.64	+1,315,805	+ 5.01	25,217,612	.915
1882	30,221,261	99.58	+2,659,885	+ 9.65	23,334,016	.772
1883	23,306,776	99.39	−6,914,485	− 22.88	25,460,252	1.092
1884	23,956,438	98.92	+ 649,662	+ 2.79	19,990,746	.834
1885	21,533,785	98.51	−2,422,653	− 10.11	18,447,493	.856
1886	26,549,827	94.60	+5,016,042	+ 23.29	18,681,910	.704
1887	22,878,241	80.90	−3,671,586	− 13.83	16,279,971	.712
1888	16,941,397	61.36	−5,936,844	− 25.95	14,836,701	.876
1889	22,355,225	63.57	+5,413,828	+ 31.96	24,485,407	.941
1890	30,066,560	65.61	+7,711,335	+ 34.50	30,121,968	.868
1891	35,848,777	66.03	+5,782,217	+ 19.23	24,219,863	.670
1892	33,432,377	66.19	−2,416,400	− 6.74	18,830,773	.556
1893	31,365,890	64.76	−2,066,487	− 6.18	20,327,232	.640
1894	30,783,424	62.38	− 582,466	− 1.86	26,030,125	.839
1895	30,960,639	58.54	+ 177,215	+ .58	42,206,898	1.359
1896	33,971,902	55.73	+3,011,263	+ 9.73	40,203,418	1.179
1897	35,230,271	58.25	+1,258,369	+ 3.70	27,877,213	.786
1898	31,717,425	57.29	−3,512,846	− 9.97	29,096,057	.911
1899	33,068,356	57.94	+1,350,931	+ 4.26	43,041,677	1.294
1900	36,295,433	57.05	+3,227,077	+ 9.76	49,235,298	1.353
1901	33,618,171	48.45	−2,677,262	− 7.38	40,796,827	1.210
1902	32,018,787	36.07	−1,599,384	− 4.76	40,451,593	1.238
1903	31,558,248	31.41	− 460,539	− 1.44	49,905,813	1.590
1904	31,408,567	26.83	− 149,681	− .47	50,598,184	1.628
1905	29,366,960	21.80	−2,041,607	− 6.50	40,279,635	1.394
1906	27,741,472	21.93	−1,625,488	− 5.54	43,633,601	1.598
1907	25,342,137	15.26	−2,399,335	− 8.65	43,766,686	1.745
1908	24,945,517	13.97	− 396,620	− 1.57	43,888,020	1.780
1909	26,535,844	14.49	+1,590,327	+ 6.38	43,237,233	1.646
1910	26,892,579	12.83	+ 356,735	+ 1.33	35,841,749	1.336
1911	23,749,832	10.77	−3,142,747	− 11.37	30,830,354	1.308
1912	26,338,516	11.81	+2,588,684	+ 10.90	42,818,384	1.626
1913	25,921,785	10.43	− 416,731	− 1.58	63,708,981	2.458
1914	24,101,048	9.07	−1,820,737	− 7.02	45,239,201	1.877
1915	22,860,048	8.13	−1,241,000	− 5.15	35,468,973	1.552
1916	23,009,455	7.65	+ 149,407	+ .55	56,689,178	2.464
1917	24,932,205	7.44	+1,922,750	+ 8.36	77,786,495	3.120
	1,196,437,035	28.13			1,653,036,431	1.382

Petroleum marketed, value, and average price per barrel in the Appalachian field, 1908–1917.

Year.	Pennsylvania.			New York.			Southeastern Ohio.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1908.....	9,424,325	$16,881,194	$1.791	1,160,128	$2,071,533	$1.786	4,110,121	$7,316,617	$1.780
1909.....	9,299,403	15,424,554	1.658	1,134,897	1,878,217	1.655	4,717,436	7,773,880	1.648
1910.....	8,794,662	11,908,914	1.354	1,053,838	1,414,668	1.342	4,822,234	6,469,939	1.342
1911.....	8,248,158	10,894,074	1.321	952,515	1,248,950	1.311	4,281,237	5,591,423	1.306
1912.....	7,837,948	12,886,752	1.644	874,128	1,401,880	1.604	5,013,110	8,177,189	1.631
1913.....	7,917,302	19,690,502	2.487	948,191	2,284,307	2.409	4,964,425	12,229,610	2.463
1914.....	8,170,335	15,573,822	1.906	938,974	1,760,868	1.875	4,809,265	8,937,415	1.858
1915.....	7,838,705	12,431,353	1.584	887,778	1,390,325	1.566	4,431,493	6,760,660	1.526
1916.....	7,592,394	19,149,855	2.522	874,087	2,190,195	2.506	4,608,544	11,245,236	2.440
1917.....	7,733,200	25,154,290	3.253	879,685	2,850,378	3.240	4,839,679	15,472,705	3.197

Year.	West Virginia.			Kentucky-Tennessee.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1908.....	9,523,176	$16,911,865	$1.776	a 727,767	$706,811	$0.971	24,945,517	$43,888,020	$1.759
1909.....	10,745,092	17,642,283	1.642	a 639,016	518,299	.811	26,535,844	43,237,233	1.629
1910.....	11,753,071	15,723,544	1.338	a 468,774	324,684	.692	26,892,579	35,841,749	1.332
1911.....	9,795,464	12,767,293	1.303	a 472,458	328,614	.695	23,749,832	30,830,354	1.298
1912.....	12,128,962	19,927,721	1.643	a 484,368	424,842	.877	26,338,516	42,818,384	1.625
1913.....	11,567,299	28,828,814	2.492	a 524,568	675,748	1.288	25,921,785	63,708,981	2.458
1914.....	9,680,033	18,468,540	1.908	a 502,441	498,556	.992	24,101,048	45,239,201	1.877
1915.....	9,264,798	14,468,278	1.561	a 437,274	418,357	.957	22,860,048	35,468,973	1.552
1916.....	8,731,184	21,914,080	2.510	1,203,246	2,189,812	1.820	23,009,455	56,689,178	2.464
1917.....	8,379,285	27,246,960	3.252	3,100,356	7,062,162	2.278	24,932,205	77,786,495	3.120

a No production in Tennessee recorded.

Petroleum marketed in the Appalachian field in 1913–1917, in barrels.

Month.	1913	1914	1915	1916	1917
January	2,178,053	2,103,509	1,898,525	1,735,045	1,960,044
February	1,982,615	1,773,632	1,833,601	1,675,288	1,724,571
March	2,046,832	2,245,177	2,039,101	1,878,543	2,116,689
April	2,307,646	2,271,018	2,002,542	1,852,473	1,978,046
May	2,251,441	2,131,921	1,882,709	2,035,481	2,204,088
June	2,188,442	2,153,470	1,963,778	1,978,564	2,130,741
July	2,253,474	2,211,697	1,944,675	1,905,241	2,174,197
August	2,130,941	1,216,397	1,884,214	2,034,233	2,202,312
September	2,135,811	1,760,930	1,868,186	1,908,448	2,112,610
October	2,237,913	2,329,973	1,831,468	2,045,396	2,265,129
November	1,972,899	1,895,464	1,787,842	2,004,037	2,118,687
December	2,235,718	2,007,860	1,923,407	1,956,706	1,945,091
	25,921,785	24,101,048	22,860,048	23,009,455	24,932,205

Average daily output of petroleum in the Appalachian field, 1913–1917, in barrels.

Month.	1913	1914	1915	1916	1917
January	70,260	67,855	61,243	55,969	63,227
February	70,808	63,344	65,486	57,769	61,592
March	66,027	72,425	65,777	60,590	68,280
April	76,921	75,701	66,751	61,749	65,935
May	72,627	68,772	60,733	65,661	71,099
June	72,948	71,782	65,459	65,952	71,625
July	72,693	71,345	62,731	61,459	70,135
August	68,740	39,239	60,781	65,620	71,042
September	71,194	58,698	62,273	63,615	70,420
October	72,191	75,160	59,080	65,981	73,068
November	75,763	63,182	59,595	66,801	70,623
December	72,120	64,770	62,045	63,120	62,745
Average	71,024	66,030	62,630	62,867	68,316

RUNS, DELIVERIES, AND STOCKS.

Pipe-line runs and deliveries to trade of petroleum from the Appalachian field in 1916 and 1917 and stocks at end of each month, in barrels.

Month.	1916			1917		
	Runs.	Deliveries.	Stocks.	Runs.	Deliveries.	Stocks.
Dec. 31, 1915	....	....	5,741,496	....	....	....
January	1,735,045	1,936,824	5,539,717	1,960,044	1,647,718	4,161,870
February	1,375,288	1,840,671	5,374,334	1,724,571	1,897,055	3,989,386
March	1,878,543	1,863,412	5,389,465	2,116,689	2,072,860	4,033,215
April	1,852,473	2,285,075	4,956,863	1,978,046	1,908,872	4,102,389
May	2,035,481	2,229,750	4,762,594	2,204,088	1,785,721	4,520,756
June	1,978,564	2,456,539	4,284,619	2,130,741	2,279,484	4,372,013
July	1,905,241	2,260,912	3,928,948	2,174,197	2,182,206	4,364,004
August	2,034,233	2,164,917	3,798,264	2,202,312	2,164,250	4,402,066
September	1,908,448	2,288,443	3,418,269	2,112,610	2,031,290	4,483,386
October	2,045,396	1,721,662	3,742,003	2,265,129	2,573,508	4,175,007
November	2,004,037	2,024,330	3,721,710	2,118,687	2,270,347	4,023,347
December	1,956,706	1,828,872	3,849,544	1,945,091	2,147,022	3,821,416
	23,009,455	24,901,407	....	24,932,205	24,960,333	....

Pipe-line runs of Appalachian oil in 1916 and 1917, in barrels.

1916.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	New York Transit.	Tidewater.
January	208,980	99,350	575,302	30,799	14,641	108,280
February	182,984	96,415	600,121	38,345	12,424	93,986
March	204,846	108,767	674,080	49,242	12,864	101,622
April	243,149	101,112	604,219	63,104	16,516	114,814
May	245,282	113,011	690,804	83,349	16,865	120,116
June	229,861	108,075	665,718	76,469	15,615	114,243
July	221,005	103,184	631,024	85,974	14,987	113,142
August	225,360	113,219	678,532	125,799	15,431	115,630
September	205,496	103,605	627,592	136,659	14,206	110,287
October	217,903	108,621	678,904	155,147	14,522	112,046
November	199,279	108,237	649,728	152,652	13,054	104,610
December	193,021	112,437	661,744	147,213	13,378	106,918
	2,577,166	1,276,033	7,737,768	1,144,752	174,503	1,315,694

Pipe-line runs of Appalachian oil in 1916 and 1917, in barrels—Continued.

1916.

Month.	Producers and Refiners.	Emery.	Buckeye Macksburg.	Franklin.	Other lines.	Total.
January	165,903	28,690	258,932	3,684	240,484	1,735,045
February	158,177	24,732	249,017	2,227	216,860	1,675,288
March	177,913	27,599	279,903	2,852	238,855	1,878,543
April	165,656	29,242	271,073	3,203	240,385	1,852,473
May	180,754	30,818	290,708	3,399	260,375	2,035,481
June	172,466	29,261	311,731	3,204	251,921	1,978,564
July	165,182	29,251	285,043	2,930	253,519	1,905,241
August	170,928	29,429	297,725	3,354	258,826	2,034,233
September	160,572	27,115	270,649	2,786	249,481	1,908,448
October	176,091	27,404	283,194	2,815	263,749	2,045,396
November	210,962	26,112	282,050	2,890	254,463	2,004,037
December	171,905	26,800	266,612	2,884	253,794	1,956,706
	2,076,509	336,453	3,346,637	36,228	2,987,712	23,009,455

1917.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	New York Transit.	Tidewater.
January	214,047	119,028	606,213	150,330	13,831	110,335
February	174,478	102,821	548,979	136,935	11,706	94,605
March	238,786	135,533	649,088	172,452	15,218	123,207
April	226,796	134,165	596,642	162,816	13,738	111,294
May	234,002	138,564	653,960	237,704	15,612	126,155
June	226,859	130,870	598,579	254,488	15,904	122,528
July	220,718	128,050	607,281	309,315	13,874	117,495
August	217,126	125,365	617,710	312,229	14,869	121,850
September	198,964	112,084	545,058	327,857	14,002	108,924
October	210,389	117,273	610,230	348,031	14,033	119,602
November	196,834	112,148	565,668	334,205	12,944	116,266
December	164,012	111,681	545,272	281,474	12,282	106,162
	2,523,011	1,467,582	7,144,680	3,027,836	168,013	1,378,423

Month.	Producers and Refiners.	Emery.	Buckeye Macksburg and Cleveland.	Franklin.	Other lines.	Total.
January	168,580	26,970	283,538	2,932	264,240	1,960,044
February	149,459	23,048	254,666	2,031	225,843	1,724,571
March	172,766	27,866	299,653	2,864	279,256	2,116,689
April	156,439	26,870	291,296	3,236	254,754	1,978,046
May	167,114	29,524	317,708	2,778	280,967	2,204,088
June	160,509	29,021	302,584	2,996	286,403	2,130,741
July	159,057	27,540	314,777	2,711	273,379	2,174,197
August	160,731	28,489	321,884	2,717	279,342	2,202,312
September	149,531	25,882	291,516	2,691	336,101	2,112,610
October	161,309	27,486	318,291	2,893	335,592	2,265,129
November	151,382	25,872	292,374	2,429	308,565	2,118,687
December	136,689	25,237	257,374	2,188	302,720	1,945,091
	1,893,566	323,805	3,545,661	32,466	3,427,162	24,932,205

Deliveries to trade by eastern pipe lines[a] in 1916 and 1917, in barrels.

1916.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	Southern.	Crescent.
January	317,395	142,661	66,617	7,662	237,681	160,024
February	348,172	141,767	69,071	9,414	237,532	151,476
March	357,274	164,198	66,738	13,407	315,658	140,736
April	467,894	168,270	56,865	10,073	309,559	150,387
May	593,618	179,265	82,055	3,206	237,419	165,120
June	523,282	153,488	78,768	2,716	376,795	128,862
July	487,593	164,937	91,059	3,469	310,844	202,985
August	507,656	182,859	82,703	1,235	286,308	94,897
September	438,775	168,416	71,814	4,243	382,152	143,134
October	512,451	134,981	85,458	2,707	291,850	171,364
November	495,946	154,441	81,010	2,399	279,810	192,612
December	437,870	172,383	81,107	3,833	255,317	148,926
	5,487,926	1,927,666	913,265	64,364	3,520,925	1,850,523

Month.	New York Transit.	Tidewater.	Producers and Refiners.	Emery.	Buckeye Macksburg.	Franklin.
January	701,582	169,327	312,794	29,303	....	578
February	706,043	169,520	192,234	22,874	....	....
March	715,160	138,177	175,717	24,129	490	....
April	759,759	202,215	235,500	52,821	968	....
May	767,440	117,306	228,267	33,663	1,285	237
June	877,647	193,439	212,262	33,516	4,495	6,761
July	878,902	176,349	183,313	37,271	749	5,619
August	782,886	168,891	246,572	32,379	2,425	....
September	673,224	152,127	174,513	21,153	1,679	483
October	603,597	156,376	132,016	16,460	3,835	6,398
November	659,727	157,814	177,983	27,173	5,010	12,590
December	735,118	142,973	156,517	18,801	5,120	10,939
	8,861,085	1,944,514	2,427,688	349,543	26,056	43,605

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	Southern.	Crescent.
January	482,034	182,234	81,138	3,816	256,890	161,619
February	428,904	158,692	88,946	4,175	294,416	101,816
March	382,089	204,012	90,103	3,580	319,889	153,137
April	453,196	156,075	77,720	4,103	378,309	143,986
May	378,223	172,802	83,832	3,618	287,829	148,983
June	379,169	199,905	78,155	3,210	487,631	151,875
July	516,982	153,600	90,480	3,979	572,309	154,661
August	492,047	202,214	84,052	4,453	514,538	174,604
September	533,363	169,309	83,803	38,869	502,900	119,647
October	570,436	215,850	107,341	6,397	550,123	224,558
November	484,264	168,944	111,824	3,004	540,776	137,484
December	441,035	173,715	90,664	5,616	619,187	128,902
	5,541,742	2,157,352	1,068,058	84,820	5,324,797	1,801,272

[a] These pipe lines connect with the delivering lines of the Illinois, Kansas, and Oklahoma fields and receive and transfer large quantities of these western oils to the Atlantic seaboard in addition to the oil from wells directly tributary to their own systems.

Deliveries to trade by eastern pipe lines[a] in 1916 and 1917, in barrels—Continued.

1917—Continued.

Month.	New York Transit.	Tidewater.	Producers and Refiners.	Emery.	Buckeye Macksburg and Cleveland.	Franklin.
January	737,518	127,869	181,573	24,983	7,675	5,537
February	731,980	116,186	139,594	43,192	5,823	486
March	769,157	155,072	165,503	23,050	7,433	30
April	657,970	151,711	123,739	25,972	6,592	72
May	552,482	127,095	190,359	28,335	7,439	....
June	643,714	161,265	229,830	30,552	4,386	6,667
July	859,452	174,223	189,059	28,739	2,490	....
August	769,010	214,800	129,648	19,631	5,070	14,094
September	712,175	86,548	128,487	34,992	2,728	9,488
October	786,678	175,074	229,309	30,657	5,496	10,445
November	809,608	148,573	225,249	25,260	6,711	6,602
December	972,166	95,067	201,313	23,699	7,002	556
	9,001,910	1,733,483	2,133,663	339,062	68,845	53,977

Stocks of petroleum held by eastern pipe lines in the Appalachian field at the end of each month for 1916 and 1917, in barrels.

1916.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	Southern.	Crescent.
January	956,546	565,088	1,828,652	189,752	751,880	74,573
February	962,465	584,024	2,004,218	160,453	567,955	61,898
March	962,983	699,281	1,789,970	107,870	809,338	80,177
April	977,477	598,004	1,657,792	117,629	779,746	93,164
May	962,501	649,803	1,686,605	124,404	538,926	104,050
June	1,027,359	586,768	1,518,794	125,274	589,741	120,329
July	878,519	529,850	1,464,190	127,262	538,621	76,989
August	873,916	517,083	1,332,998	159,368	690,035	135,345
September	821,404	490,385	1,328,957	160,625	524,807	141,522
October	858,397	467,660	1,145,354	176,920	590,170	119,585
November	772,725	422,597	1,253,007	189,867	476,908	77,150
December	794,530	467,098	1,250,366	197,557	476,342	81,943

Month.	New York Transit.	Tidewater.	Northern.	Producers and Refiners.	Emery.	Buckeye Macksburg.
January	1,223,796	801,318	577,837	563,433	44,975	677,445
February	1,196,749	847,660	880,895	528,739	46,833	634,508
March	1,270,426	835,170	863,242	533,884	50,303	588,630
April	1,354,005	792,679	782,419	463,997	26,724	526,064
May	1,309,956	842,619	741,626	413,328	23,879	434,885
June	1,245,108	775,364	740,563	371,115	19,625	340,363
July	1,330,409	689,520	937,964	351,258	11,605	255,218
August	1,444,757	766,984	836,368	271,420	8,656	295,549
September	1,619,253	787,752	674,847	255,934	14,618	260,392
October	1,867,433	781,323	628,253	300,896	25,562	394,938
November	1,598,930	809,407	612,676	334,527	24,501	473,226
December	1,443,631	784,852	751,438	347,807	32,499	571,889

Month.	Buckeye Lima.	Indiana.	Franklin.	Other lines.	Total.
January	2,467,706	834,097	44,199	1,306,845	12,908,142
February	2,437,318	844,565	46,426	1,240,263	13,044,969
March	2,269,764	826,120	49,279	1,150,771	12,887,208
April	2,229,725	772,180	52,481	1,091,937	12,316,023
May	2,388,713	796,115	55,643	1,068,277	12,141,330
June	2,557,492	851,072	52,086	959,049	11,880,102
July	2,467,430	903,991	49,397	928,364	11,540,587
August	2,465,764	942,966	52,751	962,029	11,755,989
September	2,593,224	857,584	55,054	926,323	11,512,681
October	2,508,030	942,147	51,471	936,200	11,794,339
November	2,638,044	894,833	41,771	945,232	11,565,401
December	2,524,874	840,461	33,715	907,871	11,506,873

Stocks of petroleum held by eastern pipe lines in the Appalachian field at the end of each month for 1916 and 1917, in barrels—Continued.

1917.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	Southern.	Crescent.
January	689,931	590,119	1,408,229	207,006	567,623	74,933
February	765,476	523,137	1,450,145	195,411	595,523	113,540
March	853,856	531,093	1,463,338	222,802	523,418	112,813
April	709,755	545,802	1,429,021	207,690	623,853	123,232
May	826,837	528,403	1,444,879	250,569	692,587	128,519
June	840,560	545,908	1,432,054	253,522	660,275	127,470
July	795,963	646,477	1,353,850	230,797	705,768	126,379
August	861,000	574,541	1,397,643	212,655	674,640	102,441
September	804,419	591,726	1,336,509	202,466	651,571	130,702
October	784,380	681,075	1,308,893	180,509	695,025	62,830
November	784,432	492,225	1,303,498	190,244	734,332	86,583
December	752,113	395,134	1,330,522	147,665	599,662	122,929

Month.	New York Transit.	Tidewater.	Northern.	Producers and Refiners.	Emery.	Buckeye Macksburg and Cleveland.
January	1,259,480	493,313	918,874	337,756	34,486	601,863
February	1,171,789	514,015	797,619	345,682	14,343	489,343
March	1,184,023	488,784	795,803	259,257	19,160	521,232
April	1,012,488	542,856	724,371	290,920	20,057	552,260
May	1,043,571	556,642	586,035	411,259	21,247	515,819
June	1,267,221	567,377	732,690	341,854	11,365	468,125
July	1,422,661	507,390	913,762	341,257	18,516	467,997
August	1,463,939	644,276	1,039,124	366,801	27,373	519,131
September	1,228,602	738,531	1,159,722	380,786	18,263	542,229
October	953,587	684,359	1,151,137	360,423	15,093	360,600
November	1,066,139	822,925	828,470	288,421	15,705	315,260
December	1,109,607	819,931	724,899	275,918	17,242	322,827

Month.	Buckeye Lima.	Indiana.	Franklin.	Other lines.	Total.
January	2,202,582	830,263	31,110	1,010,859	11,258,427
February	2,269,385	822,932	32,655	930,097	11,031,092
March	2,430,786	810,048	35,489	938,772	11,190,674
April	2,424,760	1,031,399	38,684	980,602	11,257,750
May	2,654,411	818,199	41,461	986,968	11,507,406
June	2,565,867	925,623	37,790	1,031,556	11,809,257
July	2,611,419	921,588	40,501	1,012,889	12,117,214
August	2,515,706	904,044	29,124	889,735	12,222,173
September	2,527,878	769,905	22,327	930,001	12,035,637
October	2,443,549	894,671	14,775	978,817	11,569,723
November	2,305,404	907,095	10,602	941,587	11,092,922
December	2,042,633	988,431	12,235	924,641	10,586,389

Stocks of all grades of petroleum held by eastern pipe lines[a] *in the Appalachian field at end of each month in 1916 and 1917, in barrels.*

Month.	Pennsylvania.[b]	Lima.	Illinois.	Kentucky.	Mid-Continent.	Total.
1916.						
January	5,262,860	2,700,442	1,736,181	276,857	2,931,802	12,908,142
February	5,071,840	2,512,167	2,052,343	302,494	3,106,125	13,044,969
March	5,150,091	2,322,934	1,994,313	239,374	3,180,496	12,887,208
April	4,701,121	2,113,295	1,870,888	255,742	3,374,977	12,316,023
May	4,431,168	2,114,924	1,561,634	331,426	3,702,178	12,141,330
June	3,975,575	2,117,362	1,550,828	309,044	3,927,293	11,880,102
July	3,628,242	2,256,006	1,336,219	300,706	4,019,414	11,540,587
August	3,442,734	2,388,681	1,106,246	355,530	4,462,798	11,755,989
September	3,053,415	2,359,913	1,132,464	364,854	4,602,035	11,512,681
October	3,358,737	2,169,193	1,155,469	383,266	4,727,674	11,794,339
November	3,318,933	2,062,922	1,170,912	402,777	4,609,857	11,565,401
December	3,423,612	2,088,365	1,268,155	425,932	4,300,809	11,506,873

[a] These pipe lines connect with the delivering lines of the Illinois, Kansas, and Oklahoma fields and receive and transfer large quantities of these western oils to the Atlantic seaboard in addition to the oil from the wells directly tributary to their own systems.
[b] Includes natural lubricating oil from Pennsylvania and West Virginia.

Stocks of all grades of petroleum held by eastern pipe lines in the Appalachian field at end of each month in 1916 and 1917, in barrels—Continued.

Month.	Pennsylvania.	Lima.	Illinois.	Kentucky.	Mid-Continent.	Total.
1917.						
January	3,726,719	2,276,642	1,205,524	435,151	3,614,391	11,258,427
February	3,539,801	2,338,671	1,216,378	449,585	3,486,657	11,031,092
March	3,589,729	2,489,553	958,799	443,486	3,709,107	11,190,674
April	3,662,200	2,397,305	977,419	440,189	3,780,637	11,257,750
May	3,932,485	2,257,449	733,855	588,271	3,995,346	11,507,406
June	3,802,583	2,167,158	762,394	569,430	4,507,692	11,809,257
July	3,710,478	2,129,019	722,273	653,526	4,901,918	12,117,214
August	3,744,241	2,059,377	628,959	657,825	5,131,771	12,222,173
September	3,767,701	1,909,947	671,251	715,685	4,971,053	12,035,637
October	3,465,012	1,920,604	743,178	709,995	4,730,934	11,569,723
November	3,286,319	1,981,655	829,297	737,028	4,258,623	11,092,922
December	3,229,901	1,906,241	502,312	591,515	4,356,420	10,586,389

PRICES OF APPALACHIAN OIL.

Prices paid at wells by the Seep Purchasing Agency for petroleum produced in the Appalachian field in 1916 and 1917.

1916.

Date.	Pennsylvania and Tiona, Pa.	Mercer black, Pa., and New Castle [a] and Corning, Ohio.	Cleveland, Ohio.	Wooster, Ohio.	Cabell, W. Va.	Somerset, Ky. (light).	Ragland, Ky. (heavy).
Jan. 1	$2.25	$1.75	$1.50	$1.50	$1.78	$1.63	$0.75
Jan 3			1.60	1.60			
Jan. 6			1.80				
Jan. 22			1.85	1.65			
Jan. 27			1.90	1.70			
Jan. 28	2.35	1.85			1.88	1.73	.80
Feb. 6				1.75			
Feb. 7			1.95				
Feb. 21	2.40	1.90			1.95	1.78	.82
Mar. 6	2.50	2.00			2.02	1.85	.85
Mar. 7			2.00	1.80			
Mar. 16			2.10	1.90			
Mar. 17	2.60	2.10			2.12	1.95	.90
May 19			2.20	2.00			
July 28				1.90			
July 29	2.50	2.00			2.02	1.85	.80
Aug. 1				1.80			
Aug. 3	2.40	1.90			1.92	1.75	.75
Aug. 4				1.70			
Aug. 10	2.35	1.85			1.87	1.70	
Aug. 14				1.65			
Aug. 15	2.30	1.80			1.82	1.65	
Sept. 28	2.40	1.90			1.92	1.75	.80
Oct. 10	2.50	2.00			2.02	1.85	.85
Oct. 20	2.60	2.10			2.12	1.95	.90
Oct. 31						1.90	
Nov. 18				1.70			
Dec. 5	2.75	2.20			2.17	2.00	.95
Dec. 13				1.75			
Dec. 19				1.80			
Dec. 29	2.85	2.30			2.22	2.05	

[a] New Castle was not quoted separately after Oct. 20.

Prices paid at wells by the Seep Purchasing Agency for petroleum produced in the Appalachian field in 1916 and 1917—Continued.

1917.

Date.	Pennsylvania and Tiona, Pa.	Mercer black, Pa.	Corning, Ohio.	Cleveland, Ohio.	Wooster, Ohio.	Cabell, W. Va.	Somerset, Ky. (light).	Ragland, Ky. (heavy).
Jan. 1	$2.85	$2.30	$2.25	$2.20	$1.80	$2.22	$2.05	$0.95
Jan. 2					1.90			
Jan. 5	2.95	2.35	2.30			2.27	2.10	.97
Jan. 8					2.00			
Jan. 9	3.05	2.43	2.38			2.35	2.18	1.00
Jan. 30				2.25	2.05			
Apr. 16				2.30	2.10			
Apr. 17	3.10	2.45	2.40			2.37	2.20	
May 1								
May 15		2.18		2.38	2.18			
Aug. 13	3.25	2.23	2.50			2.47	2.30	1.10
Aug. 16				2.58	2.38			
Aug. 20	3.50		2.60			2.57	2.40	
Dec. 4	3.75		2.80			2.72	2.55	1.20

NOTE.—In addition to these prices bonuses ranging from 2 to 10 cents a barrel were paid by various pipe lines and refineries.

Average monthly prices of Appalachian petroleum in 1916 and 1917.

1916.

Month.	Pennsylvania and Tiona, Pa.	Mercer black, Pa., and New Castle and Corning, Ohio.	Cleveland, Ohio.	Wooster, Ohio.	Cabell, W. Va.	Somerset, Ky.	Ragland, Ky.
January	$2.26	$1.76	$1.79	$1.62	$1.79	$1.64	$0.76
February	2.37	1.87	1.94	1.74	1.90	1.75	.81
March	2.53	2.03	2.04	1.84	2.06	1.89	.87
April	2.60	2.10	2.10	1,90	2.12	1.95	.90
May	2.60	2.10	2.14	1.94	2.12	1.95	.90
June	2.60	2.10	2.20	2.00	2.12	1.95	.90
July	2.59	2.09	2.20	1.99	2.11	1.94	.89
August	2.34	1.84	2.20	1.68	1.86	1.69	.75
September	2.31	1.81	2.20	1.65	1.83	1.66	.76
October	2.51	2.01	2.20	1.65	2.03	1.86	.85
November	2.60	2.10	2.20	1.67	2.12	1.90	.90
December	2.74	2.20	2.20	1.75	2.17	1.99	.94
Average	2.51	2.00	2.12	1.79	2.02	1.85	.85

1917.

Month.	Pennsylvania and Tiona, Pa.	Mercer black, Pa.	Corning, Ohio.	Cleveland, Ohio.	Wooster, Ohio.	Cabell, W. Va.	Somerset, Ky.	Ragland, Ky.
January	$3.01	$2.40	$2.29	$2.20	$1.98	$2.32	$2.15	$0.99
February	3.05	2.43	2.38	2.25	2.05	2.35	2.18	1.00
March	3.05	2.43	2.38	2.25	2.05	2.35	2.18	1.00
April	3.07	2.44	2.39	2.28	2.08	2.36	2.19	1.00
May	3.10	2.30	2.40	2.38	2.14	2.37	2.20	1.00
June	3.10	2.18	2.40	2.38	2.18	2.37	2.20	1.00
July	3.10	2.18	2.40	2.38	2.18	2.37	2.20	1.00
August	3.29	2.21	2.50	2.48	2.28	2.47	2.30	1.06
September	3.50	2.23	2.60	2.58	2.38	2.57	2.40	1.10
October	3.50	2.23	2.60	2.58	2.38	2.57	2.40	1.10
November	3.50	2.23	2.60	2.58	2.38	2.57	2.40	1.10
December	3.73	2.23	2.72	2.58	2.38	2.71	2.54	1.19
Average	3.25	2.29	2.62	2.41	2.21	2.45	2.28	1.05

Monthly and yearly average prices of pipe-line certificates of petroleum of Pennsylvania grade at wells in daily market, 1908–1917, per barrel.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
1908	$1.78	$1.78	$1.78	$1.78	$1.78	$1.78	$1.78	$1.78	$1.78	$1.78	$1.78	$1.78	$1.780
1909	1.78	1.78	1.78	1.78	1.70	1.67¼	1.60¼	1.58	1.58	1.56¼	1.49	1.44⅜	1.646
1910	1.40½	1.40	1.40	1.36⅛	1.35	1.31¾	1.30	1.30	1.30	1.30	1.30	1.30	1.336
1911	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.31	1.301
1912	1.41	1.50	1.50	1.52	1.55	1.59	1.60	1.60	1.60	1.60	1.75	1.96	1.598
1913	2.07	2.49	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.463
1914	2.50	2.50	2.50	2.37	1.93	1.78	1.72	1.54	1.45	1.45	1.45	1.45	1.889
1915	1.50	1.50	1.45	1.35	1.35	1.35	1.35	1.47	1.64	1.75	1.91	2.12	1.563
1916	2.26	2.37	2.53	2.60	2.60	2.60	2.59	2.34	2.31	2.51	2.60	2.74	2.507
1917	3.01	3.05	3.05	3.07	3.10	3.10	3.10	3.29	3.50	3.50	3.50	3.73	3.250

Highest and lowest prices of crude petroleum of Pennsylvania grade, 1859–1917, per barrel.

Year.	Highest.		Lowest.	
	Month.	Price.	Month.	Price.
1859	September	$20.00	December	$20.00
1860	January	20.00	do	2.00
1861	do	1.75	do	.10
1862	December	2.50	January	.10
1863	do	4.00	do	2.00
1864	July	14.00	February	3.75
1865	January	10.00	August	4.00
1866	do	5.50	December	1.35
1867	October	4.00	June	1.50
1868	July	5.75	January	1.70
1869	January	7.00	December	4.25
1870	do	4.90	August	2.75
1871	June	5.25	January	3.25
1872	October	4.55	December	2.67½
1873	January	2.75	November	.82½
1874	February	2.25	do	.62½
1875	do	1.82½	January	.75
1876	December	4.23¾	do	1.47½
1877	January	3.69⅜	June	1.53¾
1878	February	1.87½	September	.78¾
1879	December	1.28¾	June	.63⅛
1880	June	1.24⅜	April	.71¼
1881	September	1.01¼	July	.72½
1882	November	1.37	do	.49¼
1883	June	1.24¾	January	.83¼
1884	January	1.15⅝	June	.51¼
1885	October	1.12⅝	January	.68
1886	January	.92¼	August	.59¾
1887	December	.90	July	.54
1888	March	1.00	June	.71⅜
1889	November	1.12½	April	.79½
1890	January	1.07⅝	December	.60¾
1891	February	.81⅜	August	.50
1892	January	.64⅛	October	.50
1893	December	.80	January	.52⅞
1894	do	.95¾	do	.78½
1895	April	2.60	do	.95¼
1896	January	1.50	December	.90
1897	March	.96	October	.65
1898	December	1.19	January	.65
1899	do	1.66	February	1.13
1900	January	1.68	November	1.05
1901	January, September	1.45	May	.80
1902	December	1.54	January, February, March	1.15
1903	do	1.90	January, February, March, April, May, June, July.	1.50
1904	January	1.85	July, December	1.50
1905	October	1.61	May	1.27
1906	April, May, June, July	1.64	January, February, March, April, August, September, October, November, December.	1.58
1907	March to December, inclusive	1.78	January	1.58
1908	No change	1.78	No change	1.78
1909	January, February, March	1.78	December	1.43
1910	January	1.43	June to December, inclusive	1.30
1911	December	1.35	January to December	1.30
1912	do	2.00	January	1.35
1913	March to December, inclusive.	2.50	do	2.00
1914	January to March, inclusive	2.50	September to December, inclusive	1.45
1915	December	2.25	April to August, inclusive	1.35
1916	do	2.85	January	2.25
1917	do	3.75	do	2.85

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade-journal sources and differ somewhat from those on pages 696–699, which were taken from reports received directly from the oil producers.

Wells completed in the Appalachian field, 1913–1917.

State.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Pennsylvania and New York	3,420	2,247	1,409	2,500	1,936	521	338	284	296	356	4,251	2,869	1,906	3,051	2,558
Southeastern and central Ohio	1,246	863	677	927	868	603	517	472	525	504	2,191	2,044	1,910	1,854	1,828
West Virginia	1,285	1,043	763	1,055	933	339	347	246	296	267	2,065	1,758	1,289	1,793	1,635
Kentucky	133	119	56	878	1.162	69	55	36	179	417	210	178	92	1,074	1,638
Tennessee	.....	.....	4	2	8	.....	.....	7	7	.....	.....	.....	12	9	11
	6,084	4,272	2,909	5,362	4,907	1,532	1,257	1,045	1,303	1,544	8,717	6,849	5,209	7,781	7,670

[a] Including gas wells.

Oil wells and dry holes drilled in the Appalachian field in 1917.

State.	Jan.		Feb.		Mar.		Apr.		May.		June.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Pennsylvania and New York	155	23	124	25	146	32	173	37	176	35	183	34
Southeastern and central Ohio	54	40	65	27	74	37	81	39	86	56	80	54
West Virginia	80	18	74	19	78	21	74	17	79	31	101	26
Kentucky	76	22	78	23	83	27	81	23	123	37	106	53
Tennessee	.....	.....	1	.....	1	.....	.....	.....	.....	.....	3	.....
	365	103	342	94	382	117	409	116	464	159	473	167

State.	July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Pennsylvania and New York	177	28	187	28	161	32	149	35	197	32	108	15	1,936	356
Southeastern and central Ohio	75	41	67	38	83	58	66	43	82	48	55	23	868	504
West Virginia	75	29	71	27	72	21	79	17	75	21	75	20	933	267
Kentucky	77	43	104	50	104	23	135	30	106	41	89	45	1,162	417
Tennessee	.....	.....	.....	.....	3	.....	.....	.....	.....	.....	.....	.....	8	.....
	404	141	429	143	423	134	429	125	460	142	327	103	4,907	1,544

Wells completed in the Appalachian field, 1913–1917.

Month.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
January	317	445	185	323	365	96	117	89	87	103	513	649	408	503	552
February	318	364	164	312	342	111	133	74	82	94	528	574	367	485	538
March	394	321	211	276	382	106	88	84	87	117	585	464	395	439	600
April	466	524	224	351	409	126	137	75	102	116	675	734	390	514	629
May	541	531	237	463	464	112	141	87	121	159	727	770	407	668	711
June	632	489	214	504	473	139	135	83	119	167	829	734	382	723	748
July	569	463	237	591	404	139	121	88	129	141	786	738	411	812	652
August	595	375	251	538	429	155	113	104	127	143	846	615	455	773	682
September	580	198	238	524	423	142	76	84	128	134	814	427	415	763	658
October	601	197	312	541	429	132	70	86	100	125	855	388	508	731	657
November	565	177	337	461	460	121	69	113	103	142	793	385	588	683	722
December	506	188	299	478	327	153	57	78	118	103	766	371	483	687	521
	6,084	4,272	2,909	5,362	4,907	1,532	1,257	1,045	1,303	1,544	8,717	6,849	5,209	7,781	7,670

[a] Including gas wells.

Initial daily production of new wells in the Appalachian field in 1917, in barrels.

State.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Pennsylvania and New York	617	536	1,257	1,912	527	720	1,150	662	417	454	559	949	9,760
Southeastern and central Ohio	773	934	982	1,204	1,180	1,134	1,398	1,120	1,021	616	1,025	589	11,976
West Virginia	1,090	1,441	1,147	1,147	919	1,179	1,451	1,184	1,106	1,665	1,376	1,162	14,867
Kentucky	3,018	4,596	4,259	3,973	5,651	1,586	1,536	1,897	2,565	2,710	1,961	1,541	35,293
Tennessee	......	250	200	......	......	70	......	......	95	......	......	......	615
	5,498	7,757	7,845	8,236	8,277	4,689	5,535	4,863	5,204	5,445	4,921	4,241	72,511

Total and average initial daily production of new wells in the Appalachian field, 1913–1917, by States, in barrels.

State.	Total initial production.					Average per well.				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Pennsylvania and New York	8,958	6,627	9,320	10,774	9,760	2.6	3.0	6.6	4.3	5.0
Southeastern and central Ohio	16,302	12,047	8,373	10,838	11,976	13.1	14.0	12.4	11.7	13.8
West Virginia	34,835	24,474	13,501	24,234	14,867	27.1	23.5	17.7	23.0	15.9
Kentucky	2,215	1,568	728	27,310	35,293	16.1	13.2	13.0	31.1	30.4
Tennessee	....	....	250	45	615	....	....	62.5	22.5	76.9
	62,310	44,716	32,172	73,201	72,511	10.2	10.5	11.1	13.7	14.8

Total initial daily production of new wells in the Appalachian field, 1913–1917, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1913	4,768	5,816	5,223	6,283	4,510	7,464	4,412	5,162	4,423	5,626	4,557	4,066	62,310	5,193
1914	4,787	4,256	4,452	4,190	5,141	4,312	4,102	3,420	2,256	3,776	1,976	2,048	44,716	3,726
1915	2,537	1,794	2,445	2,040	2,433	2,523	3,283	3,077	2,697	2,348	3,731	3,014	31,922	2,660
1916	3,135	3,475	2,361	5,062	4,023	6,652	7,314	6,730	6,727	8,967	8,701	10,054	73,201	6,100
1917	5,498	7,757	7,845	8,236	8,277	4,689	5,535	4,863	5,204	5,445	4,921	4,241	72,511	6,043

PENNSYLVANIA.

GENERAL STATEMENT.

Contrary to the trend in recent years the output of petroleum credited to Pennsylvania in 1917 represents an appreciable gain over the output in the year next preceding it. The output in 1917 was 7,733,200 barrels, a gain of 140,806 barrels, or nearly 2 per cent, over the output in 1916. This gain is ascribed primarily to the fact that prices of crude oil attained in 1917 a level that rendered profitable the cleaning and pumping of hundreds of wells of small individual capacity, which, except for those prices, would probably have been abandoned for the sake of the casing they contain, and secondarily to the success of the quest for new production in the southwestern district. The average price received at the well for all grades of oil produced in Pennsylvania in 1917 was $3.25 a barrel and the market value of the oil sold in that year was $25,154,290, a gain of 73 cents in average unit price and of $6,004,435 in gross market value of the oil as compared with 1916.

DEVELOPMENT.

Inclusive of the New York portion of the Bradford district, 2,376 new wells were drilled for oil in Pennsylvania in 1917, a loss of 451 wells, or 16 per cent, as compared with 1916. Of these, 1,776, or 75 per cent, were completed as oil wells and credited with an average yield of 5.3 barrels each during the first day of productive life, 248 were gas wells, and 352, an average of 3 in every 20 drilled, were failures.

In the old Bradford district nothing unusual disturbed the orderly course of routine operations. A total of 469 wells were completed during the year, including 443 oil wells credited with an average production of 3.1 barrels each the first 24 hours after completion, 16 gas wells, and 10 dry holes. The average of 1 failure in every 47 wells drilled was the same as in 1916.

In the Middle district, which embraces the areas of oil production in Warren, Elk, and Forest counties, unusual interest was created by the discovery of a new pool of oil on Peters Run, in the borough of Tionesta, Forest County. The initial well in this pool was drilled by Proper, Wilson & Co., on the Oliver Wirt farm, to test the Speechley sand, which in that locality lies at a depth of 1,400 to 1,500 feet. This objective was abandoned, however, when a "gusher" that produced, by estimate, more than 50 barrels a day, unexpectedly tapped a pool in the fourth sand at a depth of about 600 feet. This pool, which proved to be small, was afterward outlined by drilling. The significance of this discovery lies in the fact that the nearest fourth sand pools are at Tidioute, Warren County, 10 miles to the north, and at Miola, Clarion County, 25 miles to the south, and that other production in the vicinity of this pool is from the second and third sands. In all, 288 wells were completed in the Middle district, of which 219 produced an average of 1.7 barrels of oil each the first day of productive life, 35 produced gas only, and 34, an average of about 1 in every 8, were failures.

In the Venango-Clarion-Jefferson district activity in drilling resulted in the completion of 768 wells in 1917 as against 1,105 in 1916. Of these, 644 were oil wells averaging 1.8 barrels each the first 24 hours after completion, 42 were gas wells, and 82, an average of 1 to every 8 drilled, were failures. Late in 1917 interest was aroused in this district by the completion, as a 100-barrel oil well, of a wildcat test well drilled on the holdings of the Pine Run Coal Co., near New Bethlehem, in Red Bank Township, in the southern part of Clarion County. The oil produced was said to come from the Hundred-foot sand, which was reached at a depth of about 800 feet. Before the end of the year two additional oil wells of fair capacity and one dry hole had been completed and several wells had been started in this new pool, which is about 6 miles east of the eastern limit of previous production of oil in Clarion County. The oil obtained is amber in color and of exceptionally high grade, testing 43° Baumé, and commands a premium of 25 cents a barrel over Pennsylvania grade in the market.

In the Butler-Armstrong district no very significant results were obtained in 1917. Of 263 wells drilled during the year, 168 produced an average of 3 barrels of oil each during the first 24 hours after completion, 33 produced gas only, and 62, an average of about 1 in 4, were failures.

The Southwestern district was the mainstay of oil production in Pennsylvania in 1917, as in other recent years. The Gordon-sand pool, opened in December, 1916, in Springhill Township, Greene County, furnished a number of wells, the initial capacities of which were considerably above the average for the Southwestern district. The most prolific of these was No. 4, on the Strope farm, completed in December by the Manufacturers Light & Heat Co., and credited with a production of 1,166 barrels during the first 24 hours after completion. In other parts of the Southwestern district especial interest was manifest from time to time in 1917, particularly in the Pleasant Grove district, East Finley Township, Washington County, which was extended areally during the year and which proved to be a reliable source of new production from the Gordon sand; in the Sharp and Davidson farms, in Plum Township, Allegheny County, where oil wells of 40 to 50 barrels initial capacity were completed at a depth of about 3,500 feet in the Speechley sand, which had previously been considered important only as a source of gas in this locality; in the Industrial School farm, Franklin Township, Allegheny County, where indifferent success attended efforts to develop a new pool of oil discovered early in the year; and in the development of a rather disappointing extension to the old Ferguson pool in Beaver County, proved in January by the completion of a 40-barrel oil well a quarter of a mile southwest of the nearest point of previous production. After three years of drilling, the deep test well of the Peoples Natural Gas Co., on the Geary farm, near McDonald, Washington County, was abandoned in 1917 at a depth of 7,242 feet, a failure as far as oil and gas are concerned. In all, 588 wells were completed in the Southwestern districts in 1917, compared with 612 in 1916. These included 302 oil wells that averaged 20 barrels each the first day of productive life, 122 gas wells, and 164 dry holes, an average of 2 failures in every 7 wells drilled.

NEW YORK.

The slight gain in production credited to western New York in 1917 was due to an advancing market for high-grade oil that rendered feasible a continuance of the quest for oil in territory which has been under development for nearly 60 years and in which the initial daily output of new wells averages only about 2 barrels each. No important developments resulted from the routine work in these old fields in 1917. In the Allegany district 182 wells, only 81 per cent of the number drilled in 1916, were completed in 1917. Of these, 160 produced an average of 2.1 barrels of oil each the first 24 hours after completion, 18 produced gas only, and only 4 were failures. The remarkable ratio of 1 to 45 between dry holes and total completions indicates the extent to which drilling was restricted to proved territory and reflects the scarcity of oil-field supplies, which prevented the campaign of wildcat drilling that normally follows a substantial advance in the price of crude oil.

COMBINED STATISTICS OF PENNSYLVANIA AND NEW YORK FIELDS.

PETROLEUM MARKETED.

Petroleum marketed in Pennsylvania and New York, 1913–1917, in barrels.

Pennsylvania.

Month.	1913	1914	1915	1916	1917
January	669,134	677,284	629,588	625,720	641,092
February	577,763	532,826	615,005	555,410	555,525
March	637,250	726,605	672,343	625,987	712,735
April	703,829	782,378	697,036	662,241	672,875
May	700,585	701,685	638,490	701,435	711,358
June	661,542	724,172	683,410	658,195	686,789
July	688,055	731,080	682,583	641,148	670,550
August	653,090	646,412	655,242	663,901	665,484
September	651,046	688,761	654,036	609,754	610,115
October	693,996	704,024	645,333	638,244	645,981
November	609,033	614,126	623,955	605,049	608,631
December	671,979	640,982	641,684	605,310	552,065
	7,917,302	8,170,335	7,838,705	7,592,394	7,733,200

New York.

Month.	1913	1914	1915	1916	1917
January	80,906	78,983	74,101	72,216	74,332
February	66,969	62,424	67,755	61,611	59,615
March	74,592	80,660	79,840	64,909	81,305
April	82,580	88,268	79,018	79,439	71,511
May	83,742	84,548	75,114	80,140	81,371
June	77,819	84,110	76,408	78,586	80,232
July	83,237	84,783	79,012	76,489	75,270
August	78,005	75,512	72,531	76,552	76,836
September	78,594	76,102	72,914	72,946	71,247
October	84,480	81,569	72,399	73,056	74,836
November	74,437	71,593	66,218	68,351	67,106
December	82,830	70,422	72,468	69,792	66,024
	948,191	938,974	887,778	874,087	879,685

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade-journal sources and differ somewhat from those on pages 696–697, which are obtained from reports received directly from the oil producers.

Wells completed in Pennsylvania and New York, 1913–1917.

District.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Allegany	441	215	76	202	160	22	17	4	9	4	509	267	98	224	182
Bradford	675	455	313	485	443	31	28	11	11	10	755	531	348	509	469
Middle	352	207	159	234	219	66	17	16	20	34	435	230	182	262	288
Venango and Clarion	1,352	813	458	955	644	141	68	66	83	82	1,578	936	595	1,105	768
Butler and Armstrong	354	183	224	239	168	110	81	84	57	62	497	284	324	339	263
Southwestern Pennsylvania	246	374	179	385	302	151	127	103	116	164	477	621	359	612	588
	3,420	2,247	1,409	2,500	1,936	521	338	284	296	356	4,251	2,869	1,906	3,051	2,558

[a] Including gas wells.

Oil wells and dry holes drilled in Pennsylvania and New York in 1917.

District.	Jan.		Feb.		Mar.		Apr.		May.		June.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Allegany	12	......	7	......	10	......	14	......	21	1	16	......
Bradford	36	1	27	1	28	......	30	2	36	1	41	1
Middle	8	......	13	3	8	......	18	1	19	4	21	6
Venango and Clarion	56	6	41	4	62	7	67	8	66	11	60	4
Butler and Armstrong	17	9	14	5	15	9	13	7	10	7	16	6
Southwestern Pennsylvania	26	7	22	12	23	16	31	19	24	11	29	17
	155	23	124	25	146	32	173	37	176	35	183	34

District.	July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Allegany	15	......	17	......	9	2	17	......	16	1	6	......	160	4
Bradford	42	1	47	......	39	1	48	1	42	......	27	1	443	10
Middle	25	4	15	3	25	4	12	3	39	5	16	1	219	34
Venango and Clarion	48	5	61	6	56	9	43	12	55	7	29	3	644	82
Butler and Armstrong	16	4	15	5	14	1	11	4	17	2	10	3	168	62
Southwestern Pennsylvania	31	14	32	14	18	15	18	15	28	17	20	7	302	164
	177	28	187	28	161	32	149	35	197	32	108	15	1,936	356

Wells completed in Pennsylvania and New York, 1913–1917.

Month.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
January	153	220	75	143	155	26	29	18	21	23	205	271	104	178	196
February	129	164	67	152	124	27	37	17	23	25	183	216	103	186	171
March	204	139	95	115	146	36	24	14	24	32	268	179	114	155	196
April	248	303	105	164	173	48	39	17	29	37	329	355	135	213	235
May	303	286	101	237	176	37	42	26	26	35	363	366	151	293	232
June	375	286	99	267	183	49	42	24	28	34	439	356	138	322	238
July	352	273	123	288	177	53	30	29	30	28	431	340	172	340	230
August	344	209	132	256	187	57	22	33	27	28	427	261	190	305	248
September	335	115	116	231	161	56	24	38	21	32	416	163	172	271	215
October	356	94	182	236	149	45	18	26	14	35	431	133	228	281	200
November	341	83	179	208	197	37	17	28	17	32	406	123	230	248	256
December	280	75	135	203	108	50	14	14	36	15	353	106	169	259	141
	3,420	2,247	1,409	2,500	1,936	521	338	284	296	356	4,251	2,869	1,906	3,051	2,558

[a] Including gas wells.

Initial daily production of new wells completed in Pennsylvania and New York in 1917, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Allegany	21	15	25	26	52	31	29	29	17	33	45	13	336
Bradford	95	94	94	87	107	115	139	174	134	134	137	80	1,390
Middle	10	19	14	23	33	41	43	23	54	19	53	49	381
Venango and Clarion	91	69	106	114	96	122	90	143	104	70	81	41	1,127
Butler and Armstrong	37	51	69	84	21	31	26	26	30	60	50	15	500
Southwestern Pennsylvania	363	288	949	1,578	218	380	823	267	78	138	193	751	6,026
	617	536	1,257	1,912	527	720	1,150	662	417	454	559	949	9,760

Total and average initial daily production of new wells in Pennsylvania and New York, 1913–1917, by districts, in barrels.

District.	Total initial production.					Average per well.				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Allegany	820	446	122	407	336	1.9	2.1	1.6	2.0	2.1
Bradford	1,676	1,588	1,019	1,596	1,390	2.5	3.5	3.3	3.3	3.1
Middle	649	586	354	421	381	1.8	2.8	2.2	1.8	1.7
Venango and Clarion	2,301	1,263	629	1,584	1,127	1.7	1.6	1.4	1.7	1.8
Butler and Armstrong	1,487	684	4,288	713	500	4.2	3.7	19.1	3.0	3.0
Southwestern Pennsylvania	2,025	2,060	2,908	6,053	6,026	8.2	5.5	16.2	15.7	20.0
	8,958	6,627	9,320	10,774	9,760	2.6	2.9	6.6	4.3	5.0

Total initial daily production of new wells in Pennsylvania and New York, 1913–1917, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1913	426	387	733	638	729	959	838	860	826	891	869	802	8,958	746
1914	618	527	476	928	764	706	741	727	300	247	334	259	6,627	552
1915	208	216	234	275	405	969	1,527	1,726	830	921	1,440	569	9,320	777
1916	814	1,429	348	924	632	754	775	740	578	964	510	2,306	10,774	898
1917	617	536	1,257	1,912	527	720	1,150	662	417	454	559	949	9,760	813

WEST VIRGINIA.

GENERAL STATEMENT.

In spite of the incentive to development provided by a record market for crude oil and in spite of an active drilling campaign, less petroleum was marketed from the oil fields of West Virginia in 1917 than in 1916. The output in 1917 was 8,379,285 barrels, a loss of 351,899 barrels, or 4 per cent, compared with 1916. This loss, like that in 1916, is attributed to the steadily dwindling capacity of the new wells drilled in proved territory and to the continued failure of wildcat operations to discover new pools of consequence.

DEVELOPMENT.

The field work done in West Virginia in 1917 included drilling in 18 counties and resulted in the completion of 1,635 new wells, 158 less than in 1916. Of these 933 produced an average of 16 barrels of oil each for the first 24 hours after completion —a loss of 7 barrels in initial capacity compared with 1916—435 produced gas only, and 267, an average of 1 in every 6 drilled, were failures. In drilling activity Marion County led with a total of 456 wells, 210 of which were oil wells credited with an average initial yield of 17 barrels each, but in new production Kanawha County held first place, its total of 210 new wells including 169 oil wells averaging 41 barrels each the first day of productive life.

These two counties included the principal centers of drilling interest in 1917—the Dents run pool, Mannington district, Marion County, and the Berea sand development on Longbottom Run, Cabin Creek district, Kanawha County. The former pool, which came into prominence in 1916 as a consequence of the development of prolific wells in the 30-foot sand, retained its hold on the attention of the oil operators in 1917 as a result of the discovery that the deeper-lying Gordon sand was also productive in that locality. The developments were, however, rather disappointing, as the area of Gordon sand production proved small and the wells declined rapidly in yield. The feature of operations in Kanawha County was the regularity with which wells of moderate capacity, giving every promise of long productive life, were completed in the Berea sand in the Cabin Creek district. At the end of 1917 there were about 125 productive oil wells in this district, credited with an aggregate capacity of 4,000 barrels a day. Early in the year the discovery of oil in the Weir sand in a test drilled by the Cabin Creek Gas Co., on the farm of David Ward's heirs, on Kellys Creek, gave promise of a new pool in Cabin Creek district, north of the pool on Longbottom Run. Subsequent drilling proved disappointing in this respect, but resulted in the development of a gas field of considerable importance.

In Sherman district, Calhoun County, the quest for natural gas along Little Kanawha River resulted in discoveries of oil in the Big Injun sand on the Rafferty and Brake farms that aroused interest in the possible development of an oil pool in that area. Unsuccessful tests, of special interest because of their depth and location, were completed in 1917, as follows:

In August, by the Philadelphia Co., on the farm of S. and O. Leonard, in Buckhannon district, Upshur County; depth, 5,513 feet.

In October, by the Reserve Gas Co., No. 1, on the A. J. Richmond farm, Cove district, Barbour County; depth, 4,700 feet.

In December, by the Coal River Oil Co., No. 1, on the property of the Bowman Lumber Co., at Stovers Fork of Sycamore Run, Clear Creek district, Raleigh County; depth, 3,340 feet. A small flow of gas was reported in the "Big Lime" at 1,855 feet.

Drilling was continued in 1917 in the deep test of the Hope Natural Gas Co., on the farm of M. O. Goff, on Owens Fork, Simpson district, Harrison County, and at the end of the year the well was reported to have reached a depth of 7,260 feet.

PETROLEUM MARKETED.

Petroleum marketed in West Virginia, 1913–1917, in barrels.

Month.	1913	1914	1915	1916	1917
January	978,401	855,886	777,702	647,805	700,840
February	936,733	770,300	754,034	672,843	617,115
March	970,900	919,377	848,926	751,018	731,373
April	1,026,129	900,998	801,046	674,056	669,982
May	1,003,425	864,519	767,685	765,938	739,808
June	995,098	872,074	789,545	737,701	684,290
July	1,009,383	897,065	780,749	704,071	684,461
August	939,479	272,098	761,111	749,881	704,155
September	928,610	675,518	752,751	706,416	702,030
October	956,772	985,724	716,638	783,475	760,430
November	893,274	799,728	720,267	786,723	700,231
December	983,095	866,746	794,344	751,257	684,570
	11,567,299	9,680,033	9,264,798	8,731,184	8,379,285

Petroleum marketed in West Virginia, 1908–1917, in barrels.

Year.	Regular crude.			Lubricating.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1908	9,519,875	$16,902,968	$1.775	3,301	$8,897	$2.70	9,523,176	$16,911,865	$1.776
1909	10,742,026	17,634,335	1.642	3,066	7,948	2.59	10,745,092	17,642,283	1.642
1910	11,751,018	15,717,796	1.338	2,053	5,748	2.80	11,753,071	15,723,544	1.338
1911	9,792,324	12,757,861	1.302	3,140	9,432	3.00	9,795,464	12,767,293	1.303
1912	12,126,137	19,919,952	1.643	2,825	7,769	2.75	12,128,962	19,927,721	1.643
1913	11,562,730	28,813,822	2.492	4,569	14,982	3.28	11,567,299	28,828,814	2.492
1914	9,677,553	18,462,175	1.908	2,480	6,365	2.56	9,680,033	18,468,540	1.908
1915	9,260,914	14,458,513	1.561	3,884	9,765	2.51	9,264,798	14,468,278	1.561
1916	8,727,930	21,904,236	2.510	3,254	9,844	3.03	8,731,184	21,914,080	2.510
1917	8,377,697	27,240,608	3.252	1,588	6,352	4.00	8,379,285	27,246,960	3.252

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade-journal sources and differ somewhat from those on page 697 which are obtained from reports received directly from the oil producers.

Wells completed in West Virginia, 1913–1917.

County.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Brooke	28	15	4	5	1	6	16	10	12	6	38	40	21	22	10
Cabell	.....	.....	.....	.....	1	1	.....	.....	.....	.....	1	.....	.....	.....	1
Calhoun	18	5	3	5	23	6	6	1	16	5	32	17	10	26	51
Clay	.....	9	14	17	27	.....	4	.....	2	2	.....	16	17	23	31
Gilmer	.....	12	15	.....	8	.....	8	10	.....	8	.....	23	32	.....	37
Hancock	21	16	5	5	8	7	6	7	6	8	33	23	13	12	18
Kanawha	177	114	86	170	169	20	17	6	8	10	227	153	105	187	210
Lincoln	66	59	88	124	59	4	8	.....	3	2	75	105	96	137	63
Marion	230	311	181	228	210	51	81	33	67	49	526	535	357	533	456
Marshall	.....	7	.....	3	4	.....	3	2	1	2	.....	18	9	7	29
Pleasants	108	74	71	85	78	42	25	24	51	48	150	102	100	139	129
Ritchie	129	125	53	116	98	39	49	49	23	36	191	190	117	160	159
Roane	253	115	64	74	50	21	15	16	5	9	295	152	99	92	63
Wetzel and Tyler	105	81	97	117	78	61	48	50	61	38	242	199	185	305	213
Wirt	49	53	53	63	66	8	24	15	16	21	60	78	72	81	88
Wood	71	47	25	43	53	36	16	15	25	23	108	63	41	68	76
Miscellaneous	30	.....	4	.....	.....	37	21	8	.....	.....	87	44	15	1	1
	1,285	1,043	763	1,055	933	339	347	246	296	267	2,065	1,758	1,289	1,793	1,536

[a] Including gas wells.

Oil wells and dry holes drilled in West Virginia in 1917.

County.	Jan.		Feb.		Mar.		Apr.		May.		June.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Brooke	......	1	......	......	......	1	......	1	......	......	......	1
Cabell	......	......	......	......	......	......	......	......	......	......	......	......
Calhoun	1	1	......	1	......	1	1	......	2	......	1	1
Clay	3	......	2	......	1	1	2	......	3	......	4	......
Gilmer	......	......	......	......	......	......	......	......	......	......	......	......
Hancock	1	1	......	......	1	1	......	......	2	2	......	1
Kanawha	10	1	15	1	23	......	13	1	12	......	14	......
Lincoln	9	......	8	2	5	......	4	......	4	......	3	......
Marion	21	2	14	4	19	3	19	5	20	6	26	5
Marshall	......	1	......	......	1	......	1	......	......	......	......	......
Pleasants	3	3	3	4	5	2	4	2	11	5	10	6
Ritchie	5	2	6	2	7	3	5	5	8	6	11	5
Roane	5	......	5	......	3	1	9	......	5	2	9	1
Wetzel and Tyler	11	4	11	4	5	3	5	2	6	6	8	4
Wirt	7	1	5	......	4	3	6	......	3	2	10	2
Wood	4	1	5	1	4	2	5	1	3	2	5	......
	80	18	74	19	78	21	74	17	79	31	101	26

County.	July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Brooke	.....	1	.....	1	1	.....	.....	.....	.....	.....	.....	.....	1	6
Cabell	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1	.....
Calhoun	3	.....	1	.....	2	1	3	.....	3	.....	6	.....	23	5
Clay	1	1	3	.....	1	.....	1	.....	4	.....	2	.....	27	2
Gilmer	.....	.....	2	.....	2	.....	1	1	3	3	.....	4	8	8
Hancock	2	.....	1	1	1	.....	.....	1	.....	1	.....	.....	8	8
Kanawha	16	1	10	1	14	1	15	1	14	2	13	1	169	10
Lincoln	4	.....	3	.....	6	.....	3	.....	4	.....	6	.....	59	2
Marion	12	5	15	7	12	3	20	5	13	2	19	2	210	49
Marshall	.....	.....	1	.....	.....	1	.....	.....	.....	.....	1	.....	4	2
Pleasants	10	10	5	4	14	2	3	2	4	3	6	5	78	48
Ritchie	7	.....	9	1	6	5	13	2	14	3	7	2	98	36
Roane	2	1	2	2	2	.....	4	.....	1	2	3	.....	50	9
Wetzel and Tyler	5	6	8	2	5	2	5	3	4	.....	5	2	78	38
Wirt	6	3	4	3	4	2	9	1	4	2	4	2	66	21
Wood	7	1	7	5	2	4	2	1	6	3	3	2	53	23
	75	29	71	27	72	21	79	17	75	21	75	20	933	267

Wells completed in West Virginia, 1913–1917.

Month.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
January	92	109	54	66	80	21	31	26	17	18	157	165	102	121	133
February	98	102	55	79	74	26	38	24	11	19	157	174	99	123	142
March	91	95	63	71	78	30	33	27	18	21	157	151	110	121	142
April	113	95	56	78	74	25	37	18	23	17	177	165	98	125	139
May	103	137	76	78	79	25	45	16	27	31	163	202	114	133	135
June	138	101	60	97	101	34	37	22	40	26	202	174	99	181	159
July	102	95	60	98	75	30	29	20	28	29	163	156	110	162	143
August	110	82	65	99	71	32	29	18	24	27	175	154	100	169	127
September	104	48	66	94	72	30	20	17	32	21	172	108	100	172	122
October	114	58	63	111	79	28	11	21	23	17	187	97	111	164	137
November	109	54	73	92	75	31	15	25	31	21	173	104	128	173	132
December	111	67	72	92	75	27	22	12	22	20	182	108	118	149	124
	1,285	1,043	763	1,055	933	339	347	246	296	267	2,065	1,758	1,289	1,793	1,635

[a] Including gas wells.

Initial daily production of new wells completed in West Virginia in 1917, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Brooke	......	......	......	......	......	......	......	......	2	......	......	......	2
Cabell	......	......	......	......	......	......	......	......	......	......	1	......	1
Calhoun	5	......	......	1	12	3	65	25	29	55	30	33	258
Clay	23	15	5	9	28	25	15	22	3	10	23	13	191
Gilmer	......	......	......	......	......	......	......	35	17	10	17	......	79
Hancock	3	......	2	......	7	......	13	2	10	......	......	......	37
Kanawha	230	754	679	612	201	509	891	472	456	730	788	641	6,963
Lincoln	75	45	11	15	20	9	23	19	33	14	16	35	315
Marion	537	347	278	176	370	329	109	306	240	477	205	158	3,532
Marshall	......	......	3	15	......	......	......	2	......	......	......	3	23
Pleasants	8	8	15	13	75	35	27	19	176	7	27	14	424
Ritchie	26	98	50	28	85	87	109	79	86	194	113	119	1,074
Roane	60	48	45	113	37	72	19	10	10	45	10	13	482
Wetzel and Tyler	84	79	23	21	63	38	31	75	19	70	103	98	704
Wirt	26	24	25	117	16	54	127	98	15	38	19	22	581
Wood	13	23	11	27	5	18	22	20	10	15	24	13	201
	1,090	1,441	1,147	1,147	919	1,179	1,451	1,184	1,106	1,665	1,376	1,162	14,867

Total and average initial daily production of new wells in West Virginia, 1913–1917, by counties, in barrels.

County.	Total initial production.					Average per well.				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Brooke	1,329	186	17	20	2	47.5	12.4	4.3	4.0	2.0
Cabell	12	....	....	....	1	....	....	....	....	1.0
Calhoun	199	22	8	40	258	11.1	4.4	2.7	8.0	11.0
Clay	([a])	84	261	128	191	....	9.3	18.6	7.5	7.0
Gilmer	....	71	109	....	79	....	5.9	7.3	....	9.9
Hancock	82	105	32	33	37	3.9	6.6	6.4	6.6	4.9
Kanawha	10,703	8,965	4,724	6,512	6,963	60.5	78.6	54.9	38.3	41.2
Lincoln	929	797	821	910	315	14.1	13.5	9.3	7.3	5.3
Marion	6,829	9,532	3,163	12,163	3,532	29.7	30.6	17.5	53.3	16.8
Marshall	....	92	....	11	23	....	13.1	....	3.7	5.8
Pleasants	2,045	455	551	694	424	18.9	6.1	7.8	8.2	5.4
Ritchie	968	1,545	536	1,005	1,074	7.5	12.4	10.1	8.7	11.0
Roane	9,185	931	696	621	482	36.3	8.1	10.9	8.3	9.6
Wetzel and Tyler	1,695	1,085	2,027	1,242	704	16.1	13.4	20.9	10.6	9.0
Wirt	212	437	410	641	581	4.3	8.2	7.7	10.2	8.8
Wood	482	167	76	214	201	6.8	3.6	3.0	5.0	3.8
Miscellaneous	165	....	70	....	....	5.5	....	17.5	....	......
	34,835	24,474	13,501	24,234	14,867	27.1	23.5	17.7	23.0	15.9

[a] Included in "Miscellaneous."

Total initial daily production of new wells in West Virginia, 1913–1917, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1913	3,428	3,988	3,144	4,121	2,360	5,085	1,846	2,527	1,846	2,452	1,795	2,243	34,835	2,903
1914	2,178	2,173	2,287	1,741	2,475	2,768	2,263	1,677	1,369	2,850	1,336	1,357	24,474	2,040
1915	1,670	814	1,685	1,112	1,177	753	1,276	981	1,079	699	1,360	895	13,501	1,125
1916	891	833	795	1,502	1,451	2,621	1,965	1,265	1,933	3,678	4,047	3,253	24,234	2,020
1917	1,090	1,441	1,147	1,147	919	1,179	1,451	1,184	1,106	1,665	1,376	1,162	14,867	1,239

KENTUCKY AND TENNESSEE.

GENERAL STATEMENT.

The promise given by Kentucky and Tennessee in 1916 of substantial increase in their contribution to the output of petroleum from the Appalachian field in 1917 was admirably fulfilled. The quantity of oil marketed from these two States in 1917 was fully 150 per cent greater than in 1916, and was no less than 3,100,356 barrels. Of this quantity Tennessee contributed 12,196 barrels, an output 18 times its contribution of 677 barrels in 1916. The relatively shallow depth of the oil sands in Kentucky and the large area of undrilled territory apparently capable of furnishing wells of moderate capacity provided a combination of conditions favoring economy of operations that made that State the center of activity in drilling in the eastern fields.

DEVELOPMENT.

KENTUCKY.

The results of drilling in Kentucky in 1917 were distributed over 46 counties and included 1,162 oil wells, having an average initial capacity of 30 barrels each, 59 gas wells, and 417 dry holes, an average of 1 failure in every 4 wells drilled, a fact which indicates much wildcat drilling. Estill County led with 604 new oil wells, which averaged 32 barrels each the first day of productive life, 3 gas wells, and 142 failures. Powell County followed with 227 oil wells, which averaged 41 barrels each the first day of productive life, 1 gas well, and 58 dry holes. Allen County was third with 88 oil wells, credited with an average initial capacity of 42 barrels each, and 65 dry holes. The remaining 450 wells, including 243 oil wells with an average initial yield of 12 barrels each, 55 gas wells, and 152 failures, were distributed over 43 other counties throughout the State. Most of the new work, however, was done in the eastern part of the State, in the counties adjacent to Estill. The results accomplished include the discovery and partial development of a prolific oil pool in the vicinity of Pilot, in the extreme eastern part of Estill County and the southeastern part of Powell County, near the east end of the Irvine anticline; the discovery of promising areas of oil production south of the Irvine-Pilot district, notably in the vicinity of Torrent, Wolfe County; Zachariah, Poplar Sign Board, Fincastle, Beattyville, and Heidelberg, Lee County; Drip Rock, in northeastern Jackson County; and on Ross Creek, south of Kentucky River, along the Estill-Lee County boundary. In Rockcastle County, some distance southwest of the Irvine-Pilot district, showings of oil were reported in one well about 2 miles south of Mount Vernon, completed in April, and in several shallow wells drilled during the latter half of 1917 on the farm of Judge J. H. Lambert, near Sniders, in the northern part of the county. In the southern part of Lincoln County, which adjoins Rockcastle on the west, a gas field of some promise was discovered on the Shuler farm near Waynesburg, and late in the year oil wells of small capacity were reported from the same locality. In Breathitt County, some distance southeast of the Irvine-Pilot district, encouraging showings of oil were found during December in a wildcat test on the Breck-Crawford farm, near the mouth of Copes Branch of Middle Fork of Kentucky River.

In the counties between Estill and the West Virginia boundary wildcat drilling was especially active. In Johnson County gas was discovered in a well on the farm of Felix First, near the Lawrence County boundary, and encouraging showings of oil were obtained in a well on the Paint Creek dome near the Magoffin County boundary. In Morgan County, gas in considerable volume was obtained in a test at Mize, several miles north of the Cannel City oil field, and in Lawrence County encouraging showings of oil found in tests drilled near Ulysses, 10 miles south of the old Busseyville field, aroused considerable interest in the possibilities of a new pool near the West Virginia border. Near Denton, in Carter County, and near Russell in Greenup County, gas in fair volume was found in wildcat wells drilled in 1917.

In the area north of the Irvine-Pilot district a shallow sand oil pool of undetermined limits was proved in the vicinity of Olympia and Salt Lick, Bath County, following discoveries of both oil and gas in that locality in 1916.

Along the Tennessee border, in Knox and Whitley counties, there was a decided revival of activity in drilling. In Knox County new territory of considerable promise was opened near Himyar, southeast of Barbourville, and near Indiancreek post office, about 6 miles west of Barbourville. A number of productive oil wells were completed in the old territory adjacent to Barbourville and along Richfield Creek and its branches north of that town. In Whitley County operations were restricted for the most part to the Williamsburg district, which furnished a few oil wells of small capacity and a number of creditable gas wells.

No new territory was discovered in 1917 in the old Wayne County districts, but in McCreary County the completion in April of a 20-barrel oil well on the farm of Judge F. D. Sampson, near the center of that county and some 10 miles east of the fields in Wayne County, was interpreted as the forerunner of the exploitation of a new pool.

In central Kentucky wildcat drilling resulted in the discovery of a promising gas field remote from existing markets, near Whitewood, in the eastern part of Green County, and of encouraging showings of oil in Metcalfe County, in the vicinity of the Gaddie farm, near Beachville, on which two successful oil wells were drilled in 1916. Discoveries of oil 3 miles west of Glasgow, in Barren County, some distance in advance of the old Boyd Creek field, caused a revival of activity in the old Glasgow district.

In western Kentucky drilling was more active in Allen County than elsewhere, and new territory of value was proved in the vicinity of the detached pools that comprise the Scottsville-Petroleum district. Promising extensions of productive territory were added on the south and a shallow pool of oil was opened on town lots in the municipality of Adolphus, on the Tennessee border. Late in the year the discovery of oil on the farm of Susan Moore, 6 miles northwest of Scottsville, provided the incentive for additional tests in quest of a new pool or of an extension into Warren County. In Simpson County, which adjoins Allen County on the west, encouraging showings of oil were reported at a depth of 87 feet in a test on the farm of T. J. Finn, on Lick Creek near Franklin.

In Warren County the most significant development of the year 1917 was the discovery in July by the Chenault Oil & Gas Co. of a promising pool of dark-green oil at a depth of about 1,200 feet on the farm of William Jackson, about 10 miles west of Bowling Green. A second well, completed later in the year, on the same farm, confirmed the discovery. The subsequent completion of a producing oil well drilled by the Ithaca Oil & Gas Co. on the farm of Dillard Duncan, near Browning, 3 miles south of the Jackson farm, and of a similar well drilled by the Walmer Oil Co., on the farm of G. W. Bates, near Alvaton, 9 miles southeast of Bowling Green, near the Allen County boundary, assured for Warren County a thorough testing in 1918. After the discovery of natural gas near Anneta in December, 1916, Grayson County received considerable attention from the "wildcatter" in 1917. The positive results of this activity were the discovery of gas in volume estimated at 2,000,000 cubic feet a day in a well drilled by the Kentucky Oil & Refining Co., on the Hunter farm, about half a mile south of Leitchfield, and the discovery of oil in quantity reported at 25 barrels a day in a well drilled by the Dresser Oil Co., on the farm of W. J. Majors, about 4 miles west of Leitchfield.

TENNESSEE.

The significant increase in the output of petroleum from Tennessee in 1917 was a consequence of the success that attended the development of the Glenmary field, in Scott County, which was discovered in 1916. Eleven wells were completed in this district in 1917. Eight of these produced an average of 21 barrels of oil each on the first day of productive life and the remaining three produced sufficient gas to warrant their classification as gas wells. The most successful well of the year was No. 1 of Russell Bros., on the farm of Anna Pemberton, half a mile south of Glenmary, which was credited with an initial yield of 17 barrels an hour when completed. Oil from this field was shipped by tank car from Rugby Road, Tenn., to Somerset, Ky., and thence by the Cumberland Pipe Line to market.

PETROLEUM MARKETED.

Petroleum marketed in Kentucky, 1913–1917, in barrels.

Month.	1913	1914	1915	1916	1917
January	42,074	46,930	34,898	33,751	154,378
February	36,843	44,545	35,707	40,657	139,417
March	39,391	53,860	39,562	51,323	174,299
April	39,036	50,465	40,015	65,545	165,331
May	42,932	44,903	39,323	86,102	240,024
June	39,285	44,361	37,070	81,409	266,328
July	48,211	42,630	35,905	94,001	318,776
August	49,908	26,758	37,531	134,432	320,529
September	52,538	21,177	34,929	143,093	330,626
October	46,301	51,625	33,564	162,060	352,481
November	44,137	36,900	34,702	157,685	339,783
December	43,912	38,287	34,063	153,188	286,188
	524,568	502,441	437,274	[a] 1,203,246	3,088,160

[a] Includes 677 barrels from Tennessee.

Pipe-line runs in Kentucky in 1916 and 1917, in barrels.

1916.

Month ending—	Wayne County. Cooper.	Wayne County. Griffin (Denny).	Wayne County. Parmleysville.	Wayne County. Steubenville.	Wayne County. Total.	Wolfe County. Campton.	Wolfe County. Stillwater.	Wolfe County. Page Hollow.	Wolfe County. Total.	Estill County. Ravenna-Irvine.	Estill County. Fitchburg.	Estill County. Wagersville.	Estill County. Total.	Lawrence County (Busseyville).	Morgan County. Cannel City.	Morgan County. Lewis.	Morgan County. Total.	Beaver Creek.	Ragland.	Williamsburg.	State total.
Jan. 29	3,144	3,823	3,197	5,813	15,977	987	760	301	2,048	2,121	......	......	2,121	1,420	1,715	......	1,715	854	2,972	......	27,107
Feb. 26	4,267	3,711	3,087	4,782	15,847	1,485	639	......	2,124	8,725	......	......	8,725	2,213	1,882	......	1,882	836	2,554	149	34,330
Apr. 1	4,164	3,227	3,103	5,159	15,653	714	785	1,137	2,636	15,000	......	......	15,000	3,278	232	1,919	2,151	838	2,631	149	42,336
Apr. 29	4,201	3,592	2,941	4,990	15,724	2,076	684	......	2,760	32,344	......	......	32,344	2,454	......	1,141	1,141	1,079	3,324	......	58,826
May 27	4,113	3,323	3,001	5,339	15,776	1,211	807	......	2,018	48,250	......	......	48,250	1,682	......	1,318	1,318	887	3,324	......	73,255
July 1	5,147	4,697	4,055	5,393	19,292	2,646	608	......	3,254	57,846	......	......	57,846	3,865	......	2,338	2,338	926	2,798	......	90,319
July 29	4,098	2,561	3,071	4,290	14,020	1,386	322	......	1,708	55,721	......	......	55,721	2,886	......	1,735	1,735	378	2,807	......	79,255
Sept. 2	5,134	4,277	4,070	4,871	18,352	2,392	778	......	3,170	102,364	1,825	......	104,189	4,137	......	2,297	2,297	891	3,617	......	136,653
Sept. 30	4,436	3,076	2,772	3,882	14,166	457	1,158	855	2,470	89,457	11,111	......	100,568	2,390	......	1,406	1,406	459	2,119	......	123,578
Oct. 28	3,697	3,204	2,802	3,645	13,348	1,226	821	......	2,047	103,471	9,666	......	113,137	4,190	......	1,573	1,573	1,141	2,145	......	137,581
Dec. 2	3,775	4,287	3,601	4,803	16,466	2,556	1,069	......	3,625	125,800	21,870	213	147,883	3,649	......	2,148	2,148	992	3,365	......	178,128
Dec. 30	3,190	2,905	2,871	3,095	12,061	935	921	154	2,010	94,304	18,251	2,012	114,567	4,212	......	1,338	1,338	492	2,695	......	137,375
	49,366	42,683	38,571	56,062	186,682	18,071	9,352	2,447	29,870	735,403	62,723	2,225	800,351	36,376	3,829	17,213	21,042	9,773	34,351	298	1,118,743

1917.

Month ending—	Wayne County. Cooper.	Wayne County. Griffin (Denny).	Wayne County. Parmleysville.	Wayne County. Steubenville.	Wayne County. Total.	Wolfe County. Campton.	Wolfe County. Stillwater.	Wolfe County. Page Hollow.	Wolfe County. Total.	Estill County. Ravenna Irvine.	Estill County. Fitchburg.	Estill County. Wagersville.	Total.
Feb. 3	4,191	3,721	3,776	3,884	15,572	2,279	1,324	....	3,603	106,049	22,530	5,375	133,954
Mar. 3	3,966	3,062	2,544	3,221	12,793	1,122	760	....	1,882	71,398	18,481	16,600	106,479
Mar. 31	3,709	2,958	2,913	2,964	12,544	973	1,321	....	2,294	84,797	28,898	26,457	140,152
Apr. 28	4,003	3,355	3,114	3,116	13,588	1,781	1,865	....	3,646	56,491	21,901	34,733	113,125
June 2	4,433	3,543	3,272	3,876	15,124	1,180	2,707	902	4,789	130,496	45,093	38,459	214,048
June 30	3,886	3,137	3,768	3,095	13,886	1,831	3,136	687	5,654	106,290	66,750	20,976	194,016
July 28	3,988	2,708	2,827	5,588	15,111	2,422	2,484	....	4,906	119,445	79,890	19,029	218,364
Sept. 1	5,140	2,571	3,395	3,818	14,924	2,636	1,812	....	4,448	128,967	95,937	12,230	237,134
Sept. 29	3,840	2,571	2,463	2,797	11,671	1,220	862	....	2,082	115,094	82,664	10,146	207,904
Nov. 3	5,972	3,256	2,844	3,752	15,824	2,985	1,097	....	4,082	123,842	103,650	11,328	238,820
Dec. 1	3,658	2,798	2,612	3,624	12,692	1,256	1,439	....	2,695	96,547	84,661	9,250	190,458
Dec. 29	2,540	2,382	1,785	3,252	9,959	1,407	1,156	....	2,563	88,183	69,186	6,071	163,440
	49,326	36,062	35,313	42,987	163,688	21,092	19,963	1,589	42,644	1,227,599	719,641	210,654	2,157,894

Month ending—	Lawrence County.			Morgan County.			Beaver Creek.	Ragland.	Williamsburg.	Pilot-Ashley.	Zachariah.	State total.
	Busseyville.	Fallsburg.	Total.	Cannel City.	Lewis.	Total.						
Feb. 3	3,809	....	3,809	....	2,194	2,194	850	2,319	146	....	....	162,447
Mar. 3	3,919	....	3,919	....	1,097	1,097	597	2,346	....	3,740	....	132,853
Mar. 31	3,749	....	3,749	....	1,156	1,156	954	2,734	....	8,928	....	172,511
Apr. 28	4,160	....	4,160	....	432	432	863	2,524	....	1,130	....	139,468
June 2	3,900	....	3,900	....	2,658	2,658	688	2,423	....	17,203	....	260,833
June 30	4,202	341	4,543	868	589	1,457	748	2,581	....	17,165	....	240,050
July 28	843	4,115	4,958	1,281	....	1,281	571	1,848	....	31,945	....	278,984
Sept. 1	1,807	4,769	6,576	1,767	....	1,767	638	1,721	150	62,324	....	329,682
Sept. 29	1,017	3,635	4,652	1,228	....	1,228	1,627	1,373	5,204	73,260	....	309,001
Nov. 3	1,640	3,855	5,495	1,257	....	1,257	610	2,883	....	113,700	318	382,989
Dec. 1	1,139	5,425	6,564	1,377	....	1,377	542	1,501	....	90,945	647	307,421
Dec. 29	1,336	2,958	4,294	943	....	943	529	1,888	....	74,580	2,476	260,672
	31,521	25,098	56,619	8,721	8,126	16,847	9,217	26,141	5,500	494,920	3,441	2,976,911

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade-journal sources and differ somewhat from those on page 698, which are obtained from reports received directly from the oil producers.

Wells completed in Kentucky, 1913–1917.

County.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Adair					2					2					4
Allen	7	16	1	99	88	1	1	1	28	65	8	19	2	131	153
Barren	3			5	5	3			1	2	6			6	10
Bath				1	15				1	7				3	25
Boyle					1					2					3
Breathitt										1					1
Carter															1
Casey										1					1
Clark										1					1
Clay															1
Cumberland						1					2				
Daviess		2					1	3				3	3		
Edmonson			1										1		
Estill		3	2	681	604				86	142		3	2	773	749
Floyd					2	1	1		2		1	1		2	3
Grayson					2					3				1	6
Green										1					8
Greenup										2					3
Hardin															1
Hopkins										1					1
Jackson					9				3	11				3	20
Johnson		1								2		1			3
Knox					29					5					36
Larue										3					6
Lawrence	9	9	10	20	27	1		2	1	5	11	10	12	21	34
Lee				2	43				2	13				4	58
Lincoln					16					6					30
Logan										3					3
McCreary					8					2					10
Madison				1						2				2	2
Magoffin					5										5
Marion										1					1
Martin				1										1	
Menifee															1
Metcalfe				2	4				2	5				4	9
Monroe					1					1					2
Montgomery									2	1				2	1
Morgan	32	10	1	2	5	13	5	1	5	4	48	15	2	7	12
Ohio		4					4					8			
Owsley										2					2
Perry										1					1
Powell				21	227				10	58				32	286
Pulaski					1					3					6
Rockcastle					12				7	3				8	15
Simpson					2					1				1	3
Taylor										1					9
Warren				1	6					5				2	11
Wayne	67	68	31	29	22	31	34	27	27	28	98	102	58	56	50
Webster								1		1			1		1
Whitley				1	4				1	5				2	13
Wolfe	12	6	10	12	22	10	4	1	1	15	22	10	11	13	37
Other	3					8	5				14	6			
	133	119	56	878	1,162	69	55	36	179	417	210	178	92	1,074	1,638

[a] Including gas wells.

Oil wells and dry holes drilled in Kentucky in 1917.

County.	Jan.		Feb.		Mar.		Apr.		May.		June.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Adair												1
Allen		1	11	8	4	7	5		8	6	12	13
Barren	1		1							1		1
Bath			2			1			1		1	1
Estill	68	15	50	6	59	12	57	11	82	19	70	12
Grayson		1										
Jackson		1					1		1	1	2	2
Johnson				1								
Knox			1		3		6		2	1	2	1
Lawrence		1	2		2		2	2	3		1	1
Lee				2	7				1		2	
Lincoln						1						1
McCreary			1	1			1		5		1	
Magoffin									3			
Metcalfe			1									2
Morgan			1			1			1		1	
Powell	3		6	3	5	2	4	6	9	2	12	12
Rockcastle							1		1		1	1
Simpson												1
Warren				1					1	1		
Wayne	2	1			2	3	3	2	3	4		4
Whitley	2	2	1	1						1		
Wolfe			1		1		1	2	2	1	1	
	76	22	78	23	83	27	81	23	123	37	106	53

County.	July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Adair	1								1	1			2	2
Allen	5	3	4	9	13	2	11	3	6	10	9	3	88	65
Barren	1				1		1						5	2
Bath	2	2	3	1	3	1				1	3		15	7
Boyle	1							1				1	1	2
Breathitt										1				1
Casey				1										1
Clark		1												1
Estill	43	14	46	22	27	2	59	10	24	10	19	9	604	142
Floyd	1										1		2	
Grayson			2			1						1	2	3
Green						1								1
Greenup						1						1		2
Hopkins								1						1
Jackson		4					1	1	3	1	1	1	9	11
Johnson												1		2
Knox	1	1	4			1	4		2	1	4		29	5
Larue						1		1				1		3
Lawrence	2		2		3		4	1	3		3		27	5
Lee	3	1			3	2	3	1	13	4	11	3	43	13
Lincoln			9	1	2	1	3				2	2	16	6
Logan												3		3
McCreary												1	8	2
Madison										1		1		2
Magoffin	1				1								5	
Marion												1		1
Metcalfe	1	2	1							1	1		4	5
Monroe										1	1		1	1
Montgomery												1		1
Morgan			1	1	1	1						1	5	4
Owsley		1										1		2
Perry										1				1
Powell	11	7	29	6	35	6	39	4	44	5	30	5	227	58
Pulaski							1			1		2	1	3
Rockcastle	1	2			8								12	3
Simpson							1				1		2	1
Taylor												1		1
Warren	1			1					4	1		1	6	5
Wayne	2	3	1	4	1	2	5	2	3	1		2	22	28
Webster		1												1
Whitley							1	1					4	5
Wolfe		1	2	4	6	1	2	4	3		3	2	22	15
	77	43	104	50	104	23	135	30	106	41	89	45	1,162	417

Wells completed in Kentucky, 1913–1917.

Month.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
January	6	11	1	48	76	4	5	3	7	22	11	16	4	58	100
February	15	12	3	25	78	7	7	4	7	23	23	19	7	32	105
March	4	11	4	30	83	4	2	1	8	27	9	13	5	38	113
April	11	14	5	35	81	9	7	.....	6	23	21	21	5	41	108
May	12	8	10	51	123	4	4	9	15	37	17	12	19	66	161
June	9	14	5	48	106	7	8	6	3	53	16	22	11	52	162
July	11	12	4	104	77	6	5	2	15	43	18	18	6	120	123
August	10	14	3	94	104	5	6	1	25	50	17	20	4	122	163
September	19	8	2	121	104	7	5	1	31	23	26	14	3	156	133
October	11	3	5	123	135	2	3	3	30	30	13	7	8	153	173
November	10	8	6	96	106	4	2	4	12	41	14	10	10	110	155
December	15	4	8	103	89	10	1	2	20	45	25	6	10	126	142
	133	119	56	878	1,162	69	55	36	179	417	210	178	92	1,074	1,638

[a] Including gas wells.

Initial daily production of new wells completed in Kentucky in 1917, in barrels

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Adair	......	......	......	......	......	......	5	......	......	......	3	......	8
Allen	......	1,053	275	900	298	203	130	16	148	255	70	365	3,713
Barren	15	25	......	......	......	......	6	......	5	10	......	......	61
Bath	......	31	......	......	50	15	110	30	25	......	......	15	276
Boyle	......	......	......	......	......	......	4	......	......	......	......	......	4
Estill	2,573	3,081	3,285	2,792	3,954	858	535	783	250	691	195	219	19,216
Floyd	......	......	......	......	......	......	5	......	......	......	......	1	6
Grayson	......	......	......	......	......	......	......	10	......	......	......	......	10
Jackson	......	......	......	10	25	25	......	......	......	20	40	25	145
Knox	......	5	28	60	75	35	5	95	......	22	15	35	375
Lawrence	......	10	55	8	18	4	12	12	12	15	19	18	183
Lee	......	......	85	......	5	20	25	......	20	235	155	229	774
Lincoln	......	......	......	......	......	......	......	51	13	30	......	10	104
McCreary	......	20	......	12	90	15	......	......	......	......	......	......	137
Magoffin	......	......	......	......	20	......	3	......	3	......	......	......	26
Metcalfe	......	10	......	......	......	......	5	5	......	......	......	5	25
Monroe	......	......	......	......	......	......	......	......	......	......	......	5	5
Morgan	......	5	......	......	2	25	......	4	10	......	......	......	46
Powell	300	291	510	145	1,050	371	634	848	2,010	1,372	1,330	569	9,430
Pulaski	......	......	......	......	......	......	......	......	......	10	......	......	10
Rockcastle	......	......	......	10	5	5	5	......	9	......	......	......	34
Simpson	......	......	......	......	......	......	......	......	......	10	......	5	15
Warren	......	......	......	......	20	......	50	......	......	......	50	......	120
Wayne	20	......	18	11	9	......	2	3	5	20	29	......	117
Whitley	110	60	......	......	......	......	......	......	......	5	......	......	175
Wolfe	......	5	3	25	30	10	......	40	55	15	55	40	278
	3,018	4,596	4,259	3,973	5,651	1,586	1,536	1,897	2,565	2,710	1,961	1,541	35,293

Total and average initial daily production of new wells in Kentucky, 1913–1917, by counties, in barrels.

County.	Total initial production.					Average per well.				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Adair					8					4.0
Allen	114	335	50	3,877	3,713	16.3	20.9	50.0	39.2	42.1
Barren	14			22	61	4.7			4.4	12.2
Bath				30	276				30.0	18.4
Boyle					4					4.0
Daviess		10					5.0			
Edmonson			10					10.0		
Estill		23	125	22,581	19,216		7.7	62.5	33.2	31.8
Floyd					6					3.0
Grayson					10					5.0
Jackson					145					16.1
Johnson		10					10.0			
Knox					375					12.9
Lawrence	65	69	78	94	183	7.2	7.7	7.8	4.7	6.8
Lee				35	774				17.5	18.0
Lincoln					104					6.5
McCreary					137					17.1
Madison				5					5.0	
Magoffin					26					5.2
Martin				10					10.0	
Metcalfe				12	25				6.0	6.3
Monroe					5					5.0
Morgan	967	96	3	30	46	30.2	9.6	3.0	15.0	9.2
Ohio		150					37.5			
Powell				365	9,439				17.4	41.5
Pulaski					10					10.0
Rockcastle					34					2.8
Simpson					15					7.5
Warren				1	120				1.0	20.0
Wayne	723	843	408	106	117	10.8	12.4	13.2	3.7	5.3
Whitley				10	175				10.0	43.8
Wolfe	107	32	54	132	278	8.9	5.3	5.4	11.0	12.6
Other	225					75.0				
	2,215	1,568	728	27,310	35,293	16.7	13.2	13.0	31.1	30.4

Total initial daily production of new wells in Kentucky, 1913–1917, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1913	43	325	105	501	93	138	221	166	192	124	109	198	2,215	185
1914	140	238	148	267	94	122	155	165	120	28	66	25	1,568	131
1915	1	122	33	119	128	24	14	25	6	53	30	173	728	61
1916	660	517	779	1,281	1,123	2,114	3,678	3,659	3,412	3,331	3,227	3,529	27,310	2,276
1917	3,018	4,596	4,259	3,973	5,651	1,586	1,536	1,897	2,565	2,710	1,961	1,541	35,293	2,941

Wells completed in Tennessee in 1916 and 1917.

County.	Oil.		Dry.		Total completed.[a]	
	1916	1917	1916	1917	1916	1917
Fentress			1		1	
Scott	2	8	6		8	11
	2	8	7		9	11

[a] Including gas wells.

Oil wells and dry holes drilled in Tennessee in 1917.

County.	January.		February.		March.		April.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Fentress														
Scott			1		1						3			
			1		1						3			

County.	August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Fentress												
Scott			3								8	
			3								8	

Wells completed in Tennessee in 1916 and 1917.

Month.	Oil.		Dry.		Total completed.[a]	
	1916	1917	1916	1917	1916	1917
January	2				2	
February		1				1
March		1				1
April						1
May						
June		3				3
July	5				5	
August						
September		3	1		1	3
October						1
November			1		1	
December						1
	7	8	2		9	11

[a] Including gas wells.

Total and average initial daily production of new wells in Tennessee in 1916 and 1917, in barrels.

County.	Total initial production.		Average per well.	
	1916	1917	1916	1917
Fentress				
Scott	45	615	22.5	76.9
	45	615	22.5	76.9

Total initial daily production of new wells in Tennessee in 1916 and 1917, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1916									25		20		45	4
1917		250	200			70			95				615	51

OHIO.[1]

GENERAL STATEMENT.

The response of Ohio to the increased demand for crude petroleum in 1917 was an increase in petroleum yield of 6,029 barrels, or about 0.08 per cent, compared with its output in 1916. The quantity of petroleum marketed from all sources in Ohio in 1917 was 7,750,540 barrels, including 4,839,679 barrels from the southeastern-central division, belonging to the Appalachian field, and 2,910,861 barrels from the northwestern division, belonging to the Lima-Indiana field. Credit for the increase in output of crude oil in Ohio in 1917 belongs wholly to the producing districts in the southeastern-central division, which produced in that year 231,135 barrels more oil than in 1916. The loss in the same period of 225,106 barrels in the output of the northwestern division accounts for the fact that the State is credited with a net gain of only 6,029 barrels in 1917.

The average price received at the wells for all grades of petroleum produced in Ohio in 1917 was $2.72 a barrel, and the market value of the entire output was $21,104,483, a gain of 64 cents in average unit price and of $4,949,543, or 31 per cent, in gross market value, compared with 1916. Of the total income from the sales of crude oil at the wells in Ohio in 1917 some 73 per cent is credited to the southeastern-central division and 27 per cent to the northwestern division. The average price received for the product of the former division was $3.20 a barrel, compared with $2.44 a barrel in 1916, a gain of 76 cents, and the average price received for the product of the latter division was $1.94 a barrel, a gain of 37 cents.

DEVELOPMENT.

SOUTHEASTERN-CENTRAL DIVISION.

The increase of 5 per cent in the output of petroleum credited to the many productive districts in eastern and central Ohio in 1917 is especially gratifying as it was effected by the completion of fewer new wells than in 1916. In all 1,828 wells were drilled for oil and gas in this area in 1917, compared with 1,854 in 1916. Of these, however, only 868 produced oil as compared with 927 in 1916. The oil wells completed in 1917 were credited with an average yield of 14 barrels each the first 24 hours after completion as against 12 barrels in 1916, and as energetic methods were employed to retard the decline of the older wells this slight gain was sufficient to bring about the increase recorded. The results of drilling in 1917 include also 456 gas wells and 504 dry holes, an average of 5 complete failures in every 18 wells drilled.

In the "shallow sand" districts of southeastern Ohio no significant discoveries were made. Developments resulting from the discovery of oil in the Berea sand on the Sutton farm, Union Township, Carroll County, were rather disappointing, for though a number of new wells of fair capacity were completed in that locality the pool proved to be small.

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[1] Of the two areas of oil production in Ohio only the southeastern-central area belongs geographically in the Appalachian oil field, the Lima area, in northwestern Ohio, forming a part of the so-called Lima-Indiana oil field. In accordance with the custom in previous reports, however, the statistics for both areas are given here, to make the statement for Ohio cover the whole State. The Lima statistics are, of course, omitted from the tables covering the Appalachian field as a whole.

In the "deep sand" districts the trend of development was northward, and though Hocking and Vinton counties supported a fair activity the best wells of the year were credited to Muskingum County and particularly to the O'Bannon lease of the Ed. H. Everett Co., in Licking Township, which furnished a number of wells credited with initial flows in excess of 100 barrels each. Farther northward much success attended further efforts to develop in Holmes and Knox counties the "Clinton" sand pool that was discovered near Brinkhaven in 1915. The quest for gas in Wayne County resulted in the opening of a promising pool of oil in the Clinton sand on the Whittaker and McIntire farms in sec. 14, Wooster Township, 2 miles north of the old Wooster oil pool and about the same distance southeast of Wooster.

At the north end of the central Ohio field a few scattered oil wells of small capacity were found in the course of drilling for natural gas in Cuyahoga County.

NORTHWESTERN DIVISION.

The production of 2,910,861 barrels of petroleum by the old Lima field in 1917 was a decrease of 225,106 barrels, or 7 per cent, from the production in 1916, and was due in part to diminished activity in drilling and in part to the fact that the new production developed was considerably below the minimum required to offset the normal decline in output of the old wells. In all 534 new wells were completed in 1917, compared with 699 in 1916. Of these, 473 produced an average of 16 barrels of oil each on the first day of productive life, 9 produced gas only, and 52, an average of 1 in every 10 drilled, were failures.

Field activity in the oil districts of northwestern Ohio was confined almost wholly to the drilling of wells in territory from which the flush production was obtained years ago, and to the intensive development of restricted pools overlooked in the course of the earlier development of the region. Only in Seneca, Wood, and Hancock counties did this type of development work result in wells having initial daily capacities in excess of 100 barrels each, and in these counties the number of wells in that class did not exceed a dozen.

PETROLEUM MARKETED.

Petroleum marketed in Ohio in 1913–1917, in barrels.

Month.	Lima.				
	1913	1914	1915	1916	1917
January	336,665	341,162	271,437	247,491	250,916
February	275,831	229,310	274,450	252,535	208,869
March	279,117	343,414	311,095	287,652	273,073
April	349,204	338,745	313,775	271,492	250,248
May	333,866	329,256	283,022	287,382	270,702
June	317,476	331,060	295,378	277,206	266,356
July	327,556	337,431	291,978	265,272	252,166
August	319,486	319,529	275,442	269,449	253,704
September	319,443	312,202	276,998	250,038	223,100
October	332,992	314,526	278,632	260,332	244,957
November	296,090	275,469	261,197	248,223	231,764
December	329,317	254,983	260,429	218,895	185,006
	3,817,043	3,727,087	3,393,833	3,135,967	2,910,861

Petroleum marketed in Ohio in 1913–1917, in barrels—Continued.

Month.	Southeastern Ohio.				
	1913	1914	1915	1916	1917
January	407,538	444,426	382,236	355,553	389,402
February	364,307	363,537	361,100	344,767	352,102
March	324,699	464,675	398,430	385,306	415,850
April	456,072	448,909	385,427	371,192	398,347
May	420,757	436,266	362,097	401,866	430,389
June	414,698	428,753	377,345	422,673	412,722
July	424,588	456,139	366,426	389,532	424,766
August	410,459	195,617	357,799	409,467	434,381
September	425,023	299,372	353,556	376,239	394,632
October	456,364	507,031	363,534	388,561	429,751
November	406,018	373,117	342,700	386,229	401,629
December	453,902	391,423	380,843	377,159	355,708
	4,964,425	4,809,265	4,431,493	4,608,544	4,839,679

Month.	Total.				
	1913	1914	1915	1916	1917
January	744,203	785,588	653,673	603,044	640,318
February	640,138	592,847	635,550	597,302	560,971
March	603,816	808,089	709,525	672,958	688,923
April	805,276	787,654	699,202	642,684	648,595
May	754,623	765,522	645,119	689,248	701,091
June	732,174	759,813	672,723	699,879	679,078
July	752,144	793,570	658,404	654,804	676,932
August	729,945	515,146	633,241	678,916	688,085
September	744,466	611,574	630,554	626,277	617,732
October	789,356	821,557	642,166	648,893	674,708
November	702,108	648,586	603,897	634,452	633,393
December	783,219	646,406	641,272	596,054	540,714
	8,781,468	8,536,352	7,825,326	7,744,511	7,750,540

Quantity, value, and average price per barrel of petroleum produced in Ohio, 1908–1917.

Year.	Lima.			Southeastern Ohio.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1908	6,748,676	$6,861,885	$1.016	4,110,121	$7,316,617	$1.780	10,858,797	$14,178,502	$1.305
1909	5,915,357	5,451,497	.921	4,717,436	7,773,880	1.647	10,632,793	13,225,377	1.243
1910	5,094,136	4,181,629	.821	4,822,234	6,469,939	1.341	9,916,370	10,651,568	1.074
1911	4,535,875	3,888,119	.857	4,281,237	5,591,423	1.306	8,817,112	9,479,542	1.075
1912	a 3,955,897	3,908,809	.988	5,013,110	8,177,189	1.628	8,969,007	12,085,998	1.347
1913	3,817,043	5,308,842	1.391	4,964,425	12,229,610	2.463	8,781,468	17,538,452	1.997
1914	3,727,087	4,435,314	1.190	4,809,265	8,937,415	1.858	8,536,352	13,372,729	1.567
1915	3,393,833	3,300,833	.973	4,431,493	6,760,660	1.526	7,825,326	10,061,493	1.286
1916	3,135,967	4,909,704	1.566	4,608,544	11,245,236	2.440	7,744,511	16,154,940	2.086
1917	2,910,861	5,631,778	1.935	4,839,679	15,472,705	3.197	7,750,540	21,104,483	2.723

a Includes production of Michigan.

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade-journal sources and differ somewhat from those on pages 698–699, which are obtained from reports received directly from the oil producers.

SOUTHEASTERN-CENTRAL DIVISION.

Wells completed in central and southeastern Ohio, 1913–1917.

County.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Ashland	1	2	1	1		21	15	27	22	30	118	88	88	57	73
Ashtabula									1					1	
Athens	15	7	16	16	31	12	7	4	4	10	28	19	21	21	42
Belmont	21	15	12	14	9	29	24	13	9	12	58	55	34	29	34
Carroll	21	29	24	19	40	22	7	13	9	16	44	38	41	29	61
Columbiana	28	58	37	16	19	18	12	23	18	17	47	72	64	46	39
Coshocton	15	13	2	4	12		5	4	3	7	18	18	7	8	24
Cuyahoga		7	13	19	5	1	35	68	29	11	1	384	515	169	58
Erie							1					2			
Fairfield	44	25	12	13	5	28	13	7	9	6	91	44	23	30	22
Guernsey	11					22	2				33	2			
Harrison	19	17	12	13	12	10	7	2	9	7	29	25	16	25	22
Hocking	178	97	71	95	71	30	48	17	27	32	137	181	105	127	122
Holmes	1			6	3	2		3	3	3	3		3	10	13
Jackson									1	5				1	9
Jefferson	60	33	16	39	41	22	16	14	22	22	83	58	32	67	63
Knox	1		1	5	11	8	1	5		16	24	1	13	9	31
Licking	38	16	16	18	12	26	18	9	13	12	144	92	68	74	53
Lorain	1					5	3	3	2	1	8	4	5	5	7
Marion					1					1					2
Medina			4	3	6	8	7	11	8	15	28	29	28	24	73
Meigs								1					1		
Monroe	100	51	34	60	33	31	35	17	17	14	137	93	53	82	50
Morgan	142	91	64	35	56	50	45	21	20	18	192	136	85	56	74
Muskingum	21	15	19	71	79	8	5	7	18	9	33	23	27	92	93
Noble	62	45	36	22	42	37	40	25	31	22	101	96	67	57	64
Perry	172	112	41	104	102	40	34	12	18	23	220	151	55	123	141
Richland						8	16	10	2	5	31	33	32	11	23
Summit						2					2				
Tuscarawas				2	2	1			2	4	1			4	9
Vinton			6	25	4		2	14	29	21		6	41	110	96
Washington	370	221	240	326	253	151	104	111	183	141	533	333	360	525	405
Wayne	25	9		1	19	11	15	31	16	24	47	61	126	62	125
	1,246	863	677	927	868	603	517	472	525	504	2,191	2,044	1,910	1,854	1,828

[a] Including gas wells.

Oil wells and dry holes drilled in central and southeastern Ohio in 1917.

County.	Jan.		Feb.		Mar.		Apr.		May.		June.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Ashland		7		4		3		2		1		2
Athens	3		2		3		1		3	1	2	3
Belmont	1		1		1				1	2		2
Carroll	1	1		2	4		4	2	2	3	3	5
Columbiana	1		2	1	2	2	4	1	1	1	1	2
Coshocton												1
Cuyahoga	1				2		1			3		1
Fairfield			1				1		1			
Harrison		1	1	1			3			2	1	1
Hocking	4	5	8	1	4	5	10	6	5	1	11	2
Holmes											1	1
Jackson												
Jefferson	1	3	5	2	6	1	4		6		3	3
Knox	1			1	2		1		3	2		2
Licking		1		1	1	1	2			1		2
Lorain				1								
Marion											1	
Medina			1	2				1	2	1		1
Monroe	2	3	3		2	3	1	2	1	2	2	1
Morgan	1	2	2		2		6	2	8	4	6	1
Muskingum	9	1	8		12	1	7		9	1	8	2
Noble	5	1	3				2	2	5	3	3	4
Perry	11	2	5		7		7	1	10	2	10	4
Richland												
Tuscarawas	2					2				2		
Vinton	2	1		1	2	2		5		3		2
Washington	9	10	23	10	22	17	26	10	27	17	24	11
Wayne		2			2		1	5	2	4	4	1
	54	40	65	27	74	37	81	39	86	56	80	54

Oil wells and dry holes drilled in central and southeastern Ohio in 1917—Continued.

County.	July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Ashland	.....	4	.....	1	.....	2	.....	2	.....	2	.....	.....	.....	30
Athens	3	1	1	.....	.....	2	2	1	5	1	6	1	31	10
Belmont	1	.....	.....	.....	1	2	.....	4	2	2	1	.....	9	12
Carroll	5	.....	5	.....	7	1	5	2	1	.....	3	.....	40	16
Columbiana	1	4	2	1	1	1	1	3	.....	1	3	.....	19	17
Coshocton	3	2	1	1	2	1	1	.....	4	1	1	1	12	7
Cuyahoga	1	1	.....	1	.....	3	.....	1	.....	1	.....	.....	5	11
Fairfield	.....	1	.....	2	1	2	.....	1	.....	.....	1	.....	5	6
Harrison	.....	.....	3	.....	.....	.....	2	.....	1	1	1	1	12	7
Hocking	5	2	1	2	7	4	6	1	6	2	4	1	71	32
Holmes	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	2	.....	3	3
Jackson	.....	2	.....	.....	.....	2	.....	.....	.....	1	.....	.....	.....	5
Jefferson	4	3	3	3	1	2	3	2	3	2	2	1	41	22
Knox	2	3	.....	3	1	1	1	2	.....	1	.....	1	11	16
Licking	1	2	2	1	1	1	1	1	4	1	.....	.....	12	12
Lorain	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Marion	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	1	1
Medina	.....	.....	1	.....	1	3	.....	2	1	3	.....	2	6	15
Monroe	5	.....	3	1	4	1	3	.....	4	1	3	.....	33	14
Morgan	3	.....	2	1	7	1	8	3	7	3	4	1	56	18
Muskingum	5	.....	7	.....	6	1	4	.....	2	3	2	.....	79	9
Noble	2	3	5	2	4	1	1	3	8	2	4	1	42	22
Perry	9	1	9	4	8	5	8	1	12	3	6	.....	102	23
Richland	.....	.....	.....	1	.....	2	.....	.....	.....	1	.....	1	.....	5
Tuscarawas	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	4
Vinton	.....	2	.....	.....	.....	3	.....	.....	.....	2	.....	.....	4	21
Washington	22	7	17	10	30	12	19	14	22	11	12	12	253	141
Wayne	3	3	5	3	1	3	1	.....	.....	3	.....	.....	19	24
	75	41	67	38	83	58	66	43	82	48	55	23	868	504

Wells completed in central and southeastern Ohio, 1913–1917.

Month.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
January	66	105	55	66	54	45	52	42	40	40	140	197	198	144	123
February	76	86	39	56	65	51	51	29	41	27	165	165	158	144	119
March	95	76	49	60	74	36	29	42	37	37	151	121	166	125	148
April	94	112	58	74	81	44	54	40	44	39	148	193	152	135	146
May	123	100	50	97	86	46	50	36	53	56	184	190	123	176	183
June	110	88	50	92	80	49	48	31	48	54	172	182	134	168	186
July	104	83	47	101	75	50	57	36	51	41	174	224	119	185	156
August	131	70	51	89	67	61	56	52	51	38	227	180	161	177	144
September	122	27	54	77	83	49	28	27	44	58	200	142	139	163	185
October	120	42	61	71	66	57	37	35	33	43	224	151	158	133	146
November	105	32	79	64	82	49	35	54	43	48	200	148	218	151	179
December	100	42	84	80	55	66	20	48	40	23	206	151	184	153	113
	1,246	863	677	927	868	603	517	472	525	504	2,191	2,044	1,910	1,854	1,828

[a] Including gas wells.

Initial daily production of new wells completed in central and southeastern Ohio in 1917, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Athens	10	4	6	2	4	3	8	2	......	4	10	13	66
Belmont	20	15	1	......	2	......	2	......	1	......	10	10	61
Carroll	2	......	133	82	35	47	210	171	141	45	125	22	1,013
Columbiana	1	3	2	13	1	1	2	3	2	1	......	6	35
Coshocton	......	......	......	......	......	......	115	10	85	10	55	50	325
Cuyahoga	45	......	25	15	......	......	8	......	......	......	......	......	93
Fairfield	......	5	......	25	5	......	......	......	10	......	......	10	55
Harrison	......	8	......	14	......	2	......	7	......	10	5	5	51
Hocking	160	395	170	510	390	227	170	25	95	113	272	250	2,777
Holmes	......	......	......	......	......	25	......	......	......	......	......	30	55
Jefferson	1	13	43	28	20	5	22	4	1	6	6	12	161
Knox	60	......	40	20	40	......	30	......	60	15	......	......	265
Licking	......	......	80	45	......	......	400	25	20	8	160	......	738
Marion	......	......	......	......	......	10	......	......	......	......	......	......	10
Medina	......	10	......	......	4	......	......	2	20	......	6	......	42
Monroe	2	5	6	1	3	5	29	16	9	19	22	16	133
Morgan	2	3	4	21	12	9	6	4	40	19	19	10	149
Muskingum	224	198	163	178	203	205	96	69	195	50	4	17	1,602
Noble	12	5	......	3	11	8	13	33	8	40	29	7	169
Perry	178	80	76	117	147	183	85	404	137	135	243	47	1,832
Tuscarawas	4	......	......	......	......	......	......	......	......	......	......	......	4
Vinton	10	......	10	......	......	......	......	......	......	......	......	......	20
Washington	42	190	212	125	253	144	72	160	177	116	59	84	1,634
Wayne	......	......	11	5	50	260	130	185	20	25	......	......	686
	773	934	982	1,204	1,180	1,134	1,398	1,120	1,021	616	1,025	589	11,976

Total and average initial daily production of new wells in central and southeastern Ohio, 1913–1917, by counties, in barrels.

County.	Total initial production.					Average per well.				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Ashland	20	50	5	10	....	20.0	25.0	5.0	10.0	......
Athens	39	14	42	33	66	2.6	2.0	2.6	2.1	2.1
Belmont	710	318	92	117	61	33.8	21.2	7.7	8.4	6.8
Carroll	62	72	128	133	1,013	3.0	2.5	5.3	7.0	25.3
Columbiana	105	278	93	23	35	3.7	4.8	2.5	1.4	1.8
Coshocton	152	82	....	37	325	10.1	6.3	....	9.3	27.1
Cuyahoga	....	78	215	395	93	....	11.1	16.5	20.8	18.6
Fairfield	1,227	530	97	127	55	27.9	21.2	8.1	9.8	11.0
Guernsey	45	....	....	....	....	4.1	....	....	....	......
Harrison	86	57	35	59	51	4.5	3.4	2.9	4.5	4.3
Hocking	3,638	4,711	3,816	3,261	2,777	46.6	48.6	53.7	34.3	39.1
Holmes	2	....	....	53	55	2.0	....	....	8.8	28.3
Jefferson	218	101	53	181	161	3.6	3.1	3.3	4.6	3.9
Knox	10	....	100	73	265	10.0	....	100.0	14.6	24.1
Licking	857	330	383	372	738	22.6	20.6	23.9	20.7	61.5
Lorain	15	....	....	....	....	15.0	....	....	....	......
Marion	....	....	....	....	10	....	....	....	....	10.0
Medina	....	....	35	60	42	....	....	8.8	20.0	7.0
Monroe	912	348	338	382	133	9.1	6.8	9.4	6.4	4.0
Morgan	454	361	210	98	149	3.2	4.0	3.3	2.8	2.7
Muskingum	107	105	311	1,002	1,602	5.1	7.0	16.4	14.1	20.3
Noble	318	169	93	64	169	5.1	3.8	2.6	2.9	4.0
Perry	4,785	2,806	1,021	2,287	1,832	27.8	25.1	24.9	22.0	17.9
Tuscarawas	....	....	....	4	4	....	....	....	2.0	2.0
Vinton	....	....	96	246	.20	....	....	16.0	9.8	5.0
Washington	1,676	1,307	1,210	1,796	1,634	4.5	5.9	5.0	5.5	6.5
Wayne	864	330	....	25	686	34.6	36.7	....	25.0	36.1
	16,302	12,047	8,373	10,838	11,976	13.1	14.0	12.4	11.7	13.8

Total initial daily production of new wells in central and southeastern Ohio, 1913–1917, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1913	871	1,116	1,241	1,023	1,328	1,282	1,507	1,609	1,559	2,159	1,784	823	16,302	1,359
1914	1,851	1,318	1,541	1,254	1,808	716	943	851	467	651	240	407	12,047	1,004
1915	658	642	493	534	723	777	466	345	782	675	901	1,377	8,373	698
1916	770	696	439	1,355	817	1,163	896	1,066	779	994	897	966	10,838	903
1917	773	934	982	1,204	1,180	1,134	1,398	1,120	1,021	616	1,025	589	11,976	998

NORTHWESTERN DIVISION.

Wells completed in the Lima district, 1913–1917.

County.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Allen	138	71	9	35	26	5	4	.....	2	2	143	75	9	37	28
Auglaize	19	24	4	13	28	7	6	3	10	4	27	30	8	23	35
Champaign	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
Crawford	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1	1
Darke	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
Erie	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	2	.....	.....
Hancock	172	120	36	106	73	20	19	4	5	8	193	144	40	114	84
Hardin	.....	2	.....	.....	.....	.....	2	.....	.....	.....	.....	4	.....	1	.....
Henry	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....
Lucas	29	39	3	5	2	8	3	1	.....	.....	37	42	6	5	2
Marion	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Mercer	40	15	3	51	35	5	2	1	7	8	45	17	4	59	44
Ottawa	24	17	4	25	39	3	.....	.....	.....	2	29	17	5	26	41
Putnam	2	3	.....	.....	.....	.....	.....	.....	1	.....	2	3	.....	1	.....
Sandusky	104	145	27	79	61	5	6	1	5	2	109	152	28	85	63
Seneca	35	23	17	53	30	7	6	6	15	6	43	29	23	68	36
Shelby	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....
Van Wert	38	41	5	33	29	4	2	1	5	5	42	45	6	38	34
Wood	271	263	116	216	148	23	19	7	21	11	298	288	127	240	161
Wyandot	1	.....	.....	.....	1	2	.....	1	.....	1	3	2	3	1	2
Miscellaneous	.....	.....	.....	.....	.....	1	.....	.....	1	.....	1	.....	.....	.....	.....
	873	765	224	616	473	90	69	27	72	52	972	850	261	699	534

[a] Including gas wells.

Oil wells and dry holes drilled in the Lima district in 1917.

County.	Jan.		Feb.		Mar.		Apr.		May.		June.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Allen	3	.....	1	.....	2	1	1	.....	1	.....	3	.....
Auglaize	1	.....	1	.....	4	1	1	.....	2	.....	5	.....
Champaign	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....
Crawford	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....
Darke	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....
Hancock	8	.....	3	.....	2	.....	6	.....	7	1	10	1
Lucas	1	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....
Marion	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mercer	6	.....	2	.....	3	1	1	1	4	3	3	.....
Ottawa	3	.....	6	.....	3	.....	6	.....	5	.....	4	.....
Sandusky	2	.....	2	.....	6	.....	6	1	8	.....	6	1
Seneca	1	.....	1	1	1	1	3	1	3	.....	3	.....
Van Wert	1	.....	1	1	.....	.....	1	1	3	.....	3	.....
Wood	5	.....	8	1	17	3	11	.....	12	.....	12	2
Wyandot	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	31	.....	26	3	38	7	36	5	43	6	40	4

Oil wells and dry holes drilled in the Lima district in 1917—Continued.

County.	July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Allen	3	1	.....	.....	4	.....	4	.....	1	.....	3	.....	26	2
Auglaize	.....	.....	2	1	3	.....	4	.....	3	2	2	.....	28	4
Champaign	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Crawford	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Darke	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Hancock	7	.....	6	2	4	2	5	2	9	.....	6	.....	73	8
Lucas	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....
Marion	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Mercer	1	.....	4	.....	2	2	5	1	1	.....	3	.....	35	8
Ottawa	3	.....	3	.....	2	.....	1	2	2	.....	1	.....	39	2
Sandusky	6	.....	6	.....	5	.....	4	.....	5	.....	5	.....	61	2
Seneca	2	.....	6	.....	3	1	3	1	3	1	1	.....	30	6
Van Wert	2	1	2	2	5	.....	3	.....	6	.....	2	.....	29	5
Wood	17	.....	19	.....	15	2	16	.....	10	.....	6	3	148	11
Wyandot	.....	.....	.....	1	.....	.....	1	.....	.....	.....	.....	.....	1	1
	41	2	48	6	43	7	46	6	40	3	29	3	473	52

Wells completed in the Lima district, 1913–1917.

Month.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
January	48	84	9	27	31	4	5	1	6	.....	53	91	10	34	31
February	39	74	19	21	26	3	6	3	5	3	43	82	24	28	29
March	57	65	12	45	38	8	3	2	2	7	65	70	15	47	46
April	41	63	18	56	36	10	11	2	5	5	52	74	20	62	41
May	70	94	15	57	46	8	10	2	8	6	78	104	18	65	54
June	73	75	13	65	49	6	14	2	8	4	80	89	16	73	54
July	98	75	12	63	41	6	4	6	8	2	107	80	21	71	46
August	102	71	21	72	48	16	4	4	6	6	119	76	25	78	56
September	83	66	22	59	43	13	5	.....	10	7	96	72	22	71	50
October	88	39	21	52	46	8	6	2	5	6	96	49	24	59	52
November	86	25	38	64	40	4	.....	.....	8	3	90	26	39	74	43
December	88	34	24	35	29	4	1	3	1	3	93	37	27	37	32
	873	765	224	616	473	90	69	27	72	52	972	850	261	699	534

[a] Including gas wells.

Initial daily production of new wells completed in the Lima district in 1917, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Allen	37	10	35	8	10	20	45	.....	50	55	20	35	325
Auglaize	35	40	39	15	30	47	.....	27	57	27	26	25	368
Hancock	84	53	40	176	149	109	79	92	91	75	192	165	1,305
Lucas	2	.....	.....	.....	7	.....	.....	.....	.....	.....	.....	.....	9
Marion	.....	10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10
Mercer	113	68	27	3	65	30	9	25	20	85	20	21	486
Ottawa	36	61	18	80	32	21	25	40	30	10	45	10	408
Sandusky	12	9	39	50	65	38	32	44	50	21	24	40	424
Seneca	30	175	15	230	58	215	40	158	24	155	203	40	1,343
Van Wert	3	40	.....	12	55	65	45	22	58	30	70	16	416
Wood	75	86	448	286	111	101	277	404	228	141	77	30	2,264
Wyandot	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	.....	.....	6
	427	552	661	860	582	646	552	812	608	605	677	382	7,364

Total and average initial daily production of new wells in the Lima district, 1913–1917, by counties, in barrels.

County.	Total initial production.					Average per well.				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Allen	1,883	762	120	440	325	13.6	10.7	13.3	12.6	12.5
Auglaize	142	285	25	202	368	7.5	11.9	6.3	15.5	13.1
Hancock	2,924	1,543	422	1,414	1,305	17.0	12.9	11.7	13.3	17.9
Hardin	....	61	....	....	....	....	30.5	....	....	....
Henry	....	3	....	....	....	....	3.0	....	....	....
Lucas	373	792	26	39	9	12.9	20.3	8.7	7.8	4.5
Marion	....	....	....	....	10	....	....	....	....	10.0
Mercer	573	183	38	1,084	486	14.4	12.2	12.7	21.3	13.9
Ottawa	148	117	46	265	408	6.2	6.9	11.5	10.6	10.5
Putnam	7	43	....	....	....	3.5	14.3	....	....	....
Sandusky	625	764	106	537	424	6.0	5.3	3.9	6.8	7.0
Seneca	713	713	1,554	1,587	1,343	20.4	31.0	91.4	29.9	44.8
Shelby	....	10	....	....	....	....	10.0	....	....	....
Van Wert	379	530	58	800	416	10.0	12.7	11.6	24.2	14.4
Wood	3,404	3,523	2,101	2,957	2,264	12.6	13.4	18.1	13.7	15.3
Wyandot	10	....	....	....	6	10.0	....	....	....	6.0
	11,181	9,329	4,496	9,325	7,364	12.8	12.2	20.1	15.1	15.6

Total daily initial production of new wells in the Lima district, 1913–1917, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1913	709	439	599	632	871	1,206	1,243	1,414	893	923	1,222	1,025	11,181	932
1914	959	916	1,057	759	967	1,088	1,117	657	697	277	221	614	9,329	777
1915	68	845	178	332	168	287	141	273	700	592	666	246	4,496	375
1916	482	475	742	859	730	980	944	947	759	861	957	589	9,325	777
1917	427	552	661	860	582	646	552	812	608	605	677	382	7,364	614

LIMA-INDIANA OIL FIELD.

GENERAL STATEMENT.

The Lima-Indiana field embraces all areas of oil production in the northwestern part of Ohio and in Indiana. Petroleum in this field is derived from strata belonging to the Ordovician, Silurian, and Carboniferous systems, the principal source being porous dolomitic lenses in the "Trenton" limestone of the Ordovician system. In the detached pools of western Indiana production is derived from the "Corniferous" limestone, of the Devonian system, and from sandstone in the Chester group of the Mississippian series (lower Carboniferous). The occurrence of the oil is in terraces or other minor structures on the flanks of the Cincinnati uplift or simply in porous lenses in limestone strata of uninterrupted dip.

Following the precedent of recent years, broken in the last decade only in 1914, the petroleum marketed from the oil fields of northwestern Ohio and of Indiana registered a decline. The statistics record an output in 1917 of 3,670,293 barrels, a loss of some 234,710 barrels, or 6 per cent, compared with 1916. The advancing market for crude oil in 1917 included all grades of oil produced in the Lima-Indiana field, as a consequence of which the average price per barrel received at the wells increased from $1.57 in 1916 to $1.94 in 1917, and the market value of the diminished output—$7,102,326—was nearly a million dollars greater than that of the output in 1916. Scarcity of drilling materials together with the proximity of the old Lima-Indiana districts to the more promising territory in Kentucky resulted in decreased activity in drilling in the Trenton rock fields. In 1917 there were 800 new wells drilled in northwestern Ohio and in Indiana, compared with 965 in 1916. Of these 647 produced an average of 19 barrels of oil each on the first day of productive life, 18 produced gas only, and 135, an average of 1 in 6, were failures.

PETROLEUM MARKETED.

Petroleum marketed in the Lima-Indiana field in 1916 and 1917, in barrels.

Month.	1916			1917		
	Lima, Ohio.	Indiana.	Total.	Lima, Ohio.	Indiana.	Total.
January	247,491	57,063	304,554	250,916	64,259	315,175
February	252,535	60,731	313,266	208,869	54,593	263,462
March	287,652	61,260	348,912	273,073	62,038	335,111
April	271,492	63,195	334,687	250,248	59,497	309,745
May	287,382	69,660	357,042	270,702	67,327	338,029
June	277,206	69,725	346,931	266,356	63,306	329,662
July	265,272	66,191	331,463	252,166	65,120	317,286
August	269,449	72,841	342,290	253,704	65,527	319,231
September	250,038	67,462	317,500	223,100	62,992	286,092
October	260,332	65,937	326,269	244,957	70,282	315,239
November	248,223	57,596	305,819	231,764	67,808	299,572
December	218,895	57,375	276,270	185,006	56,683	241,689
	3,135,967	769,036	3,905,003	2,910,861	759,432	3,670,293

Petroleum marketed in the Lima-Indiana field since 1886.

Year.	Quantity. (barrels).	Percentage of total production.	Increase or decrease.		Value.	Yearly average price per barrel.
			Barrels.	Per cent.		
1886	1,137,869	4.06	....	....	$444,198	$0.390
1887	4,650,375	16.44	+3,512,506	+308.69	953,327	.205
1888	9,682,683	35.07	+5,032,308	+108.21	1,452,402	.150
1889	12,186,564	34.66	+2,503,881	+ 25.86	1,833,859	.150
1890	15,078,378	32.91	+2,891,814	+ 23.73	4,536,927	.301
1891	17,452,612	32.15	+2,374,234	+ 15.75	5,333,797	.306
1892	15,867,575	31.41	−1,585,037	− 9.08	5,814,629	.366
1893	15,982,097	33.00	+ 114,522	+ .75	7,497,597	.469
1894	17,296,510	35.05	+1,314,413	+ 8.22	8,306,025	.480
1895	20,236,741	38.26	+2,940,231	+ 17.00	14,184,256	.700
1896	25,255,870	41.43	+5,019,129	+ 24.80	16,678,028	.660
1897	22,805,033	37.71	−2,450,837	− 9.70	10,848,097	.476
1898	20,321,323	36.71	−2,483,710	− 10.89	12,458,904	.613
1899	20,225,356	35.44	− 95,967	− .47	18,082,723	.894
1900	21,758,750	34.20	+1,533,394	+ 7.58	21,367,287	.982
1901	21,933,379	31.61	+ 174,629	+ .80	18,734,438	.854
1902	23,358,626	26.31	+1,425,247	+ 6.50	20,810,694	.890
1903	24,080,264	23.97	+ 721,638	+ 3.09	27,825,466	1.155
1904	24,689,184	21.09	+ 608,920	+ 2.53	26,970,803	1.092
1905	22,294,171	16.55	−2,395,013	− 9.70	19,466,901	.873
1906	17,554,661	13.88	−4,739,510	− 21.26	15,927,707	.907
1907	13,121,094	7.90	−4,433,567	− 25.26	11,962,410	.912
1908	10,032,305	5.62	−3,088,789	− 23.54	10,065,768	1.003
1909	8,211,443	4.48	−1,820,862	− 18.15	7,449,107	.907
1910	7,253,861	3.46	− 957,582	− 11.66	5,750,104	.793
1911	6,231,164	2.83	−1,022,697	− 14.10	5,116,954	.821
1912	[a] 4,925,906	2.21	−1,305,258	− 20.95	4,794,784	.932
1913	4,773,138	1.93	− 152,768	− 3.10	6,588,068	1.380
1914	5,062,543	1.90	+ 289,405	+ 6.07	5,983,356	1.182
1915	4,269,591	1.52	− 792,952	− 15.66	4,114,228	.964
1916	3,905,003	1.298	− 364,588	− 8.54	6,117,269	1.567
1917	3,670,293	1.09	− 234,710	− 6.01	7,102,326	1.935
	445,304,362	10.48	....	....	334,572,439	.737

[a] Includes production of Michigan.

Petroleum marketed in the Lima-Indiana field in 1916 and 1917, by districts.

District.	Quantity (barrels).		Decrease.	
	1916	1917	Barrels.	Per cent.
Lima, Ohio	3,135,967	2,910,861	225,106	7.18
Indiana	769,036	759,432	9,604	1.25
	3,905,003	3,670,293	234,710	6.01

Petroleum marketed, value, and average price per barrel in the Lima-Indiana field, 1908–1917.

Year.	Lima, Ohio.			Indiana.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1908	6,748,676	$6,861,885	$1.016	3,283,629	$3,203,883	$0.976	10,032,305	$10,065,768	$1.003
1909	5,915,357	5,451,497	.921	2,296,086	1,997,610	.870	8,211,443	7,449,107	.907
1910	5,094,136	4,181,629	.821	2,159,725	1,568,475	.726	7,253,861	5,750,104	.793
1911	4,535,875	3,888,119	.857	1,695,289	1,228,835	.725	6,231,164	5,116,954	.821
1912	[a] 3,955,897	3,908,809	.988	970,009	885,975	.913	4,925,906	4,794,784	.932
1913	3,817,043	5,308,842	1.391	956,095	1,279,226	1.337	4,773,138	6,588,068	1.380
1914	3,727,087	4,435,314	1.190	1,335,456	1,548,042	1.159	5,062,543	5,983,356	1.182
1915	3,393,833	3,300,833	.973	875,758	813,395	.929	4,269,591	4,114,228	.964
1916	3,135,967	4,909,704	1.566	769,036	1,207,565	1.570	3,905,003	6,117,269	1.567
1917	2,910,861	5,631,778	1.935	759,432	1,470,548	1.936	3,670,293	7,102,326	1.935

[a] Includes production of Michigan.

Petroleum marketed in the Lima-Indiana field, 1913–1917, in barrels.

Month.	1913	1914	1915	1916	1917
January	409,902	451,053	353,827	304,554	315,175
February	346,167	326,355	360,140	313,266	263,462
March	336,321	463,922	388,034	348,912	335,111
April	427,768	465,415	396,458	334,687	309,745
May	411,245	457,749	358,944	357,042	338,029
June	390,532	460,915	374,312	346,931	329,662
July	401,394	458,553	364,167	331,463	317,286
August	391,953	429,468	341,894	342,290	319,231
September	400,905	422,501	339,008	317,500	286,092
October	424,560	420,495	344,964	326,269	315,239
November	394,534	363,741	319,644	305,819	299,572
December	437,857	342,376	328,199	276,270	241,689
	4,773,138	5,062,543	4,269,591	3,905,003	3,670,293

Average daily output of petroleum in the Lima-Indiana field, 1913–1917, in barrels.

Month.	1913	1914	1915	1916	1917
January	13,223	14,550	11,414	9,824	10,167
February	12,363	11,656	12,862	10,802	9,409
March	10,849	14,965	12,517	11,255	10,810
April	14,259	15,514	13,215	11,156	10,325
May	13,266	14,766	11,579	11,518	10,904
June	13,017	15,364	12,477	11,564	10,989
July	12,948	14,792	11,747	10,692	10,234
August	12,644	13,854	11,029	11,042	10,298
September	13,364	14,083	11,300	10,583	9,536
October	13,695	13,564	11,128	10,525	10,167
November	13,151	12,125	10,655	10,194	9,986
December	14,124	11,044	10,587	8,912	7,796
Average	13,077	13,870	11,698	10,669	10,052

PIPE-LINE RUNS, DELIVERIES, AND STOCKS.

Pipe-line runs in the Lima-Indiana field in 1916 and 1917, in barrels.

Month.	Buckeye pipe line.	Other Ohio lines.	Indiana pipe line.	Other Indiana lines.	Total.
1916					
January	163,324	84,167	21,395	35,668	304,554
February	164,918	87,617	25,325	35,406	313,266
March	188,137	99,515	20,839	40,421	348,912
April	175,247	96,245	25,015	38,180	334,687
May	191,018	96,364	26,809	42,851	357,042
June	185,400	91,806	25,243	44,482	346,931
July	176,591	88,681	24,541	41,650	331,463
August	180,703	88,746	25,102	47,739	342,290
September	167,323	82,715	22,058	45,404	317,500
October	172,535	87,797	22,969	42,968	326,269
November	162,120	86,103	17,435	40,161	305,819
December	147,564	71,331	16,971	40,404	276,270
	2,074,880	1,061,087	273,702	495,334	3,905,003
1917					
January	169,642	81,274	21,668	42,591	315,175
February	138,895	69,974	17,692	36,901	263,462
March	185,901	87,172	18,516	43,522	335,111
April	164,303	85,945	20,676	38,821	309,745
May	181,347	89,355	21,259	46,068	338,029
June	172,361	93,995	20,250	43,056	329,662
July	167,428	84,738	20,403	44,717	317,286
August	170,026	83,678	19,583	45,944	319,231
September	146,793	76,307	17,181	45,811	286,092
October	164,157	80,800	18,507	51,775	315,239
November	152,932	78,832	15,326	52,482	299,572
December	122,129	62,877	13,463	43,220	241,689
	1,935,914	974,947	224,524	534,908	3,670,293

Pipe-line runs and deliveries to trade of Lima-Indiana oil and stocks at end of each month in 1916 and 1917, in barrels.

Month.	1916			1917		
	Runs.	Deliveries.	Stocks.	Runs.	Deliveries.	Stocks.
Dec. 31, 1915	....	....	2,918,648	....	....	....
January	304,554	522,760	2,700,442	315,175	126,898	2,276,642
February	313,266	501,541	2,512,167	263,462	201,433	2,338,671
March	348,912	538,145	2,322,934	335,111	184,229	2,489,553
April	334,687	544,326	2,113,295	309,745	401,993	2,397,305
May	357,042	355,413	2,114,924	338,029	477,885	2,257,449
June	346,931	344,493	2,117,362	329,662	419,953	2,167,158
July	331,463	192,819	2,256,006	317,286	355,425	2,129,019
August	342,290	209,615	2,388,681	319,231	388,873	2,059,377
September	317,500	346,268	2,359,913	286,092	435,522	1,909,947
October	326,269	516,989	2,169,193	315,239	304,582	1,920,604
November	305,819	412,090	2,062,922	299,572	238,521	1,981,655
December	276,270	250,827	2,088,365	241,689	317,103	1,906,241
	3,905,003	4,735,286	....	3,670,293	3,852,417	....

PRICES.

Prices of Lima and Indiana petroleum in 1915–1917, per barrel.

1915					1916				1917			
Date.	Lima. North.	Lima. South.	Indiana.	Princeton, Ind.	Date.	Lima.	Indi-Ind.	Princeton, Ind.	Date.	Lima.	Indiana.	Princeton, Ind.
Jan. 1	$0.93	$0.88	$0.88	$0.89	Jan. 1	$1.33	$1.18	$1.47	Jan. 1	$1.58	$1.43	$1.62
Feb. 16	.88	.83	.83	.84	Jan. 3	1.43	1.28	1.57	Jan. 2	1.58	1.53	1.72
Feb. 19	....	....	.78	....	Jan. 22	1.48	1.33	....	Jan. 8	1.78	1.63	1.82
Aug. 12	....	....	....	.89	Jan. 27	1.53	1.38	1.62	Jan. 27	....	1.68	....
Aug. 20	.93	.88	....	.94	Feb. 7	1.58	1.43	....	Jan. 30	1.83	1.73	1.87
Aug. 23	.98	.93	.83	.99	Feb. 16	....	....	1.72	Apr. 16	1.88	1.78	1.92
Aug. 30	....	.98	....	....	Mar. 7	1.63	1.48	....	May 15	....	....	2.18
Sept. 4	1.03		.88	1.04	Mar. 16	1.73	1.58	1.82	Aug. 16	2.08	1.98	2.12
Sept. 15	1.08		.93	1.09	July 28	1.63	1.48	1.72				
Sept. 27	....		....	1.12	Aug. 1	1.58	1.43	1.60				
Oct. 5	....		....	1.17	Aug. 4	1.48	1.33	1.52				
Oct. 23	1.13		.98	1.27	Aug. 14	1.43	1.28	1.47				
Nov. 15	1.18		1.03	1.32	Nov. 18	1.48	1.33	1.52				
Nov. 17	1.23		1.08	1.37	Dec. 13	1.53	1.38	1.57				
Dec. 3	1.28		1.13	1.42	Dec. 19	1.58	1.43	1.62				
Dec. 15	1.33		1.18	1.47								

Average monthly prices of Lima and Indiana petroleum in 1915, 1916, and 1917, per barrel.

Month.	1915				1916			1917		
	Lima. North.	Lima. South.	Indiana.	Princeton, Ind.	Lima.	Indiana.	Princeton, Ind.	Lima.	Indiana.	Princeton, Ind.
January	$0.93	$0.88	$0.88	$0.89	$1.45	$1.30	$1.57	$1.75	$1.62	$1.79
February	.91	.86	.84	.87	1.57	1.42	1.67	1.83	1.73	1.87
March	.88	.83	.78	.84	1.67	1.52	1.77	1.83	1.73	1.87
April	.88	.83	.78	.84	1.73	1.58	1.82	1.86	1.76	1.90
May	.88	.83	.78	.84	1.73	1.58	1.82	1.88	1.78	2.06
June	.88	.83	.78	.84	1.73	1.58	1.82	1.88	1.78	2.18
July	.88	.83	.78	.84	1.72	1.57	1.81	1.88	1.78	2.18
August	.91	.86	.79	.90	1.46	1.31	1.50	1.98	1.88	2.15
September	1.05	1.03	.90	1.07	1.43	1.28	1.47	2.08	1.98	2.12
October	1.09	1.06	.94	1.19	1.43	1.28	1.47	2.08	1.98	2.12
November	1.18	1.18	1.03	1.32	1.45	1.30	1.49	2.08	1.98	2.12
December	1.30	1.30	1.15	1.44	1.53	1.38	1.57	2.08	1.98	2.12
Average	.98	.94	.87	.99	1.58	1.43	1.67	1.93	1.83	2.04
Average of North Lima and South Lima and Indiana	0.93				1.51			1.98		

Highest, lowest, and average prices of Lima (Ohio) petroleum, 1908–1917, per barrel.

Year.	Highest.	Lowest.	Average.	Year.	Highest.	Lowest.	Average.
1908	[a] $1.04	[b] $0.89	$1.001	1913	[a] $1.49	[b] $1.20	$1.375
1909	[a] 1.04	[b] .79	.906	1914	[a] 1.49	[b] .88	1.17
1910	[a] .84	[b] .77	.804	1915	[a b] 1.33	[b] .88	.96
1911	[a] .84	[b] .77	.801	1916	[a b] 1.73	[a b] 1.33	1.51
1912	[a] 1.25	[b] .79	.998	1917	[a b] 2.08	1.58	1.98

[a] North Lima. [b] South Lima.

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade-journal sources and differ somewhat from those on pages 698–699, which are obtained from reports received directly from the oil producers:

Wells completed in the Lima-Indiana field, 1913–1917.

District.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Lima	873	765	224	616	473	90	69	27	72	52	972	850	261	699	534
Indiana	213	470	98	160	174	86	259	86	98	83	311	742	192	266	266
	1,086	1,235	322	776	647	176	328	113	170	135	1,283	1,592	453	965	800

[a] Including gas wells.

Oil wells and dry holes drilled in the Lima-Indiana field in 1917.

District.	Jan.		Feb.		Mar.		Apr.		May.		June.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Lima	31	......	26	3	38	7	36	5	46	6	49	4
Indiana	6	4	6	3	14	1	13	7	11	9	15	9
	37	4	32	6	52	8	49	12	57	15	64	13

District.	July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
	Oil.	Dry	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Lima	41	2	48	6	43	7	46	6	40	3	29	3	473	52
Indiana	18	11	13	7	14	6	29	10	20	8	15	8	174	83
	59	13	61	13	57	13	75	16	60	11	44	11	647	135

Wells completed in the Lima-Indiana field, 1913–1917.

Month.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
January	51	120	14	36	37	6	22	10	12	4	58	145	24	50	42
February	48	119	29	30	32	3	31	5	12	6	52	153	38	45	40
March	70	107	23	58	52	11	33	5	13	8	82	144	30	73	61
April	45	107	29	65	49	10	38	9	18	12	57	145	38	84	61
May	87	168	22	79	57	10	37	9	22	15	97	208	32	102	75
June	89	154	19	87	64	11	48	10	18	13	102	202	30	105	79
July	112	129	20	78	59	13	30	16	18	13	129	162	40	96	75
August	130	111	23	86	61	22	26	10	13	13	156	139	34	99	78
September	101	89	27	74	57	28	25	12	15	13	129	115	41	92	70
October	115	49	27	68	75	23	13	8	7	16	140	67	36	77	91
November	120	33	48	73	60	15	11	13	16	11	137	47	62	92	73
December	118	49	41	42	44	24	14	6	6	11	144	65	48	50	55
	1,086	1,235	322	776	647	176	328	113	170	135	1,283	1,592	453	965	800

[a] Including gas wells.

Initial daily production of new wells completed in the Lima-Indiana field in 1917, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Lima	427	552	661	860	582	646	552	812	608	605	677	382	7,364
Indiana	173	106	281	303	432	546	493	344	453	762	430	591	4,914
	600	658	942	1,163	1,014	1,192	1,045	1,156	1,061	1,367	1,107	973	12,278

Total and average initial daily production of new wells in the Lima-Indiana field, 1913–1917, by districts, in barrels.

District.	Total initial production.					Average per well.				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Lima	11,181	9,329	4,496	9,325	7,364	12.8	12.2	20.1	15.1	15.6
Indiana	7,393	8,436	2,564	3,554	4,914	34.7	18.0	26.2	22.2	28.2
	18,574	17,765	7,060	12,879	12,278	17.1	14.4	21.9	16.6	19.0

Total initial daily production of new wells in the Lima-Indiana field, 1913–1917, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1913	774	710	926	855	1,426	1,673	1,627	1,851	1,654	2,389	2,652	2,037	18,574	1,548
1914	1,636	2,129	2,187	1,859	1,944	2,245	1,928	1,067	969	431	372	898	17,765	1,480
1915	130	960	329	502	305	512	269	288	829	919	1,109	908	7,060	588
1916	778	657	1,034	1,007	1,218	1,594	1,226	1,164	1,295	1,132	1,162	702	12,879	1,073
1917	600	658	942	1,163	1,014	1,192	1,045	1,156	1,061	1,367	1,107	973	12,278	1,023

Oil wells abandoned in the Lima-Indiana field from June, 1905, to December, 1917, by months.

Month.	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	Total.
January	.....	54	45	75	149	61	62	59	17	7	50	13	72	664
February	.....	74	83	59	108	66	21	34	21	4	31	28	14	543
March	.....	27	49	129	237	221	114	28	13	30	86	24	123	1,081
April	.....	47	129	198	98	140	31	86	47	23	55	5	100	959
May	.....	100	194	358	204	457	233	83	37	74	88	7	50	1,585
June	28	82	143	207	347	146	118	122	101	52	63	104	148	1,661
July	53	50	111	191	157	176	141	75	17	82	34	26	37	1,150
August	54	147	170	228	322	126	122	102	71	100	34	15	116	1,607
September	19	87	157	195	267	294	79	117	127	64	33	54	112	1,605
October	158	139	181	144	201	80	137	66	142	59	18	161	72	1,558
November	53	139	177	155	172	100	160	158	38	176	63	80	51	1,522
December	66	117	62	220	156	128	41	80	40	29	59	.....	72	1,070
Total, Indiana	431	1,063	1,501	2,159	2,418	1,695	1,259	1,010	671	700	614	517	967	15,005
Total, Lima	674	1,059	1,357	1,135	1,127	1,500	1,142	856	601	486	664	668	1,245	12,514
Total, Lima-Indiana	1,105	2,122	2,858	3,294	3,545	3,195	2,401	1,866	1,272	1,186	1,278	1,185	2,212	27,519

Oil wells abandoned in the Lima-Indiana field, June, 1905, to Dec. 31, 1917, by counties.

Lima.		Indiana.	
County.	Number of wells.	County.	Number of wells.
Allen	2,605	Adams	1,206
Auglaize	890	Blackford	1,433
Darke	4	Delaware	1,414
Hancock	1,563	Gibson	19
Lucas	577	Grant	4,419
Mercer	556	Hamilton	9
Ottawa	345	Huntington	1,017
Putnam	25	Jay	946
Sandusky	1,068	Knox	12
Seneca	119	Madison	87
Shelby	10	Marion	15
Van Wert	832	Miami	49
Wood	3,582	Pike	36
Wyandot	338	Randolph	219
		Sullivan	1
		Wabash	16
		Wells	4,107
	12,514		15,005

INDIANA.

GENERAL STATEMENT.

The production of 759,432 barrels of crude petroleum in Indiana in 1917 was less by 9,604 barrels, or a little more than 1 per cent, than the output in 1916. The number of new wells completed was 266, the same as in 1916, but the number of oil wells brought in was 174, or 14 more than in 1916, and the average yield—28 barrels per well for the first day of productive life—was 6 barrels greater than the average for 1916.

In the old Trenton rock districts in the eastern part of Indiana activity in drilling was sustained in 1917 by the completion of a number of new wells with initial capacities above the average for these districts in the vicinity of Camden, Jay County, where wells of large capacity featured the primary development years ago; by the discovery in Monroe Township, Allen County, of an important northward extension of the old Geneva district; and by the fair degree of success that attended a revival of activity in drilling in the old Peru district in Miami County. In western Indiana the usual activity prevailed in Sullivan, Gibson, and Pike counties, and in the last-named county new territory of promise for both oil and gas was opened in Washington Township, a few miles west of Petersburg.

PETROLEUM MARKETED.

Petroleum marketed in Indiana, 1913–1917, in barrels.

Month.	1913	1914	1915	1916	1917
January	73,237	109,891	82,390	57,063	64,259
February	70,336	97,045	85,690	60,731	54,593
March	57,204	120,508	76,939	61,260	59,497
April	78,764	126,670	82,683	63,195	62,038
May	77,379	128,493	75,922	69,660	67,327
June	73,056	129,855	78,934	69,725	63,306
July	73,838	121,122	72,189	66,191	65,120
August	72,467	109,939	66,452	72,841	65,527
September	81,462	110,299	62,010	67,462	62,902
October	91,368	105,969	66,332	65,937	70,282
November	98,444	88,272	58,447	57,596	67,808
December	108,540	87,393	67,770	57,375	56,683
	956,095	1,335,456	875,758	769,036	759,432

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade-journal sources and differ somewhat from those on page 699, which are obtained from reports received directly from the oil producers:

Wells completed in Indiana, 1913–1917.

County.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Adams	8	4									8	4			
Allen					8										8
Blackford	9	1		3	1	2			3	1	11	3		6	2
Clay								1					1		
Daviess	1		1	2				3			1		4	2	
Decatur														1	
Delaware	47	24	1	1	1	8	8			2	55	32	2	1	3
Dubois							1					1			
Gibson	18	3	4	14	21	1		5	5	7	19	3	9	19	33
Grant	1	3		3	3	1		1			4	4	1	3	3
Harrison		2										2			
Huntington										1					1
Jay	27	14	1	2	17	6	4		2	21	33	21	2	4	38
Knox			1		2	1	6	5		1	2	6	6		3
Madison										1					1
Martin							1					1			
Miami				6	12	1	2		4	3	1	2		10	15
Pike	11	6	9	38	75	5	8	12	28	24	20	14	22	69	103
Putnam								1					1		
Randolph	8	4	1	1	1	3	1		2	3	11	7	2	3	4
Shelby		4	1									4	1		
Spencer				1					1					2	
Sullivan	75	400	66	79	33	52	219	52	49	18	132	624	122	132	51
Vigo		3	13	8			2	4	3			5	17	11	
Wabash		1								1		1			1
Warrick								2	1				2	1	
Wells	5	1		2		1					6	1		2	
Miscellaneous	3					5	7				8	7			
	213	470	98	160	174	86	259	86	98	83	311	742	192	266	266

[a] Including gas wells.

Oil wells and dry holes drilled in Indiana in 1917.

County.	January.		February.		March.		April.		May.		June.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Allen							1		2			
Blackford												1
Delaware												
Gibson			1				2		1		4	1
Grant											1	
Huntington												
Jay	1	1			4		1	1		3	3	3
Knox	1								1			
Madison								1				
Miami	1						3					
Pike	3	2	3	1	7	1	5	2	5	4	5	2
Randolph								1				1
Sullivan		1	2	2	3		1	1	2	2	2	1
Wabash								1				
	6	4	6	3	14	1	13	7	11	9	15	9

County.	July.		August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Allen	2				1				2				8	
Blackford							1						1	1
Delaware							1	1				1	1	2
Gibson	1	2	2	2	3	1	2	1	3		2		21	7
Grant	1						1						3	
Huntington								1						1
Jay	1	5	1				5	2		6	1		17	21
Knox				1									2	1
Madison														1
Miami	2		2	1			3	2	1				12	3
Pike	8	2	7	1	8	3	11	1	6	1	7	4	75	24
Randolph			1									1	1	3
Sullivan	3	2		2	2	2	5	2	8	1	5	2	33	18
Wabash														1
	18	11	13	7	14	6	29	10	20	8	15	8	174	83

Wells completed in Indiana, 1913–1917.

Month.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
January	3	36	5	9	6	2	17	9	6	4	5	54	14	16	11
February	9	45	10	9	6		25	2	7	3	9	71	14	17	11
March	13	42	11	13	14	3	30	3	11	1	17	74	15	26	15
April	4	44	11	9	13		27	7	13	7	5	71	18	22	20
May	17	74	7	22	11	2	27	7	14	9	19	104	14	37	21
June	16	79	6	22	15	5	34	8	10	9	22	113	14	32	25
July	14	54	8	15	18	7	26	10	10	11	22	82	19	25	29
August	28	40	2	14	13	6	22	6	7	7	37	63	9	21	22
September	18	23	5	15	14	15	20	12	5	6	33	43	19	21	20
October	27	10	6	16	29	15	7	6	2	10	44	18	12	18	39
November	34	8	10	9	20	11	11	13	8	8	47	21	23	18	30
December	30	15	17	7	15	20	13	3	5	8	51	28	21	13	23
	213	470	98	160	174	86	259	86	98	83	311	742	192	266	266

[a] Including gas wells.

Initial daily production of new wells completed in Indiana in 1917, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Allen	......	......	......	5	119	......	70	......	10	......	85	......	289
Blackford	......	......	......	......	......	......	......	......	......	5	......	......	5
Delaware	......	......	......	......	......	......	......	......	......	75	......	......	75
Gibson	......	15	......	91	60	175	50	55	220	90	140	155	1,051
Grant	......	......	......	......	......	1	2	......	......	4	......	......	7
Jay	15	......	123	15	......	220	40	40	......	65	......	60	578
Knox	60	......	......	......	75	......	......	......	......	......	......	......	135
Miami	5	......	......	88	......	......	6	3	......	12	2	......	116
Pike	93	61	102	100	91	120	295	226	173	186	86	138	1,671
Randolph	......	......	......	......	......	......	......	20	......	......	......	......	20
Sullivan	......	30	56	4	87	30	30	......	50	325	117	238	967
	173	106	281	303	432	546	493	344	453	762	430	591	4,914

Total and average initial daily production of new wells in Indiana, 1913–1917, by counties, in barrels.

County.	Total initial production.					Average per well.				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Adams	73	43	....	....	....	9.1	10.8	....	....	......
Allen	....	....	....	....	289	....	....	....	....	36.1
Blackford	46	3	....	35	5	5.1	3.0	....	11.7	5.0
Daviess	10	....	15	30	....	10.0	....	15.0	15.0	......
Delaware	1,765	545	5	5	75	37.6	22.7	5.0	5.0	75.0
Gibson	332	9	28	155	1,051	18.4	3.0	7.0	11.1	50.0
Grant	5	27	....	23	7	5.0	9.0	....	7.7	2.3
Harrison	....	10	....	....	....	....	5.0	....	....	......
Jay	423	167	4	145	578	15.7	11.9	4.0	72.5	34.0
Knox	....	....	1	....	135	....	....	1.0	....	67.5
Miami	....	....	....	87	116	....	....	....	14.5	9.8
Pike	202	136	204	872	1,671	18.4	22.7	22.7	22.9	22.3
Randolph	395	80	2	150	20	49.4	20.0	2.0	150.0	20.0
Shelby	....	50	10	....	....	....	12.5	10.0	....	......
Spencer	....	....	....	4	....	....	....	....	4.0	......
Sullivan	4,032	7,294	1,750	1,862	967	53.8	18.2	26.5	23.6	39.3
Vigo	....	50	545	168	....	....	16.7	41.9	21.0	......
Wabash	....	20	....	....	....	....	20.0	....	....	......
Wells	50	2	....	18	....	10.0	20.0	....	9.0	......
Miscellaneous	60	....	....	....	....	20.0	....	....	....	......
	7,393	8,436	2,564	3,554	4,914	34.8	18.0	26.2	22.2	28.2

Total initial daily production of new wells in Indiana, 1913–1917, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1913	65	271	327	223	555	467	384	437	756	1,466	1,430	1,012	7,393	616
1914	677	1,213	1,130	1,100	977	1,257	811	410	272	154	151	284	8,436	703
1915	62	115	151	170	137	225	128	15	129	327	443	662	2,564	214
1916	296	182	292	148	488	524	282	217	536	271	205	113	3.554	296
1917	173	106	281	303	432	546	493	344	453	762	430	591	4,914	410

ILLINOIS OIL FIELD.

GENERAL STATEMENT.

The Illinois field lies wholly within the State of the same name and includes the principal area of oil production along the La Salle anticline in the southeastern part of the State as well as a number of scattered pools of small individual extent in the central and western parts of the State. The oil in this field ranges in gravity from 28°

to 40° Baumé, contains varying proportions of both asphalt and paraffin, and is obtained for the most part from sandstone layers in formations belonging to the Pennsylvanian and Mississippian series of the Carboniferous system. This field has been an important contributor to the petroleum supply of the United States since 1906, its output in 1908 reaching a maximum of nearly 34,000,000 barrels. Since that year, its production has declined at an average rate of 6 per cent a year, amounting in 1916 to about 53 per cent of the maximum.

Final statistics of petroleum production in Illinois in 1917 credit that State with an output of 15,776,860 barrels and indicate a decrease of 11 per cent from the output in 1916. Although no new productive territory of consequence has been discovered in Illinois in several years the rate of decline in production charged to the oil fields of that State in 1917 is nearly double that in other recent years. This great decline is due in considerable measure to the fact that only 646 new wells were completed in the State in 1917, compared with 1,461 in 1916 and with 757 in 1915, when prices of Illinois oil were less than half as great as they were in 1917. The decided slump in activity in drilling in 1917 was caused by the increase in the cost of material and labor and the abundance of more attractive territory in Kentucky and Kansas. The average price received at the wells for the oil produced in Illinois in 1917 was $1.99, a gain of 34 cents, or 21 per cent, compared with 1916, and a gain of $1.01, or 103 per cent, compared with 1915. Though the output was less in 1917 its value—$31,358,069—was 7 per cent greater than that of the output in 1916.

DEVELOPMENT.

Of 646 new wells completed in 1917 in the oil fields of Illinois, 488 were oil wells credited with an average yield of 21 barrels each on the first day of productive life, 9 were gas wells, and 149, an average of 3 in every 13 drilled, were failures. These wells were distributed over 13 counties, mainly in the southeastern part of the State, along the La Salle anticline. In the "shallow sand" area on this anticline a little new territory was opened in 1917 near Warrington, in the southern part of Embarrass Township, Edgar County, north of the old Casey-Westfield district. In the "deep sand" area a little additional territory, in section 24, Robinson Township, Crawford County, overlooked in the primary development of that locality, proved productive of oil. Wabash County, at the south end of the "deep sand" territory, was the only county in the State that failed to show a decided slump in field activity. Twenty-eight wells, a decrease of only one well compared with 1916, were completed in that county in 1917. Of these wells, 12 produced an average of 87 barrels of oil each on the first day of their productive life and the remaining 16 were barren. With the exception of one well, completed in November on the farm of A. B. Toney, in sec. 13, Friendsville Township, and credited with an initial yield of 40 barrels from a depth of 1,628 feet, all the oil wells drilled in Wabash County in 1917 were in the Allendale district, Wabash Township. In the scattered districts of central and western Illinois outside the proved areas the activity in drilling was much less than usual and but little wildcat drilling was attempted. In Macoupin County a new gas field was indicated in

Brushy Mound Township by the completion of one gas well in March, 1917, on the Spanish Needle Creek dome, about 12 miles north of the gas field opened on the Staunton dome in Dorchester Township, in 1915. Development in the Colmar district, McDonough County, in the western part of the State, was featureless, and the productive area was conceded to be practically drilled.

Unsuccessful wildcat tests were completed in southern Illinois in 1917 near Stonefort, Saline County, and near Duquoin, Perry County.

PETROLEUM MARKETED.

Petroleum marketed in Illinois, 1889–1917.

Year.	Quantity (barrels).	Percentage of total production.	Increase or decrease.		Value.	Yearly average price per barrel.
			Barrels.	Per cent.		
1889	1,460	....	....	....	$4,906	$3.360
1890	900	....	− 560	− 38.36	3,000	3.333
1891	675	....	− 225	− 25.00	2,363	3.500
1892	521	....	− 154	− 22.81	1,823	3.500
1893	400	....	− 121	− 23.22	1,400	3.500
1894	300	....	− 100	− 25.00	1,800	6.000
1895	200	....	− 100	− 33.33	1,200	6.000
1896	250	....	+ 50	+ 25.00	1,250	5.000
1897	500	....	+ 250	+ 100.00	2,000	4.000
1898	360	....	− 140	− 28.00	1,800	5.000
1899	360	....	....	....	1,800	5.000
1900	200	....	− 160	− 44.44	1,000	5.000
1901	250	....	+ 50	+ 25.00	1,250	5.000
1902	200	....	− 50	− 20.00	1,000	5.000
1903	....	....	− 200	− 100.00	....	....
1904	....	....	....	....	....	....
1905	181,084	0.13	+ 181,084	....	116,561	.644
1906	4,397,050	3.47	+ 4,215,966	+2,328.18	3,274,818	.745
1907	24,281,973	14.62	+19,884,923	+ 452.23	16,432,947	.677
1908	33,686,238	18.87	+ 9,404,265	+ 38.73	22,649,561	.672
1909	30,898,330	16.87	− 2,787,899	− 8.28	19,788,864	.640
1910	33,143,362	15.82	+ 2,244,923	+ 7.27	19,669,383	.593
1911	31,317,038	14.21	− 1,826,224	− 5.51	19,734,339	.639
1912	28,601,308	12.83	− 2,715,730	− 8.67	24,332,605	.851
1913	23,893,899	9.62	− 4,707,409	− 16.45	30,971,910	1.296
1914	21,919,749	8.25	− 1,974,150	− 8.26	25,426,179	1.160
1915	19,041,695	6.77	− 2,878,054	− 13.13	18,655,850	.980
1916	17,714,235	5.89	− 1,327,460	− 6.97	29,237,168	1.650
1917	15,776,860	4.71	− 1,937,375	− 10.94	31,358,069	1.988
	284,859,406	6.698	....	....	261,674,846	.919

Petroleum marketed in Illinois, 1913–1917, in barrels.

Month.	1913	1914	1915	1916	1917
January	2,149,264	1,935,492	1,614,026	1,373,615	1,433,901
February	1,859,412	1,570,790	1,542,383	1,330,016	1,197,218
March	2,008,245	1,969,915	1,761,099	1,552,827	1,433,513
April	2,015,058	1,833,099	1,643,479	1,396,454	1,308,431
May	2,117,425	1,970,688	1,638,733	1,572,217	1,424,684
June	2,003,278	1,932,303	1,603,733	1,527,589	1,336,263
July	2,075,444	1,907,521	1,636,932	1,540,887	1,369,464
August	2,001,228	1,844,983	1,593,436	1,561,066	1,365,871
September	1,942,052	1,817,437	1,535,040	1,467,892	1,264,595
October	1,982,002	1,813,364	1,533,972	1,522,930	1,306,136
November	1,819,116	1,678,783	1,452,285	1,454,302	1,246,410
December	1,921,375	1,645,374	1,486,577	1,414,440	1,090,374
	23,893,899	21,919,749	19,041,695	17,714,235	15,776,860

Average daily output of petroleum in Illinois, 1913–1917, in barrels.

Month.	1913	1914	1915	1916	1917
January	69,331	62,435	52,065	44,310	46,255
February	66,407	56,100	55,085	45,863	42,758
March	64,782	63,546	56,810	50,091	46,242
April	67,169	61,103	54,783	46,548	43,614
May	68,304	63,570	52,862	50,717	45,956
June	66,776	64,410	53,458	50,920	45,421
July	66,950	61,533	52,804	49,706	44,176
August	64,556	59,516	51,401	50,357	44,060
September	64,735	60,581	51,168	48,930	42,152
October	63,936	58,496	49,483	49,127	42,133
November	60,637	55,959	48,410	48,477	41,547
December	61,980	53,076	47,954	45,627	35,173
Average	65,463	60,054	52,169	48,400	43,291

PIPE-LINE RUNS, DELIVERIES, AND STOCKS.

Pipe-line runs and deliveries to trade of petroleum from Illinois and stocks at end of each month in 1916 and 1917, in barrels.

Month.	1916			1917		
	Runs.	Deliveries.	Stocks.	Runs.	Deliveries.	Stocks.
Dec. 31, 1915			11,328,014			
January	1,373,615	1,963,561	10,738,008	1,433,901	1,752,485	6,281,388
February	1,330,016	1,862,876	10,205,208	1,197,218	1,549,933	5,928,673
March	1,552,827	2,055,429	9,702,606	1,433,513	1,905,255	5,456,931
April	1,396,454	1,960,662	9,138,398	1,308,431	1,627,553	5,137,809
May	1,572,217	2,228,099	8,482,516	1,424,684	1,705,252	4,857,241
June	1,527,589	1,789,576	8,220,529	1,336,263	1,602,950	4,590,554
July	1,540,887	2,046,827	7,714,589	1,369,464	1,663,765	4,296,253
August	1,561,066	1,811,639	7,464,016	1,365,871	1,538,078	4,124,046
September	1,467,892	1,809,504	7,122,404	1,264,595	1,164,478	4,224,163
October	1,522,930	1,733,451	6,911,883	1,306,136	1,370,148	4,160,151
November	1,454,302	1,591,840	6,774,345	1,246,410	1,258,380	4,148,181
December	1,414,440	1,588,813	6,599,972	1,090,374	1,678,333	3,560,222
	17,714,235	22,442,277		15,776,860	18,816,610	

Pipe-line runs, deliveries, and stocks of the Ohio Oil Co. in 1913–14 and the Illinois Pipe Line Co. in 1915–1917 in Illinois, in barrels.

Pipe-line runs.

Month.	1913	1914	1915	1916	1917
January	1,591,944	1,425,574	1,183,446	936,570	965,686
February	1,348,292	1,148,926	1,119,973	885,070	808,350
March	1,457,711	1,469,331	1,268,446	1,056,212	965,605
April	1,456,551	1,328,430	1,159,393	933,335	870,855
May	1,551,323	1,434,303	1,155,255	1,057,769	956,166
June	1,471,437	1,407,706	1,134,519	1,043,541	892,989
July	1,531,800	1,398,849	1,144,094	1,044,236	911,342
August	1,483,801	1,371,731	1,112,979	1,071,959	903,183
September	1,437,974	1,345,016	1,077,996	1,001,549	836,609
October	1,473,679	1,350,167	1,078,114	1,025,055	856,325
November	1,360,159	1,246,292	1,013,783	976,503	813,024
December	1,420,484	1,222,575	1,016,719	954,199	721,857
	17,585,155	16,148,900	13,464,717	11,985,998	10,501,991

Pipe-line-runs, deliveries, and stocks of the Ohio Oil Co. in 1913–14 and the Illinois Pipe Line Co. in 1915–1917 in Illinois in barrels—Continued.

Deliveries.[a]

Month.	1913	1914	1915	1916	1917
January	1,201,633	936,867	31,910	25,140	26,597
February	1,042,834	1,027,023	26,809	24,406	27,389
March	1,172,522	749,703	24,703	22,729	35,659
April	1,139,433	525,769	23,681	16,768	13,616
May	1,226,625	819,105	30,611	106,715	12,982
June	1,161,667	752,134	16,192	34,618	4,649
July	1,171,492	803,558	15,907	26,437	5,393
August	794,844	474,569	21,252	38,247	11,076
September	1,039,267	594,960	36,565	21,142	7,663
October	1,065,320	630,028	29,727	8,928	162,871
November	810,907	256,567	16,551	13,346	160,090
December	1,204,375	15,090	14,319	20,889	176,627
	13,030,919	7,585,373	288,227	359,365	644,612

Stocks.[b]

Month.	1913	1914	1915	1916	1917
January	11,118,521	5,508,791	3,351,079	4,588,350	2,149,664
February	10,344,393	5,188,339	3,689,625	4,388,169	2,254,353
March	9,935,612	5,627,743	4,460,698	4,275,128	2,167,508
April	9,446,550	6,500,409	5,177,985	3,968,456	2,487,244
May	8,941,584	7,284,952	5,625,562	3,709,265	2,697,491
June	8,054,011	8,035,036	5,763,894	3,500,393	2,486,708
July	7,548,743	8,682,851	4,990,447	2,043,284	2,225,075
August	6,876,978	9,683,090	5,165,511	2,001,292	2,401,052
September	6,416,698	10,473,407	5,083,656	2,191,174	2,389,068
October	5,748,180	11,033,448	4,979,712	2,163,016	2,436,225
November	5,829,018	11,183,664	4,799,585	2,264,739	2,345,844
December	5,551,556	11,390,608	4,611,579	2,098,910	2,195,740

[a] These deliveries are to trade only. Deliveries to other pipe lines are also made.
[b] Stocks include some Indiana petroleum of Illinois grade.

PRICES.

Prices per barrel of Illinois petroleum in 1915–1917.

1915			1916			1917		
Date.	Illinois.	Plymouth.	Date.	Illinois.	Plymouth.	Date.	Illinois.	Plymouth.
Jan. 1	$0.89		Jan. 1	$1.47	$1.33	Jan. 1	$1.62	$1.53
Feb. 16	.84		Jan. 3	1.57		Jan. 2	1.72	
Aug. 13	.89	$0.58	Jan. 21		1.38	Jan. 4		1.63
Aug. 20	.94		Jan. 27	1.62	1.43	Jan. 8	1.82	1.73
Aug. 23	.99		Feb. 16	1.72		Jan. 13		1.83
Sept. 4	1.04		Mar. 6		1.53	Jan. 30	1.87	
Sept. 10		.78	Mar. 13		1.58	Apr. 16	1.92	
Sept. 13		.83	Mar. 16	1.82	1.68	May 15	2.18	2.18
Sept. 15	1.09		July 28	1.72	1.58	Aug. 16	2.12	2.03
Sept. 27	1.12	.93	Aug. 1	1.62	1.48			
Oct. 5	1.17		Aug. 3		1.38			
Oct. 23	1.27		Aug. 4	1.52				
Nov. 15	1.32	1.03	Aug. 14	1.47	1.18			
Nov. 17	1.37	1.13	Aug. 17		1.08			
Dec. 3	1.42		Aug. 28		1.03			
Dec. 14		1.23	Nov. 18	1.52				
Dec. 15	1.47	1.33	Nov. 30		1.13			
			Dec. 13	1.57	1.23			
			Dec. 19	1.62	1.33			
			Dec. 28		1.43			
			Dec. 29		1.53			

Average monthly prices per barrel of Illinois petroleum, 1913–1917.

Month.	1913	1914	1915		1916		1917	
			Illinois.	Plymouth.	Illinois.	Plymouth.	Illinois.	Plymouth.
January	$1.09	$1.45	$0.89	....	$1.57	$1.36	$1.79	$1.76
February	1.21	1.45	.87	....	1.67	1.43	1.87	1.83
March	1.25	1.45	.84	....	1.77	1.60	1.87	1.83
April	1.28	1.41	.84	....	1.82	1.68	1.90	1.83
May	1.30	1.17	.84	....	1.82	1.68	2.06	2.00
June	1.30	1.14	.84	....	1.82	1.68	2.18	2.18
July	1.30	1.12	.84	....	1.81	1.67	2.18	2.18
August	1.30	1.03	.90	$0.58	1.50	1.22	2.15	2.11
September	1.30	.98	1.07	.76	1.47	1.03	2.12	2.03
October	1.30	.91	1.19	.93	1.47	1.03	2.12	2.03
November	1.38	.89	1.32	1.03	1.49	1.03	2.12	2.03
December	1.45	.89	1.44	1.24	1.57	1.26	2.12	2.03
Average	1.288	1.16	.99	.91	1.65	1.39	2.04	1.99

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade-journal sources and differ somewhat from those on page 699, which are obtained from reports received directly from the oil producers:

Wells completed in Illinois, 1913–1917.

County.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Adams								2					2		
Bond							2		2			2		2	
Brown									2					2	
Champaign								2					2		
Clark	169	157	107	218	116	35	62	33	34	21	208	221	141	256	137
Clinton	14	2		11	1	5	2	2	23	8	19	4	2	34	9
Coles	3	16	2	6		3	5	1	5	1	6	21	3	11	1
Crawford	540	542	153	391	199	110	136	54	152	70	669	706	215	569	276
Cumberland	49	22	37	34	25	11	2	4	3	1	61	24	44	40	26
Edgar			3		4			1					4		4
Edwards								1					1		
Fayette									1					1	
Hancock		1		12	4		19	8	10	1		20	8	22	5
Henderson				2					1					3	
Jackson						2		1	1		2		1	1	
Jasper	2	3					2				2	5			
Lawrence	538	294	128	212	113	69	69	28	34	19	663	365	157	246	133
McDonough		138	97	186	14		36	33	25	4		174	130	211	18
Macoupin	3	3	1			6	2	3	3		9	5	10	6	
Madison							1	1				1	1		
Marion	21	6	6	18		1	1		8	5	22	7	6	26	6
Montgomery								3					3		
Perry										1					1
Randolph								1					1		
St.Clair								2					2		
Saline						2	1		1	2	2	1		1	2
Schuyler								17	1				17	1	
Wabash	24	7	5	17	12	24	5	1	12	16	48	12	6	29	28
Washington								1					1		
Miscellaneous						10	11				10	11			
	1,363	1,191	539	1,107	488	278	356	199	318	149	1,721	1,579	757	1,461	646

a Including gas wells.

Oil wells and dry holes drilled in Illinois in 1917.

County.	January.		February.		March.		April.		May.		June.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Clark	7	......	6	2	3	2	9	2	10	1	14	2
Clinton	......	......	......	......	1	......	......	......	......	2	......	......
Coles	......	1	......	......	......	......	......	......	......	......	......	......
Crawford	21	4	17	8	16	4	19	6	19	7	20	5
Cumberland	3	......	......	......	2	......	4	......	7	......	......	......
Edgar	......	......	......	......	......	......	......	......	......	......	1	......
Hancock	3	1	......	......	......	......	......	......	1	......	......	......
Lawrence	13	5	6	5	5	......	6	2	11	......	12	1
McDonough	2	2	......	......	......	......	1	......	1	......	2	......
Marion	......	......	......	......	......	1	......	......	......	2	......	......
Perry	......	......	......	......	......	1	......	......	......	......	......	......
Saline	......	......	......	......	......	2	......	......	......	......	......	......
Wabash	3	1	......	1	......	3	1	2	......	1	1	2
	52	14	29	16	27	13	40	12	49	13	50	10

County.	July.		August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Clark	14	4	22	2	9	1	15	......	5	3	2	2	116	21
Clinton	......	1	......	1	......	2	......	1	......	......	......	1	1	8
Coles	......	......	......	......	......	......	......	......	......	......	......	......	......	1
Crawford	17	8	20	11	10	2	13	5	11	5	13	5	199	70
Cumberland	6	1	......	......	......	......	2	......	......	......	......	......	25	1
Edgar	1	......	1	......	......	......	1	......	......	......	......	......	4	......
Hancock	......	......	......	......	......	......	......	......	......	......	......	......	4	1
Lawrence	12	1	11	......	14	3	8	......	10	......	5	2	113	19
McDonough	3	1	1	......	1	......	......	1	1	......	2	......	14	4
Marion	......	1	......	1	......	......	......	......	......	......	......	......	......	5
Perry	......	......	......	......	......	......	......	......	......	......	......	......	......	1
Saline	......	......	......	......	......	......	......	......	......	......	......	......	......	2
Wabash	1	1	2	......	2	1	......	1	1	2	1	1	12	16
	54	18	58	15	36	9	39	8	31	10	23	11	488	149

Wells completed in Illinois, 1913–1917.

Month.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
January	106	126	31	60	52	23	15	14	27	14	131	148	47	94	66
February	83	103	22	58	29	22	28	13	18	16	107	135	37	82	46
March	71	116	40	87	27	12	18	12	28	13	89	136	53	119	40
April	92	148	43	71	40	13	41	10	21	12	105	191	54	93	54
May	137	116	33	128	49	21	35	18	37	13	159	154	52	169	64
June	112	123	36	141	50	35	52	16	37	10	153	180	54	184	60
July	139	98	47	116	54	28	37	16	26	18	170	138	64	143	73
August	116	98	51	124	58	38	39	19	30	15	156	140	71	156	73
September	145	111	49	113	36	16	28	16	28	9	163	139	66	142	47
October	151	69	56	70	39	31	27	19	30	8	181	98	79	103	48
November	115	48	58	86	31	24	14	25	23	10	143	63	84	110	41
December	96	35	73	53	23	15	22	21	13	11	164	57	96	66	34
	1,363	1,191	539	1,107	488	278	356	199	318	149	1,721	1,579	757	1,461	646

[a] Including gas wells.

Initial daily production of new wells completed in Illinois in 1917, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Clark	51	61	41	81	153	134	224	277	168	201	38	10	1,439
Clinton	......	......	10	......	......	......	......	......	......	......	......	......	10
Crawford	469	499	186	266	325	249	215	311	154	116	158	145	3,093
Cumberland	18	......	13	50	34	......	23	4	......	6	......	......	148
Edgar	......	......	......	......	......	15	5	4	......	1	......	......	25
Hancock	15	......	......	......	15	......	......	......	......	......	......	......	30
Lawrence	307	230	110	217	488	685	365	579	605	348	271	92	4,297
McDonough	10	......	......	5	5	3	8	2	4	......	2	7	46
Wabash	295	......	......	75	......	75	35	260	160	......	40	100	1,040
	1,165	790	360	694	1,020	1,161	875	1,437	1,091	672	509	354	10,128

Total and average initial daily production of new wells in Illinois, 1913–1917, in barrels.

County.	Total initial production.					Average per well.				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Clark	2,610	1,590	2,014	3,737	1,439	15.4	10.1	18.8	17.1	12.4
Clinton	134	20	....	291	10	9.6	10.0	....	26.5	10.0
Coles	75	172	35	57	....	25.0	10.7	17.5	9.5	......
Crawford	9,990	8,613	1,776	6,076	3,093	18.5	15.9	11.6	15.5	15.5
Cumberland	595	127	810	434	148	12.1	5.8	21.9	12.8	5.9
Edgar	....	....	6	....	25	....	....	2.0	....	6.3
Hancock	....	45	....	167	30	....	45.0	....	13.9	7.5
Henderson	....	....	....	7	....	....	....	....	3.5	......
Jasper	30	28	....	....	....	15.0	9.3	....	....	......
Lawrence	32,316	24,324	6,329	9,540	4,297	60.1	82.7	49.4	45.0	38.0
McDonough	....	3,919	2,592	1,948	46	....	28.4	26.7	10.5	3.3
Macoupin	165	15	5	....	....	55.0	5.0	5.0	....	......
Marion	492	70	270	207	....	23.4	11.6	45.0	11.5	......
Wabash	998	345	328	2,325	1,040	41.6	49.3	65.6	136.8	86.7
	47,405	39,268	14,165	24,789	10,128	34.8	33.0	26.3	22.4	20.8

Total initial daily production of new wells in Illinois, 1913–1917, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1913	4,000	3,886	2,337	3,702	4,170	3,718	4,637	3,581	4,662	4,643	3,641	4,428	47,405	3,950
1914	2,925	3,415	2,443	4,838	5,552	6,542	3,801	2,792	2,925	1,517	1,156	1,362	39,268	3,272
1915	975	640	1,478	1,254	953	1,219	1,366	1,367	1,236	1,263	1,151	1,263	14,165	1,180
1916	984	1,105	2,374	1,056	2,686	2,828	2,647	2,957	2,700	1,862	2,478	1,112	24,789	2,066
1917	1,165	790	360	694	1,020	1,161	875	1,437	1,091	672	509	354	10,128	844

MID-CONTINENT OIL FIELD.

GENERAL STATEMENT.

For commercial purposes it is customary to group under the title "Mid-Continent field" the areas of oil production in Kansas, Oklahoma, northern and central Texas, and northern Louisiana. In Kansas, Oklahoma, and northern Texas petroleum is derived mainly from sandstone layers included in formations of the Pennsylvanian series (upper Carboniferous). In southern Oklahoma sandstone layers in the "Red Beds" of the Permian series (latest Carboniferous) form the reservoirs of oil in the Healdton district. In northern Louisiana and central Texas the oil is found in sandstones or other porous rocks belonging to the Cretaceous and Tertiary systems. The occurrence of oil throughout the Mid-Continent field is in anticlines, domes, half-domes, and terraces on the flanks of major uplifts, such as the Ozark, Wichita, Arbuckle, and Sabine.

PETROLEUM MARKETED.

Petroleum marketed in the Mid-Continent field in 1916 and 1917, in barrels.

Month.	Kansas.	Oklahoma.	Northern Texas.	Northern Louisiana.	Total.
1916.					
January	197,348	8,441,229	611,714	1,149,990	10,400,281
February	284,726	8,763,238	603,151	1,074,334	10,725,449
March	353,693	9,631,738	691,735	1,136,331	11,813,497
April	441,422	8,621,433	716,428	1,067,309	10,846,592
May	633,726	9,355,086	812,771	1,099,704	11,901,287
June	834,640	9,047,460	856,993	1,042,337	11,781,430
July	705,376	8,750,160	889,391	997,816	11,342,743
August	644,667	8,474,831	864,838	947,898	10,932,234
September	951,516	8,761,698	810,743	877,052	11,401,009
October	1,260,585	9,399,483	841,068	876,284	12,377,420
November	1,212,459	8,797,850	800,492	776,036	11,586,837
December	1,217,919	9,027,509	803,681	776,551	11,825,660
	8,738,077	107,071,715	9,303,005	11,821,642	136,934,439
1917.					
January	2,199,862	8,564,301	813,713	727,487	12,305,363
February	1,739,952	7,929,890	738,544	612,041	11,020,427
March	2,498,789	9,474,878	825,506	738,149	13,537,322
April	2,323,291	8,938,605	813,207	744,428	12,819,531
May	2,366,411	8,963,599	868,594	817,431	13,016,035
June	2,681,568	8,995,842	885,933	812,464	13,375,807
July	3,009,914	9,563,613	938,462	854,925	14,366,914
August	3,610,946	9,041,907	1,007,676	847,807	14,508,336
September	4,101,561	9,012,971	995,499	814,907	14,924,938
October	4,116,002	9,560,032	1,002,886	819,799	15,498,719
November	4,304,013	9,143,094	998,429	280,108	14,725,644
December	3,583,816	8,318,739	1,012,197	492,417	13,407,169
	36,536,125	107,507,471	10,900,646	8,561,963	163,506,205
Increase or decrease, 1917:					
Barrels	+27,798,048	+435,756	+1,597,641	−3,259,679	+26,571,766
Per cent	+ 318.13	+ 0.41	+ 17.17	− 27.57	+ 19.40

Petroleum marketed in the Mid-Continent field, 1889–1917.

Year.	Quantity. (barrels).	Percentage of total production.	Increase or decrease.		Value.	Yearly average price per barrel.
			Barrels.	Per cent.		
1889	500				$2,500	$5.000
1890	1,200		+ 700	+140.00	8,400	7.000
1891	1,430		+ 230	+ 19.17	9,950	6.958
1892	5,080		+ 3,650	+255.24	5,480	1.079
1893	18,010	0.04	+ 12,930	+254.53	18,060	1.003
1894	40,130	.08	+ 22,120	+122.82	40,810	1.017
1895	44,467	.08	+ 4,337	+ 10.81	26,910	.605
1896	115,141	.19	+ 70,674	+158.93	52,587	.457
1897	147,648	.24	+ 32,507	+ 28.23	71,914	.487
1898	616,600	1.11	+ 468,952	+317.62	305,875	.496
1899	738,183	1.29	+ 121,583	+ 19.72	523,068	.709
1900	917,225	1.44	+ 179,042	+ 24.25	945,992	1.031
1901	989,696	1.43	+ 72,471	+ 7.90	778,097	.787
1902	986,720	1.12	− 2,976	− .30	745,803	.756
1903	1,573,085	1.57	+ 586,365	+ 59.42	1,645,936	1.046
1904	6,186,629	5.28	+ 4,613,544	+293.28	5,859,982	.947
1905	12,533,777	9.30	+ 6,347,148	+102.60	6,908,002	.551
1906	22,839,911	18.05	+10,306,134	+ 82.23	10,357,923	.454
1907	46,896,267	28.23	+24,056,356	+105.33	19,239,085	.410
1908	48,823,747	27.35	+ 1,927,480	+ 4.11	19,134,658	.392
1909	50,833,740	27.75	+ 2,009,993	+ 4.12	18,863,436	.371
1910	59,217,582	28.26	+ 8,383,842	+ 16.49	23,163,676	.391
1911	66,595,477	30.21	+ 7,377,895	+ 12.46	31,928,208	.479
1912	65,473,323	29.48	− 1,122,154	− 1.68	45,300,658	.692
1913	84,920,225	34.18	+19,446,902	+ 29.70	80,767,758	.951
1914	[a]97,994,900	36.87	+13,074,675	+ 15.40	78,671,402	.803
1915	123,294,317	43.86	+25,299,417	+ 25.82	72,431,301	.587
1916	136,934,439	45.528	+13,640,122	+ 11.06	162,816,998	1.189
1917	163,506,205	48.761	+26,571,766	+ 19.40	282,796,124	1.730
	992,245,654	23.33			863,420,593	.870

[a] Does not include 19,550,000 barrels produced in 1914 in the Cushing and Healdton fields in Oklahoma and placed in field storage.

Petroleum marketed, value, and average price per barrel in the Mid-Continent field, 1908–1917, by States.

Year.	Kansas and Oklahoma.			Northern Texas.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1908	47,600,546	$18,441,538	$0.387	723,264	$479,072	$0.662
1909	49,122,982	17,920,623	.364	681,940	393,732	.577
1910	53,157,386	20,367,423	.383	969,403	505,396	.521
1911	57,348,456	27,060,523	.472	2,251,193	1,213,960	.539
1912	53,019,867	35,768,302	.674	5,275,507	4,112,815	.779
1913	65,954,413	61,830,231	.937	9,184,252	9,125,185	.992
1914	[a]76,735,309	59,686,261	.778	9,451,122	7,778,455	.823
1915	100,738,730	58,409,024	.580	7,473,553	4,656,934	.623
1916	115,809,792	138,803,763	1.199	9,303,005	11,834,973	1.272
1917	144,043,596	248,767,554	1.727	10,900,646	19,952,665	1.830

Year.	Northern Louisiana.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1908	499,937	$214,048	$0.428	48,823,747	$19,134,658	$0.392
1909	1,028,818	549,081	.533	50,833,740	18,863,436	.371
1910	5,090,793	2,290,857	.450	59,217,582	23,163,676	.391
1911	6,995,828	3,653,725	.522	66,595,477	31,928,208	.479
1912	7,177,949	5,419,541	.755	65,473,323	45,300,658	.692
1913	9,781,560	9,812,342	1.003	84,920,225	80,767,758	.951
1914	11,808,469	11,206,686	.949	97,994,900	78,671,402	.803
1915	15,082,034	9,365,343	.621	123,294,317	72,431,301	.587
1916	11,821,642	12,178,262	1.030	136,934,439	162,816,998	1.189
1917	8,561,963	14,075,905	1.644	163,506,205	282,796,124	1.730

[a] Does not include 19,550,000 barrels produced in 1914 in the Cushing and Healdton fields in Oklahoma and placed in field storage.

Petroleum marketed in the Mid-Continent field, 1913–1917, in barrels.

Month.	1913	1914	1915	1916	1917
January	6,271,174	8,040,953	8,056,449	10,400,281	12,305,363
February	5,951,436	7,246,281	8,238,063	10,725,449	11,020,427
March	6,721,358	9,226,674	9,347,522	11,813,497	13,537,322
April	6,958,467	8,593,220	13,305,713	10,846,592	12,819,531
May	7,473,214	9,161,882	9,959,638	11,901,287	13,016,035
June	7,289,629	9,081,698	10,496,652	11,781,430	13,375,807
July	7,317,115	8,872,958	11,502,482	11,342,743	14,366,914
August	6,916,638	6,837,976	10,438,861	10,932,234	14,508,336
September	7,097,031	6,274,684	10,303,130	11,401,009	14,924,938
October	7,617,577	7,901,411	10,032,685	12,377,420	15,498,719
November	7,535,142	8,193,609	10,017,997	11,586,837	14,725,644
December	7,771,444	8,563,554	11,545,125	11,825,660	13,407,169
	84,920,225	97,994,900	123,294,317	136,934,439	163,506,205

Average daily production of petroleum in the Mid-Continent field, 1913–1917, in barrels.

Month.	1913	1914	1915	1916	1917
January	202,296	259,386	259,886	335,493	396,947
February	212,551	258,796	294,216	369,843	393,587
March	216,818	297,635	301,533	381,081	436,688
April	231,949	286,440	443,523	361,553	427,318
May	241,071	295,545	321,279	383,912	419,872
June	242,988	302,724	349,889	392,714	445,860
July	236,036	286,225	371,048	365,895	463,449
August	223,117	220,580	338,351	352,653	468,011
September	236,568	209,156	343,437	380,034	497,498
October	245,728	254,885	323,635	399,272	499,959
November	251,171	273,120	333,934	386,228	490,855
December	250,692	276,243	372,424	381,473	432,489
Average	232,658	268,479	337,793	374,138	447,711

PIPE-LINE RUNS, DELIVERIES, AND STOCKS.

Pipe-line runs and deliveries to trade of petroleum from the Mid-Continent field and stocks at end of each month in 1916 and 1917, in barrels.

Month.	1916			1917		
	Runs.	Deliveries.	Stocks.	Runs.	Deliveries.	Stocks.
Dec. 31, 1915			74,296,417			
January	10,400,281	5,482,385	79,214,313	12,305,363	9,650,765	79,961,817
February	10,725,449	11,453,080	78,486,682	11,020,427	10,349,339	80,632,905
March	11,813,497	12,884,710	77,415,469	13,537,322	12,912,426	81,257,801
April	10,846,592	9,881,072	78,380,989	12,819,531	11,924,138	82,153,194
May	11,901,287	10,576,492	79,705,784	13,016,035	13,169,610	81,999,619
June	11,781,430	10,637,837	80,849,377	13,375,807	12,422,038	82,953,388
July	11,342,743	8,918,902	83,273,218	14,366,914	13,592,054	83,728,248
August	10,932,234	11,658,916	82,546,536	14,508,336	15,624,979	82,611,605
September	11,401,009	12,516,276	81,431,269	14,924,938	16,971,671	80,564,872
October	12,377,420	13,010,817	80,797,872	15,498,719	17,427,742	78,635,849
November	11,586,837	12,501,833	79,882,876	14,725,644	15,920,331	77,441,162
December	11,825,660	14,401,317	77,307,219	13,407,169	15,070,403	75,777,928
	136,934,439	133,923,637		163,506,205	165,035,496	

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade-journal sources and differ somewhat from those on pages 700–702, which are obtained from reports received directly from the oil producers:

Wells completed in the Mid-Continent field, 1913–1917.

District.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Kansas	1,422	1,753	610	3,142	2,712	260	270	147	370	538	2,016	2,340	1,088	3,624	3,427
Oklahoma	6,965	6,410	3,397	6,086	5,027	1,308	1,343	885	1,120	1,360	8,851	8,292	4,624	7,583	6,797
Central and northern Texas	581	497	307	500	728	208	221	198	145	290	799	744	528	683	1,041
Northern Louisiana	356	302	349	324	302	93	94	89	141	99	519	448	464	520	457
	9,324	8,962	4,663	10,052	8,769	1,869	1,928	1,319	1,776	2,287	12,185	11,824	6,704	12,410	11,722

[a] Including gas wells.

Oil wells and dry holes drilled in the Mid-Continent field in 1917.

District.	Jan.		Feb.		Mar.		Apr.		May.		June.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Kansas	148	20	196	44	154	35	176	28	190	35	209	26
Oklahoma	322	49	390	71	273	49	356	82	367	127	402	106
Central and northern Texas	37	8	46	16	48	23	62	19	75	23	90	29
Northern Louisiana	19	14	21	10	18	10	24	9	47	12	27	9
	526	91	653	141	493	117	618	138	679	197	728	170

Oil wells and dry holes drilled in the Mid-Continent field in 1917—Continued.

District.	July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Kansas	254	47	249	69	237	51	339	55	300	63	260	65	2,712	538
Oklahoma	466	91	396	85	491	175	625	199	528	162	411	164	5,027	1,360
Central and northern Texas	59	26	56	22	64	36	68	32	75	37	48	19	728	290
Northern Louisiana	33	11	37	7	29	6	30	3	8	4	9	4	302	99
	812	175	738	183	821	268	1,062	289	911	266	728	252	8,769	2,287

Wells completed in the Mid-Continent field, 1913–1917.

Month.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
January	488	976	290	710	526	111	211	76	116	91	669	1,260	422	873	661
February	553	921	307	715	653	98	185	94	138	141	715	1,186	457	911	862
March	514	1,067	250	897	493	100	226	76	187	117	660	1,368	362	1,146	646
April	624	1,026	312	1,004	618	77	263	85	213	138	759	1,377	452	1,263	808
May	811	1,113	293	1,262	679	162	246	75	200	197	1,083	1,461	402	1,554	939
June	867	949	297	1,209	728	191	155	99	167	170	1,180	1,176	431	1,410	941
July	880	734	264	1,131	812	237	147	76	121	175	1,207	948	391	1,282	1,026
August	927	639	307	829	738	176	107	106	165	183	1,186	812	467	1,040	951
September	839	562	261	668	821	139	101	107	150	268	1,062	712	448	867	1,170
October	881	373	477	541	1,062	177	87	118	134	289	1,144	556	647	718	1,429
November	953	269	686	577	911	184	90	217	92	266	1,223	448	1,011	698	1,256
December	987	333	919	509	728	217	110	190	93	252	1,297	520	1,214	648	1,033
	9,324	8,962	4,663	10,052	8,769	1,869	1,928	1,319	1,776	2,287	12,185	11,824	6,704	12,410	11,722

[a] Including gas wells.

Initial daily production of new wells completed in the Mid-Continent field in 1917, in barrels.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Kansas	17,532	14,824	16,703	12,843	11,778	26,606	38,974	38,896	58,004	42,444	27,817	12,672	319,093
Oklahoma	22,625	32,983	27,643	22,659	22,399	26,413	39,703	37,099	29,013	49,135	29,808	25,834	365,314
Central and northern Texas	3,864	2,861	2,719	1,629	4,552	5,903	3,835	5,322	3,030	8,048	4,544	4,821	51,128
Northern Louisiana	1,220	1,945	3,340	3,630	4,501	6,170	6,109	4,612	10,050	4,565	2,615	10,515	59,272
	45,241	52,613	50,405	40,761	43,230	65,092	88,621	85,929	100,097	104,192	64,784	53,842	794,807

Total and average initial daily production of new wells in the Mid-Continent field, 1913–1917, by districts, in barrels.

District.	Total initial production.					Average per well.				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Kansas	22,467	18,932	11,319	248,846	319,093	15.8	10.8	18.6	79.2	117.7
Oklahoma	331,050	976,244	1,036,170	521,895	365,314	48.0	152.3	305.0	85.8	72.7
Central and northern Texas	57,435	25,003	52,663	49,728	51,128	98.9	50.3	171.5	99.5	70.2
Northern Louisiana	151,955	102,193	198,116	54,871	59,272	426.8	338.4	567.7	169.4	196.3
	565,907	1,122,372	1,298,268	875,340	794,807	60.7	125.2	278.4	87.1	90.6

Total initial daily production of new wells in the Mid-Continent field, 1913–1917, by months, in barrels.

Year.	January.	February.	March.	April.	May.	June.	July.
1913	29,305	35,551	36,189	54,518	59,191	55,466	48,142
1914	38,308	53,507	90,341	73,165	121,193	152,760	95,017
1915	129,224	130,482	106,485	168,789	144,520	127,320	101,981
1916	45,967	70,905	64,541	57,888	87,869	135,023	102,801
1917	45,241	52,613	50,405	40,761	43,230	65,092	88,621

Year.	August.	September.	October.	November.	December.	Total.	Monthly average.
1913	53,929	41,405	48,436	40,756	63,019	565,907	47,159
1914	104,984	96,098	83,923	75,401	137,675	1,122,372	93,531
1915	73,418	56,150	72,337	80,763	63,629	1,255,098	104,592
1916	70,550	81,537	68,716	48,095	41,448	875,340	72,945
1917	85,929	100,097	104,192	64,784	53,842	794,807	66,234

PRICES.

The following table shows the changes in prices of Mid-Continent oil in 1916 and 1917, and the dates on which the changes were made:

Prices of Mid-Continent oil per barrel in 1916 and 1917, by grades.

1916.

Date.	Kansas and Oklahoma.	Healdton, Okla.	Northern Texas.			Northern Louisiana.[b]		
			Corsicana (light), Henrietta, Electra, and Moran.	Powell (heavy).	Thrall, Strawn, and Yale.[a]	Caddo.	De Soto and Sabine.	Red River.
Jan. 1	$1.20	$0.60	$1.20	$0.60	$1.05	$0.80–$1.20	$1.10	$0.85
Jan. 8		.65		.65				
Jan. 20	1.25							
Jan. 21		.70	1.25	.70				
Jan. 24								.90
Jan. 25						.85– 1.25	1.15	
Jan. 26	1.30				1.25			
Jan. 27		.75	1.30	.75	1.30			
Jan. 28						.90– 1.30	1.20	.95
Mar. 4	1.40		1.40					
Mar. 8						.90– 1.40	1.30	1.00
Mar. 10					1.40			
Mar. 11	1.45							
Mar. 13		.80	1.45	.80	1.45			
Mar. 14	1.55		1.55		1.55			
Mar. 15						.90– 1.45	1.35	1.05
Mar. 27						.90– 1.55	1.45	
June 16								.90
June 24								.80
July 14			1.45					
July 15						.80– 1.55		
July 16								.70
July 24	1.45							
July 25						.70– 1.45		
July 26		.70		.70			1.35	
July 27					1.45			
July 29						.65– 1.45		.65
July 31		.60		.60				
Aug. 1	1.25		1.35		1.35	.65– 1.35	1.25	
Aug. 2		.50	1.25	.50	1.25	.65– 1.25	1.15	
Aug. 7	1.15							
Aug. 8			1.15		1.15	.65– 1.15	1.05	
Aug. 12	1.05							

[a] Added to list of quotations Nov. 30.

[b] Dates of change in price are those on which quotations by the Standard Oil Co. of Louisiana became effective. Quotations by other purchasers of oil in this field became effective on or near the same date.

Prices of Mid-Continent oil per barrel in 1916 and 1917, by grades—Continued.

1916.

Date.	Kansas and Okla-homa.	Heald-ton, Okla.	Northern Texas.			Northern Louisiana.		
			Corsicana (light), Henrietta Electra, and Moran.	Powell (heavy).	Thrall, Strawn, and Yale.	Caddo.	De Soto and Sabine.	Red River.
Aug. 14		$0.45	$1.05	$0.45	$1.05		$0.95	
Aug. 15	$0.95					$0.65-$1.05		
Aug. 16		.40	.95	.40	.95		.85	
Aug. 17						.65- .95		
Aug. 26	.90		.90		.90		.80	
Aug. 29						.65- .90		$0.60
Nov. 29	1.00		1.00		1.00		.90	
Nov. 30		.45		.45				
Dec. 2						.65- 1.00		
Dec. 4								.70
Dec. 12	1.10	.50	1.10	.50	1.10		1.00	
Dec. 14						.75- 1.10		
Dec. 15								.80
Dec. 18	1.20		1.20		1.20		1.10	
Dec. 19		.60		.60		.75- 1.20		.90
Dec. 23	1.30	.70	1.30	.70				
Dec. 26							1.20	
Dec. 27					1.30	.85- 1.30		1.00
Dec. 28	1.40	.75						1.10
Dec. 29			1.40	.75	1.40	.85- 1.40	1.30	

1917.

Date.	Kansas and Okla-homa	Heald-ton, Okla.	Northern Texas.			Northern Louisiana.		
			Corsicana (light), Henrietta, Electra, and Moran.	Powell (heavy).	Thrall, Strawn, and Yale.	Caddo.	De Soto and Sabine.	Red River.
Jan. 1	$1.40	$0.75	$1.40	$0.75	$1.40	$0.85-$1.40	$1.30	$1.10
Jan. 3	1.50					.85- 1.50	1.40	
Jan. 4		.80	1.50	.80	1.50			
Jan. 6	1.60							1.20
Jan. 8		.85	1.60	.85	1.60	.95- 1.60		
Jan. 12	1.70						1.50	
Jan. 13		.90	1.70		1.70			
Jan. 23						.95- 1.70		1.50
Jan. 27							1.60	
Jan. 30								1.40
Mar. 9						.95- 1.80		
Mar. 14						1.00- 1.80		
Mar. 17						1.00- 1.90		
Aug. 1		1.00		.95				
Aug. 13		1.10		1.00				
Aug. 15	1.90							
Aug. 16		1.15	1.90	1.05	1.90			
Aug. 18	2.00							
Aug. 20		1.20	2.00		2.00			
Aug. 22						1.00- 2.00	1.90	1.50

Average monthly price per barrel of Mid-Continent petroleum in 1916 and 1917.

1916.

Month.	Kansas and Oklahoma.	Healdton, Okla.	Northern Texas.			Northern Louisiana.		
			Corsicana (light), Henrietta, Electra, and Moran.	Powell (heavy).	Thrall, Strawn, and Yale.	Caddo.	De Soto and Sabine.	Red River.
January	$1.23	$0.66	$1.23	$0.66	$1.10	$0.82–$1.19	$1.12	$0.87
February	1.30	.75	1.30	.75	1.30	.90– 1.30	1.20	.95
March	1.48	.78	1.48	.78	1.46	.90– 1.42	1.32	1.02
April	1.55	.80	1.55	.80	1.55	.90– 1.55	1.45	1.05
May	1.55	.80	1.55	.80	1.55	.90– 1.55	1.45	1.05
June	1.55	.80	1.55	.80	1.55	.90– 1.55	1.45	.95
July	1.52	.78	1.49	.78	1.53	.82– 1.53	1.43	.74
August	1.04	.45	1.06	.45	1.06	.65– 1.07	.96	.65
September	.90	.40	.90	.40	.90	.65– .90	.80	.60
October	.90	.40	.90	.40	.90	.65– .90	.80	.60
November	.91	.40	.91	.40	.91	.65– .90	.81	.60
December	1.15	.56	1.15	.56	1.14	.72– 1.12	1.04	.82
Average	1.26	.63	1.25	.63	1.24	.79– 1.25	1.15	.82

1917.

Month.	Kansas and Oklahoma.	Healdton, Okla.	Northern Texas.			Northern Louisiana.		
			Corsicana (light), Henrietta, Electra, and Moran.	Powell (heavy).	Thrall, Strawn, and Yale.	Caddo.	De Soto and Sabine.	Red River.
January	$1.62	$0.86	$1.62	$0.83	$1.62	$0.92–$1.60	$1.47	$1.26
February	1.70	.90	1.70	.85	1.70	.95– 1.70	1.60	1.40
March	1.70	.90	1.70	.85	1.70	.98– 1.82	1.60	1.40
April	1.70	.90	1.70	.85	1.70	1.00– 1.90	1.60	1.40
May	1.70	.90	1.70	.85	1.70	1.00– 1.90	1.60	1.40
June	1.70	.90	1.70	.85	1.70	1.00– 1.90	1.60	1.40
July	1.70	.90	1.70	.85	1.70	1.00– 1.90	1.60	1.40
August	1.85	1.11	1.84	1.01	1.84	1.00– 1.93	1.70	1.43
September	2.00	1.20	2.00	1.05	2.00	1.00– 2.00	1.90	1.50
October	2.00	1.20	2.00	1.05	2.00	1.00– 2.00	1.90	1.50
November	2.00	1.20	2.00	1.05	2.00	1.00– 2.00	1.90	1.50
December	2.00	1.20	2.00	1.05	2.00	1.00– 2.00	1.90	1.50
Average	1.81	1.01	1.81	.93	1.81	.99– 1.89	1.70	1.42

KANSAS.

GENERAL STATEMENT.

The phenomenal success that attended the continued development of the petroleum resources of Kansas in 1917 resulted in a four-fold increase in petroleum output in that year that was sufficient to advance Kansas from sixth to third rank among the States that contribute to the petroleum supply of the country. The quantity of crude oil marketed in 1917 from the oil fields of Kansas was 36,536,125 barrels, a gain of 27,798,048 barrels, or 318 per cent, compared with 1916. This output is approximately equivalent to the entire output of petroleum from the State from 1889, the year in which oil was first produced commercially there, to 1916, inclusive. The remarkable increase in 1917 is credited almost entirely to Butler County and to Towanda Township in that county, the development of which constituted the principal feature of the crude oil industry in Kansas in 1917.

The average price received at the wells for petroleum marketed in Kansas in 1917 was $1.84 a barrel and the market value of the entire output was $67,120,573, a gain of 66 cents in average unit selling price and of $56,780,615, or 549 per cent, in total market value, compared with 1916.

DEVELOPMENT.

Scarcity of drilling supplies and shortage of labor resulted in the completion of fewer wells in Kansas in 1917 than in 1916, a discrepancy that was fortunately offset in the year in review by a decided gain in the average initial capacity of the oil wells completed.

In all 3,427 new wells were completed in Kansas in 1917, compared with 3,624 in 1916. Of these 2,712 were oil wells credited with an average yield of 118 barrels each the first 24 hours after completion, 177 were gas wells, and 538, an average of 3 in every 19 completed, were failures. Compared with 1916 the number of oil wells completed in 1917 was less by 430, or about 14 per cent, the average initial production per well was greater by 39 barrels, or about 50 per cent, the number of gas wells was greater by 65, or 58 per cent, and the number of dry holes was greater by 168, or 45 per cent.

Butler County.—As already indicated primary interest in the development of petroleum production in Kansas in 1917 was centered in Butler County in and near the prolific Augusta and Eldorado fields. In that county alone 994 successful oil wells, 28 gas wells, and 147 dry holes were completed in 1917. The average initial daily capacity of the new oil wells was 291 barrels each, compared with 256 barrels in 1916. The center of activity in drilling and of new production was the Towanda extension of the Eldorado field opened in 1916 as a consequence of wildcat drilling southwest of the main Eldorado field. Interest in this development was only moderate until June, when well No. 1 of the Trapshooters Oil Co., on the Williams lease in sec. 11, T. 26 S., R. 4 E., was brought in as a gusher credited with an initial capacity of 15,000 to 18,000 barrels of oil a day. With the completion late in June and early in July of several other wells ranging in initial flows from 4,000 to 10,000 barrels each, in the same locality, the Towanda extension became the center of principal interest and of activity in drilling.

As a consequence of the success of subsequent development the daily output of the Eldorado district increased from an average of 15,000 to 20,000 barrels in the first five months of 1917 to 80,000 barrels on June 20 and to nearly 100,000 barrels for a few days in September, though it declined to about 50,000 barrels before the end of the year. Most of the wells of large capacity completed in the Towanda extension proved short-lived, the output declining to ordinary proportions a few days after their completion. Well No. 5 of the Gypsy Oil Co., on the Shumway lease in sec. 11, T. 26 S., R. 4 E., proved an exception to this rule. It was completed September 14 and started flowing oil at the rate of 13,000 to 14,000 barrels a day, and at the end of 1917 was still producing regularly in excess of 12,000 barrels a day.

In sec. 35, T. 25 S., R. 4 E., about 2 miles north of the Towanda extension, a small pool designated the Dillenbeck extension, which furnished a few wells with initial capacities in excess of 1,000 barrels a day and several wells of smaller capacities was developed during 1917, resulting from the completion in January of a 135-barrel oil well on the Dillenbeck farm by the Tulhoma Oil Co.

North of the Eldorado field wildcat drilling resulted in 1917 in the opening of promising extensions or new pools in secs. 3, 5, 6, 8, and 15, T. 25 S., R. 5 E.

At Potwin, 9 miles northwest of the Eldorado field, a dozen wells of small capacity were completed in sec. 31, T. 24 S., R. 4 E., and secs. 25 and 36 of the adjoining township to the west, in territory of which much was expected at the beginning of the year.

To the south and southeast of the main Eldorado field wildcat activity was scarcely less successful and before the end of 1917 new areas of distinct promise had been opened, in sec. 34, T. 26 S., R 4 E., 2½ miles southeast of the Towanda extension, in secs. 30 and 31, T. 26 S., R. 5 E., 2 and 3 miles, respectively, south of the main Eldorado field, in sec. 26 of the township last mentioned, about 4 miles southeast of the nearest wells in the main field, and in sec. 2, T. 27 S., R. 5 E., fully 5 miles southeast of the main field.

In the Augusta district in Tps. 27 and 28 S., R. 4 E., activity in drilling was well sustained throughout 1917, though devoid of the sensational features of developments in the Eldorado district to the north. Moderate extensions of productive territory were proved during the year and the output of the district decreased from a daily average of about 40,000 barrels in January to about 30,000 barrels in December.

In the vicinity of Douglass 4 or 5 miles south of the main Augusta field efforts to develop a pool in sec. 18, T. 29 S., R. 4 E., following discoveries of oil in 1916, were disappointing, though they resulted in the opening of a small pool in sec. 9 of that township 2 miles northeast of the wells in sec. 18, that supported an active development in the closing months of 1917.

Eight miles east of the main Augusta field oil in commercial quantity was found in June in a wildcat test drilled by Smith & Garden in sec. 1, T. 28 S., R. 5 E. The completion in November of a 150-barrel oil well in the same section by the Central Oil Co. added greatly to the prospects of a new pool in that locality. About 10 miles southeast of the main Augusta pool and 8 miles east of Douglass oil wells of small capacity were completed in 1917 by the A1 Oil Co., in secs. 13 and 24, T. 29 S., R. 5 E., in territory that offered fair promise for future development.

Greenwood County.—As Greenwood County borders Butler on the east and lies between that county and the shallow-sand fields in southeastern Kansas it was the logical focus of activity in quest of intervening areas of oil production. Of 23 wells drilled for oil in 1917 in Greenwood County 14 were successful to the extent of an average output of 63 barrels of oil each the first day of productive life and 9 were failures. Promise of the eventual development of an oil pool of some consequence resulted from drilling in the western part of the county, following the completion in August of a 200-barrel oil well in sec. 2, T. 26 S., R. 8 E. This well was drilled by the Great Southern Oil Co. on the Hull tract and obtained its production from a sand reported to be 30 feet thick reached at a depth of about 2,400 feet. Confirmation of the discovery was provided in November by the completion by the same company of a 300-barrel well on the Stephenson tract, south of the Hull tract, in the same section, and in October by the completion of a 50-barrel oil well at a depth of 1,380 feet by the Mid-Kansas Oil & Gas Co., in sec. 36 of the adjoining township to the north. Other localities in Greenwood County that yielded sufficient oil in initial tests to warrant additional drilling were secs. 14 and 23, T. 24 S., R. 14 E., near Virgil; sec. 9, T. 25 S., R. 11 E., near Utopia; sec. 2, T. 26 S., R. 10 E., near Eureka; and sec. 25, T. 27 S., R. 8 E., between Beaumont and Blodgett.

Cowley County.—Additional drilling in Cowley County in 1917 resulted in the completion of 7 oil wells, 1 gas well, and 29 dry holes. The oil wells were all located near Winfield and were credited with an average yield of only 22 barrels each the first 24 hours after completion.

Labette County.—The shallow-sand districts of Labette County proved unusually attractive in 1917 and as a consequence 65 new wells were completed in that county, compared with only 14 in 1916. Of these 38 were oil wells, compared with 14 the year before, 6 were gas wells, and 21 were failures. The initial output of the oil wells averaged 45 barrels each, compared with 6 barrels each in 1916, as a consequence of the opening of new territory southwest of Mound Valley, in secs. 3 and 14, T. 33 S., R. 17 E., in sec. 34 of the adjoining township to the north, and in secs. 7 and 8 of the adjoining township to the east. In these localities the producing sands were reached at an average depth of 700 feet.

Crawford and Bourbon counties.—The discovery late in July of oil in commercial quantity in a wildcat well 600 feet deep, drilled by Heggem, Davis, and others, in sec. 19, T. 27 S., R. 22 E., in the southwest corner of Bourbon County resulted in additional tests in the same locality that proved the existence of a prolific shallow-sand pool, termed the Hepler pool, of 28° Baumé gravity oil in the southwestern part of Bourbon County and the northwestern part of Crawford County. Several wells with initial capacities of 100 barrels of oil a day were completed in that district before the end of 1917.

Wilson County.—In Wilson County the development of a new shallow-sand pool, in secs. 23 and 22, T. 28 S., R. 15 E. (Guilford Township), resulted in an increase from 45 in 1916 to 137 in 1917 in the number of oil wells completed in that county.

Elk County.—The continued development of territory opened in 1916 in and near sec. 34, T. 31 S., R. 12 E. in Elk County, resulted in the completion of 44 oil wells in that county in 1917, compared with 11 in 1916.

In the other shallow-sand districts of eastern Kansas activity in drilling, though slightly less than in 1916, resulted in moderate extensions of proved territory in Miami, Franklin, Douglas, Neosho, and Allen counties.

Miscellaneous tests.—Among others the following unsuccessful tests for oil or gas completed in various localities in eastern Kansas in 1917 are of especial interest because of their location, of their depth, or of the results obtained:

CHASE COUNTY.

February—Empire Gas & Fuel Co.; No. 1 Kaufman; in sec. 2, T. 20 S., R. 7 E.; depth 3,067 feet (last 1,200 feet in granite).

GEARY COUNTY.

February—Empire Gas & Fuel Co.; No. 1 Stillwagon; sec. 9, T. 13 S., R. 8 E.; depth 2,000 feet (completed in granite).

LYON COUNTY.

February—Kansas Natural Gas Co.; No. 1 Miller; sec. 13, T. 16 S., R. 12 E.; depth 2,000 feet.
May—Wilcox and others; No. 1 Krouse; SW. ¼ sec. 32, T. 18 S., R. 12 E.; depth 1,989 feet.

M'PHERSON COUNTY.

July—Lindeburg Oil & Gas Co.; No. 1 Sangreen; sec. 9, T. 17 S., R. 4 W.; depth 3,200 feet.

MORRIS COUNTY.

February—Empire Gas & Fuel Co.; No. 1 Andrews; sec. 34, T. 17 S., R. 7 E.; depth 2,500 feet (completed in granite).

POTTAWATOMIE COUNTY.

February—Empire Gas & Fuel Co.; No. 1 Rokes; sec. 34, T. 6 S., R. 11 E.; depth 1,550 feet (completed in granite).

RILEY COUNTY.

August—Gypsy Oil Co.; No. 1 Grell; sec. 2, T. 7 S., R. 5 E., depth 2,600 feet (completed in granite).

SEDGWICK COUNTY.

August—Charles Noble and others; No. 1 Maximer; sec. 25, T. 25 S., R. 2 E.; depth 2,800 feet.
Big Chief Oil Co.; No. 1 Fulton; sec. 1, T. 26 S., R. 1 E.; depth 3,200 feet.

SUMNER COUNTY.

August—Duluth & Oklahoma Oil Co.; No. 1 Latta; sec. 8, T. 30 S., R. 2 W.; depth 3,260 feet.
September—Lock and others; No. 1 Cann; sec. 29, T. 32 S., R. 1 W.; depth 3,685 feet.

WABAUNSEE COUNTY.

February—Empire Gas & Fuel Co.; No. 1 Root; sec. 1, T. 11 S., R. 9 E.; depth 1,790 feet (completed in granite).

PETROLEUM MARKETED.

Petroleum marketed in Kansas, 1916 and 1917, in barrels.

Month.	Runs to local refineries.	Other runs and field fuel.	Rail shipments not included in pipe-line runs.	Total.
1916.				
January	19,437	177,635	276	197,348
February	20,584	263,758	384	284,726
March	21,920	331,102	671	353,693
April	20,686	420,427	309	441,422
May	22,886	610,142	698	633,726
June	21,879	810,689	2,072	834,640
July	20,782	674,317	10,277	705,376
August	21,261	546,306	77,100	644,667
September	20,535	871,590	59,391	951,516
October	22,399	1,163,002	75,184	1,260,585
November	34,500	1,112,136	65,823	1,212,459
December	29,408	1,131,792	56,719	1,217,919
	276,277	8,112,896	348,904	8,738,077

Petroleum marketed in Kansas, 1916 and 1917, in barrels—Continued.

Month.	Runs to local refineries.	Other runs and field fuel.	Rail shipments not included in pipe-line runs.	Total.
1917.				
January	42,504	2,121,085	36,273	2,199,862
February	39,356	1,627,581	73,015	1,739,952
March	56,293	2,311,649	130,847	2,498,789
April	62,965	2,146,202	114,124	2,323,291
May	56,697	2,190,426	119,289	2,366,411
June	114,719	2,434,426	132,423	2,681,568
July	178,747	2,726,119	105,048	3,009,914
August	227,320	3,308,348	75,278	3,610,946
September	248,071	3,751,367	102,123	4,101,561
October	251,222	3,734,581	130,199	4,116,002
November	242,583	3,921,165	140,265	4,304,013
December	223,388	3,278,201	82,226	3,583,816
	1,743,865	33,551,150	1,241,110	36,536,125

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the tables following are compiled from trade-journal sources and differ somewhat from those on page 700, obtained from reports received directly from the oil producers.

Wells completed in Kansas, 1913–1917.

County.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Allen	154	175	49	314	230	11	10	3	8	5	171	193	65	326	236
Anderson		1			6			4		1		1	4		8
Bourbon		1		2	2				1			1		3	2
Butler		5	22	835	994			4	132	147		29	60	1,002	1,169
Chase									1	1				1	1
Chautauqua	311	308	112	441	256	77	38	26	52	75	442	376	164	513	364
Coffey		5	3	4	1		1					7	3	4	1
Cowley		3	2	3	7		8	4	14	29		17	18	20	37
Crawford										5					5
Dickinson										1					1
Doniphan										1					1
Douglas					4					2					9
Ellsworth										1					1
Elk				11	44		3	2	7	8		3	5	19	66
Ford													1		
Franklin	54	163	71	234	142	3	30	22	15	34	58	225	114	252	188
Greenwood				2	14				6	9			1	8	23
Labette		8	19	14	38		18	3		21	3	54	29	14	65
Linn		2		1								2		1	
Lyon									2	1				2	1
Marion										1					1
McPherson									1					1	
Miami		131	33	217	182		42	15	55	58		186	52	274	257
Montgomery	602	691	201	777	336	92	75	49	48	78	867	903	379	860	441
Morris									1	3				1	3
Neosho	257	221	92	235	297	27	19	9	8	20	316	263	144	249	328
Ottawa									1					1	
Osage									1	2				1	2
Pottawatomie									1	2				1	2
Rice										1					1
Saline										1					1
Sedgwick									2					2	
Shawnee										1					1
Sumner									1	4			1	1	4
Wabaunsee										2					2
Wilson	40	27	6	45	137	45	20	4	2	22	139	59	23	50	180
Woodson	2	12		7	22	3	2	2	11	2	5	14	25	18	26
Miscellaneous	2					2	4				15	7			
	1,422	1,753	610	3,142	2,712	260	270	147	370	538	2,016	2,340	1,088	3,624	3,427

[a] Including gas wells.

Oil wells and dry holes drilled in Kansas in 1917.

County.	Jan.		Feb.		Mar.		Apr.		May.		June.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Allen	20	......	22	......	13	......	8	......	23	......	16	......
Anderson	......	......	......	......	......	......	2	......	......	......	1	......
Bourbon	......	......	......	......	......	......	......	......	......	......	......	......
Butler	48	4	71	18	69	3	62	6	55	11	81	6
Chase	......	......	......	1	......	......	......	......	......	......	......	......
Chautauqua	16	2	26	6	10	5	13	5	18	5	18	7
Coffey	......	......	......	......	......	......	......	......	......	......	......	......
Cowley	1	8	......	3	......	......	2	......	......	......	......	......
Crawford	......	......	......	......	......	......	......	......	......	5	......	......
Dickinson	......	......	......	......	......	......	......	......	......	......	......	1
Doniphan	......	1	......	......	......	......	......	......	......	......	......	......
Douglas	......	......	......	......	......	......	......	......	......	......	......	......
Ellsworth	......	......	......	......	......	......	......	......	......	......	......	......
Elk	......	......	1	......	3	......	10	......	16	1	4	......
Franklin	5	......	15	......	4	1	6	2	2	1	5	2
Greenwood	2	1	......	......	......	......	......	......	......	......	......	......
Labette	9	3	2	5	5	6	8	3	9	2	3	1
Lyon	......	......	......	......	......	......	......	......	......	......	......	......
Marion	......	......	......	......	......	......	......	......	......	......	......	......
Miami	3	......	8	3	6	4	13	2	8	1	7	2
Montgomery	24	1	22	2	18	10	24	4	43	6	31	6
Morris	......	......	......	3	......	......	......	......	......	......	......	......
Neosho	17	......	20	......	15	4	14	3	6	2	30	1
Osage	......	......	......	......	......	......	......	......	......	......	......	......
Pottawatomie	......	......	......	1	......	......	......	......	......	......	......	......
Rice	......	......	......	......	......	......	......	1	......	......	......	......
Saline	......	......	......	......	......	......	......	1	......	......	......	......
Shawnee	......	......	......	1	......	......	......	......	......	......	......	......
Sumner	......	......	......	......	......	......	......	......	......	......	......	......
Wabaunsee	......	......	......	1	......	......	......	......	......	......	......	......
Wilson	3	......	6	......	8	2	9	1	6	1	12	......
Woodson	......	......	3	......	3	......	5	......	4	......	1	......
	148	20	196	44	154	35	176	28	190	35	209	26

County.	July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Allen	13	......	37	......	6	2	22	......	25	2	25	1	230	5
Anderson	......	1	......	......	......	......	......	......	3	......	......	......	6	1
Bourbon	2	......	......	......	......	......	......	......	......	......	......	......	2	......
Butler	89	21	108	31	75	3	139	19	118	10	79	11	994	147
Chase	......	......	......	......	......	......	......	......	......	......	......	......	......	1
Chautauqua	22	7	8	3	29	3	37	7	26	14	33	11	256	75
Coffey	......	......	......	......	......	......	......	......	......	......	1	......	1	......
Cowley	......	......	1	12	......	2	1	1	1	3	1	......	7	29
Crawford	......	......	......	......	......	......	......	......	......	......	......	......	......	5
Dickinson	......	......	......	......	......	......	......	......	......	......	......	......	......	1
Doniphan	......	......	......	......	......	......	......	......	......	......	......	......	......	1
Douglas	......	......	......	......	......	......	......	......	1	......	3	2	4	2
Ellsworth	......	......	......	1	......	......	......	......	......	......	......	......	......	1
Elk	2	3	......	......	1	1	......	......	2	2	6	1	44	8
Franklin	20	1	17	5	27	4	22	9	13	5	6	4	142	34
Greenwood	1	......	2	......	1	......	4	......	3	......	1	8	14	9
Labette	2	1	......	......	......	......	......	......	......	......	......	......	38	21
Lyon	......	......	......	1	......	......	......	......	......	......	......	......	......	1
Marion	......	......	......	......	......	1	......	......	......	......	......	......	......	1
Miami	21	3	21	......	29	19	7	2	35	16	24	6	182	58
Montgomery	35	7	16	9	21	12	34	9	35	4	33	8	336	78
Morris	......	......	......	......	......	......	......	......	......	......	......	......	......	3
Neosho	28	3	31	......	29	1	47	......	25	1	35	5	297	20
Osage	......	......	......	2	......	......	......	......	......	......	......	......	......	2
Pottawatomie	......	......	......	......	......	......	......	1	......	......	......	......	......	2
Rice	......	......	......	......	......	......	......	......	......	......	......	......	......	1
Saline	......	......	......	......	......	......	......	......	......	......	......	......	......	1
Shawnee	......	......	......	......	......	......	......	......	......	......	......	......	......	1
Sumner	......	......	......	2	......	1	......	......	......	1	......	......	......	4
Wabaunsee	......	......	......	1	......	......	......	......	......	......	......	......	......	2
Wilson	19	......	8	2	20	2	26	6	11	4	9	4	137	22
Woodson	......	......	......	......	......	......	......	1	2	1	4	4	22	2
	254	47	249	69	237	51	339	55	300	63	260	65	2,712	538

Wells completed in Kansas, 1913–1917.

Month.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
January	44	207	47	140	148	6	31	9	9	20	75	266	88	156	171
February	69	194	38	180	196	9	18	24	17	44	107	228	94	209	261
March	61	199	15	254	154	12	32	1	23	35	88	251	23	293	196
April	63	191	10	296	176	13	42	5	49	28	96	254	33	352	215
May	97	230	7	416	190	29	30	7	47	35	172	284	24	477	236
June	128	203	7	436	209	30	10	4	44	26	190	228	28	489	248
July	147	153	12	397	254	31	21	12	16	47	202	201	57	423	319
August	155	115	27	251	249	20	9	14	45	69	207	144	78	305	325
September	133	95	26	235	237	23	17	6	42	51	185	133	79	287	315
October	147	61	68	148	339	32	15	13	29	55	209	119	91	179	415
November	184	50	131	239	300	24	20	26	36	63	236	114	206	279	389
December	194	55	222	150	260	31	25	26	13	65	249	118	287	175	337
	1,422	1,753	610	3,142	2,712	260	270	147	370	538	2,016	2,340	1,088	3,624	3,427

[a] Including gas wells.

Initial daily production of new wells completed in Kansas in 1917, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Allen	280	285	140	70	133	205	200	635	48	215	187	232	2,630
Anderson	......	......	......	15	......	20	......	......	......	......	95	......	130
Bourbon	......	......	......	......	......	......	30	......	......	......	......	......	30
Butler	15,350	12,040	14,870	11,165	9,470	24,235	35,440	36,090	55,835	40,062	25,105	9,240	288,902
Chautauqua	375	668	323	225	358	293	445	288	362	584	626	1,175	5,722
Coffey	......	......	......	......	......	......	......	......	......	......	......	10	10
Cowley	50	......	......	55	......	......	......	10	......	4	10	25	154
Douglas	......	......	......	......	......	......	......	......	......	......	10	35	45
Elk	......	59	55	139	309	50	20	......	......	......	14	52	689
Franklin	45	343	180	50	13	118	283	435	311	366	279	140	2,563
Greenwood	55	......	......	......	......	......	60	280	10	85	195	200	885
Labette	660	240	230	240	275	55	35	......	......	......	......	......	1,735
Miami	177	305	102	250	255	245	430	250	549	83	503	465	3,614
Montgomery	320	328	523	276	597	427	705	403	235	396	275	389	4,874
Neosho	185	455	165	250	275	785	995	440	365	305	438	529	5,187
Wilson	35	80	80	48	58	153	331	65	289	344	60	53	1,596
Woodson	......	30	35	60	35	20	......	......	......	......	20	127	327

Total and average initial production of new wells in Kansas, 1913–1917, by counties, in barrels.

County.	Total initial production.					Average per well.				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Allen	2,960	1,896	500	3,771	2,630	19.2	10.8	10.2	12.0	11.4
Anderson	....	10	....	....	130	....	10.0	....	....	21.6
Bourbon	....	5	....	20	30	....	....	....	....	15.0
Butler	....	47	3,320	213,633	288,902	....	9.4	15.1	255.8	290.6
Chautauqua	7,358	5,379	2,515	10,088	5,722	23.7	17.5	22.5	22.9	22.3
Coffey	....	45	20	40	10	....	9.0	6.7	10.0	10.0
Cowley	....	150	55	140	154	....	50.0	27.5	46.7	22.0
Douglas	....	....	....	....	45	....	....	....	....	11.2
Elk	....	....	....	159	689	....	....	....	14.5	15.6
Franklin	748	1,360	620	2,666	2,563	13.9	8.3	8.7	11.4	18.0
Greenwood	....	....	....	18	885	....	....	....	9.0	63.2
Labette	....	32	105	85	1,735	....	4.0	5.5	6.1	45.6
Linn	....	30	....	10	....	....	15.0	....	10.0	....
Miami	....	920	462	4,199	3,614	....	7.0	14.0	19.4	19.8
Montgomery	5,871	6,262	2,505	10,204	4,874	9.8	9.1	12.5	13.1	14.5
Neosho	5,168	2,414	1,182	3,368	5,187	20.1	10.9	12.8	14.3	17.4
Wilson	342	268	35	365	1,596	8.6	9.9	5.8	8.1	11.6
Woodson	13	114	....	80	327	6.5	9.5	....	11.4	14.8
Miscellaneous	7	....	....	....	....	3.5	....	....	....	....
	22,467	18,932	11,319	248,846	319,093	15.8	10.8	18.6	79.2	117.6

Total initial daily production of new wells in Kansas, 1913–1917, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1913	860	1,065	1,003	1,897	1,548	1,918	1,945	2,250	2,283	2,501	2,857	2,340	22,467	1,872
1914	2,077	2,196	1,950	2,083	2,411	2,178	1,820	1,395	1,006	700	501	615	18,932	1,578
1915	843	974	230	105	110	130	225	530	370	790	1,927	5,085	11,319	943
1916	2,845	3,875	6,410	9,784	14,429	33,501	28,741	30,569	50,243	35,232	20,402	12,815	248,846	20,737
1917	17,532	14,824	16,703	12,843	11,778	26,606	38,974	38,896	58,004	42,444	27,817	12,672	319,093	26,591

OKLAHOMA.

GENERAL STATEMENT.

For the third consecutive year the output of petroleum in Oklahoma was sufficient in 1917 to assure that State first rank among the States contributing to the petroleum supply of the country. Its output in 1917 constituted 32 per cent of the output of the entire country and was greater by 13,600,000 barrels than the output of California, its closest competitor. The quantity of petroleum marketed from the oil fields of Oklahoma in 1917 was 107,507,471 barrels and was greater by 435,756 barrels, or 0.4 per cent, than the output in 1916. Credit for the fact that Oklahoma maintained and increased slightly in 1917 the average rate of production maintained in 1916 belongs in part to the Healdton and Glenn districts but in larger measure to the many minor districts of northeastern Oklahoma, the development of which had been postponed during the period of dominance of the local petroleum industry by the prolific Cushing district. Of the major districts Healdton was the only one to increase materially its output of petroleum in 1917 compared with 1916 the gain amounting to 4,752,599 barrels, or 35 per cent. Glenn increased its output slightly, the gain amounting to 624,266 barrels, or about 8.5 per cent, but Cushing decreased markedly, the loss amounting to 13,171,420 barrels, or about 33 per cent. The aggregate output of the minor districts increased, however, from 46,277,757 barrels in 1916 to 54,508,068 barrels in 1917, a net gain of 8,230,311 barrels, or 18 per cent.

The average price received at the wells for the petroleum marketed in Oklahoma in 1917 was $1.69 a barrel, and the market value of the output was $181,646,981, a gain of 49 cents in the average unit price and of $53,183,176, or 41 per cent, in the total market value of the oil sold, compared with 1916.

DEVELOPMENT.

The quest for petroleum in Oklahoma in 1917 resulted in the completion of 6,797 wells, compared with 7,583 in 1916. Of these, 5,027, or 74 per cent, produced an average of 73 barrels of oil each the first 24 hours after completion, 410 produced gas, and 1,360, an average of 1 in 5 drilled, were failures.

NORTHEASTERN OKLAHOMA.

Cherokee district.—Activity in drilling in the shallow-sand districts in Craig, Nowata, and northern Rogers counties was appreciably less in 1917 than in 1916 because of the scarcity of undeveloped territory in that part of the State. Of 731 wells completed in 1917 in the Cherokee shallow-sand district, 647, or 88 per cent, were oil wells, 3 were gas wells, and 81 were unsuccessful. The average initial yield of the new oil wells was 18 barrels each, though the initial output of a few wells in a moderate eastward extension of the Chelsea district proved in the southeastern part of T. 24 N., R. 17 E., in 1917, ranged as high as 100 barrels each. In the deep-sand division of the Cherokee district in Washington, western Rogers, and northern Tulsa counties no new developments of consequence were reported in 1917. Only 786 new wells were completed in this division, as compared with 1,294 in 1916. Of these, 639, or 81 per cent, produced oil, 32 produced gas, and 115 were barren of either. The average yield of the new oil wells the first day of productive life was 21.5 barrels each, compared with 17.3 barrels in 1916.

Osage district.—The quantity of petroleum marketed in 1917 from the Osage Indian Reservation was 11,214,986 barrels, a gain of 2,362,143 barrels, or 27 per cent, compared with 1916. Activity in drilling in the Osage Reservation was more than twice as great in 1917 as in 1916. Data furnished by the Office of Indian Affairs show that 816 wells were completed in Osage County in 1917. Of these, 578, or 71 per cent, were oil wells, 70, or 8.5 per cent, were gas wells, and 168, or 20.5 per cent, were failures. The revenue accruing to the Indians from the sale of this oil was $3,369,187, a gain of $1,638,513, or 94 per cent, over the revenue in 1916. Two auction sales of oil leases on undeveloped quarter-section tracts in the Osage Reservation were held in 1917, one on May 31 and the other on November 12. The first sale resulted in the disposition of some 9,120 acres, on which the aggregate bonus was $1,997,600, an average of about $219 an acre. The second sale resulted in the disposition of 20,800 acres, on which the aggregate bonus was $1,687,000, an average of $81 an acre.

New territory of promise for oil production was opened in April by the completion of a 750-barrel oil well by Graham & Bird in sec. 25, T. 23 N., R. 8 E., about 3 miles southeast of the prolific pool opened last year by the Tidal Oil Co. in secs. 9 and 16 of the same township.

Near Nelagoney interest in the development of a pool opened about three years ago in the southeast corner of T. 25 N., R. 9 E., was revived in April by the completion by J. V. Foster of a 1,000-barrel oil well in sec. 25 of the township designated, a short distance northeast of the old wells.

In the eastern part of the reservation, which has been under development for 12 to 14 years, gratifying evidence that the oil resources have by no means been exhausted was furnished in 1917 in the completion by the Lewcinda Oil Co. in March and in October of wells credited with initial yields of 3,000 to 4,500 barrels of oil the first 24 hours after completion, in sec. 12, T. 25 N., R. 11 E.; and in the completion by the United Producers Co. in March of a 1,000-barrel oil well in sec. 23, T. 29 N., R. 10 E., in territory more or less condemned a decade ago.

Kay County.—Impetus was given to the gradual development of the Blackwell field in Kay County in 1917 by the discovery in June in the southeastern part of the deep-sand field of oil production in sands at 1,700 feet and 2,000 feet that in the heart of the deep territory had yielded only gas. In the last half of 1917, activity in drilling was centered in the shallow-sand territory, which was proved to extend due south from the deep-sand pool in the northwest corner of T. 28 N., R. 1 E., through the western range of sections in that township into secs. 30 and 29. The initial capacities of oil wells completed in this territory ranged from 100 to 800 barrels a day. Development in the deep-sand field, though necessarily slow, was active throughout the year, and resulted in the completion of a number of 400 to 600 barrel oil wells at depths of about 3,400 feet, New territory was added to the deep-sand field in November by the completion in that month of an oil well in sec. 25, T. 29 N., R. 1 W.. northwest of the other producing wells.

Pawnee County.—Outside the Cleveland and adjacent proved districts, in which normal activity prevailed, interest in drilling in Pawnee County in 1917 was centered in the development of the Quay and Jennings districts on the southern boundary of the county.

Early in the year evidence that the Quay district extended into Pawnee County was furnished in the completion of a 500-barrel oil well by Cosden & Co., on sec. 36, T. 20 N., R. 5 E., and further proof equally conclusive was demonstrated by the same company on that section before the end of the year. The Jennings pool, opened last year in sec. 22, T. 20 N., R. 7 E., was actively developed in 1917 and was proved to extend westward into sec. 19 and southeastward into sec. 26 of that township. A few gas wells were completed in the Otoe district in the northwest corner of Pawnee County, and a small quantity of oil was found at a reported depth of 3,890 feet in one well drilled by the Fortuna Oil Co. in sec. 5, T. 23 N., R. 3 E.

Noble County.—As a consequence of the drilling begun near Billings late in 1916, following discoveries of gas and oil in a wildcat test drilled by the Mid-Co. Petroleum Co. in sec. 22, T. 23 N., R. 2 W., an oil field of considerable promise was opened in 1917 in Noble County. When finally completed at a depth of about 2,150 feet in April, the discovery well of the Billings district was credited with an initial capacity of about 75 barrels a day. Six or seven other successful wells completed before the end of 1917 extended the proved area of the field westward from the discovery well into sec. 21, and northward from it into the northern half of sec. 15, T. 23 N., R. 2 W. The average initial capacity of the oil wells completed was 202 barrels each the first day of productive life, and the grade of oil obtained was reported to be exceptionally high.

Garfield County.—In the Garber field, opened in 1916 in Garfield County by the Sinclair Oil & Gas Co., in sec. 25, T. 22 N., R. 4 W., development was more rapid in 1917 than in the Billings district 10 miles to the northeast, a circumstance that is accounted for by the relatively shallow depth of the productive sand, 1,130 to 1,200 feet, and the superior quality of the oil, 45° Baumé gravity. In all, 96 wells were completed in the Garber district in 1917. Of these, 70 produced oil at the average rate of 167 barrels each the first 24 hours after completion, 4 produced gas only, and the remaining 22 were failures. From the discovery well the proved area of the field was extended southward to the center of sec. 25, T. 22 N., R. 4 W., northward to the south boundary of sec. 13 of that township, and eastward into the W. ½ secs. 18 and 19 of the adjoining township to the east. Marketing facilities were provided by the Enid Oil & Pipe Line Co., which constructed a 20-mile, 4-inch pipe line to Enid and began handling oil in November.

Payne County.—Principal interest in petroleum development in Payne County in 1917 was centered in the Yale-Quay district in the northeast corner of that county, where, despite the necessity of drilling to an average depth of 3,100 feet, many productive oil wells were completed in 1917 in secs. 1, 12, 13, and 14, T. 19 N., R. 5 E., and secs. 6, 7, and 18, T. 19 N., R. 6 E., as well as in the northern extension of the field in Pawnee County, to which reference has already been made. Additional oil wells of fair capacity were completed in T. 18 N., R. 5 E., near the town of Cushing, and numerous gas wells were drilled in T. 19 N., R. 4 E., near Ingalls.

In the last district an oil well, credited with an initial flow of 1,800 barrels the first 24 hours after completion, was brought in by the Fortuna Oil Co. in November in sec. 27, T. 19 N., R. 4 E., about a quarter of a mile northeast of the less valuable oil well completed by the same company in 1916. Production was obtained at a reported depth of 3,860 feet, and was maintained for four days after the well was completed, but ceased abruptly on the fourth day as a consequence of caving, and was not restored before the end of 1917.

Creek County.—In the absence of new territory of consequence in the Cushing district in western Creek County, the results of routine development were insufficient to offset the diminishing output of the old wells, and a gradual decline in the output of the entire district took place. From an average of about 85,000 barrels of oil a day at the beginning of 1917, the output of this famous district declined steadily to about 50,000 barrels at the end of the year. At the north end of the district near Oilton fair results were obtained in efforts to extend the proved limits of the field, wells of moderate capacity being completed north and east of previous production in secs. 28, 27, and 34, T. 19 N., R. 7 E., and along the common boundary of secs. 2 and 3 and in sec. 11, T. 18 N., R. 7 E. In the Shamrock division at the south end of the Cushing district development was active throughout 1917 but was featureless.

The success that attended deeper drilling in parts of the Glenn district in the eastern part of Creek County and the larger number of oil wells completed account for the moderate gain in yield of petroleum credited to that district in 1917.

Between the Cushing and Glenn districts oil wells of fair capacity were completed in the minor pools in the southeast quarter of T. 18 N., R. 10 E., and near the center of T. 15 N., R. 10 E., and promising showings of oil were reported from wildcat tests in sec. 24, T. 19 N., R. 10 E., and sec. 28, T. 14 N., R. 8 E.

Tulsa County.—The center of interest in Tulsa County in 1917 was the Bixby pool, which in the early months of the year furnished a number of oil wells credited with initial yields in excess of 1,000 barrels each the first 24 hours after completion, the greater proportion being on the Williams lease, in sec. 32, T. 17 N., R. 13 E.

Wagoner County.—Development in the Stone Bluff district in the southwestern part of Wagoner County resulted in the opening of new territory valuable for oil production in sec. 30, T. 17 N., R. 15 E., and in sec. 25 of the adjoining township to the west, northwest of the original Stone Bluff pool. In that extension several wells credited with initial yields in excess of 200 barrels a day each were completed in the last half of the year.

Okmulgee County.—Activity in drilling in Okmulgee County in 1917 resulted in the opening up of promising new territory in sec. 25, T. 14 N., R. 11 E., 7 miles northwest of Okmulgee, and in the development of a profitable pool of oil, designated the Delany pool, in a 2,000-foot sand in sec. 20, T. 14 N., R. 14 E.

Muskogee County.—Following the completion in June by the McCoach Oil Co. of a 200-barrel oil well at a depth of about 1,900 feet on the Dan lease in sec. 14, T. 13 N., R. 15 E., other wells drilled in that locality resulted in the partial development of a new pool of oil, the limits of which were not determined in 1917 in southwestern Muskogee County.

Moderate extensions to the Boynton field were proved in 1917 and in the late months of the year the completion of a number of wells of relatively large initial capacity in secs. 35 and 36, T. 15 N., R. 15 E., inspired new activity in the Haskell district.

EAST-CENTRAL OKLAHOMA.

Lincoln County.—Additional drilling by the Roxana Petroleum Co. in sec. 30, T. 17 N., R. 3 E., near the gas well completed by that company in Lincoln County last year resulted only in disappointment.

Okfuskee County.—Aside from the completion of a few wells of small capacity in secs. 22 and 36, T. 12 N., R. 11 E., in territory adjacent to the Tiger Flats district in Okmulgee County, activity in drilling in Okfuskee County in 1917 was of the wildcat type and resulted unsuccessfully in localities other than sec. 24, T. 13 N., R. 10 E., where in April John Owens and others completed an oil well, No. 2 on the Tamachee lease, credited with an initial output of 150 barrels a day.

McIntosh County.—The year 1917 was featureless as far as oil or gas developments of consequence in McIntosh County are concerned. A few oil wells of small capacity were completed in sec. 6, T. 12 N., R. 14 E., and numerous gas wells were completed in the west half of Tps. 11 and 12 N., R. 14 E.

Cherokee County.—An unsuccessful wildcat test was drilled by B. B. Rice and others in sec. 20, T. 17 N., R. 20 E., in Cherokee County.

Sequoyah County.—Nothing of consequence was found in the wildcat test drilled by the Salisaw Production Co., in sec. 13, T. 12 N., R. 24 E., and the well was abandoned in 1917.

Haskell County.—A dry hole resulted from the test drilled in 1917 by the Escrow Oil Co., in sec. 6, T. 7 N., R. 19 E., Haskell County.

Pottawatomie County.—Unsuccessful tests were completed in Pottawatomie County in 1917 by the Prairie Oil & Gas Co., on the Rose lease in sec. 7, T. 7 N., R. 5 E., and by the Wilstone Oil Co. on the Dodds farm in sec. 8, T. 9 N., R. 5 E.

Seminole County.—In Seminole County one unsuccessful wildcat test was completed in 1917 by McCoy and others on the Cyrus farm in sec. 11, T. 8 N., R. 7 E.

Pittsburg County.—The quest for oil and gas production in Pittsburg County in 1917 resulted in the completion of gas wells by the Quinton Oil & Gas Co. on the King and Buscomb leases in secs. 1 and 2, T. 7 N., R. 18 E., by the Bennington Oil & Gas Co. in sec. 28, T.

6 N., R. 12 E., and by the Cardinal Oil Co. on the Fears lease in sec. 29, T. 9 N., R. 16 E., and in barren wells completed by Shaffer and others in sec. 18, T. 8 N., R. 16 E., by the Choctaw Natural Gas Co. in sec. 2, T. 7 N., R. 18 E., and by the Lucky Tiger Oil Co. in sec. 8, T. 2 N., R. 16 E.

Coal County.—In Coal County natural gas was found in a test drilled in 1917 by the Lucilene Oil Co. on the Chiles farm in sec. 30, T. 3 N., R. 10 E., but a test drilled by Topley and others on the Van Doran lease in sec. 34, T. 3 N., R. 9 E., was barren.

Johnston County.—In sec. 25, T. 15, R. 7 E., 2 miles northwest of the village of Bromide a test drilled by the Bromide Petroleum Co. in 1917 was barren.

Atoka County.—Wildcat operations in Atoka County in 1917 resulted in the completion of one barren test in sec. 4, T. 1 S., R. 14 E., near the town of Redden.

SOUTHERN OKLAHOMA.

Carter County.—The gain of 35 per cent in the output of petroleum from the Healdton field in 1917, to which reference has already been made, was effected by the drilling in Carter County of 519 wells, of which 456, or 88 per cent, produced oil. The average output of the oil wells during the first day of productive life was 95 barrels each, compared with a corresponding average of 127 barrels in 1916. The output of the district as a whole was remarkably uniform, varying but little from a daily average of 60,000 barrels during the entire year. Marginal tests sustained interest in the development of the Healdton district throughout 1917. Toward the southeast productive territory was proved to exist in secs. 18 and 19, T. 4 S., R. 2 W., and at the end of the year interest was centered in a promising showing of oil at a depth of about 1,930 feet in an advance test drilled by the Roxana Petroleum Co. on the Westheimer farm in sec. 25, T. 4 S., R. 3 W. Toward the north a little additional territory was proved productive in the south half of sec. 30, T. 3 S., R. 3 W. In the northeastern part of the field interest at the end of 1917 was centered in efforts to demonstrate the significance of a new sand found at a depth of about 2,700 feet by the Bull Head Oil Co., in its deep test on the Dana farm in sec. 4, T. 4 S., R. 3 W. This test was completed in October and was credited with an initial output of 60 barrels of light-gravity oil a day.

Northeast of the Healdton field oil of fuel grade was found in fair quantity in wildcat tests drilled by Earl Athey in sec. 7, T. 2 S., R. 2 W., and by the Wildcat Jim Oil Co. in sec. 18 of the same township. Some distance east of the Healdton field similar oil in small quantity was found at a depth of 685 feet in a test drilled by the American Industrial Oil Co. in sec. 19, T. 4 S., R. 1 W., near Lone Grove.

Principal interest in advance drilling in Carter County was centered, however, in the Fox district, some 8 miles north of the Healdton pool in the southern part of T. 2 S., R. 3 W. Development in 1917 included the completion in April of a 500-barrel oil well, a joint test by the Gypsy and Sinclair oil companies on the Mattie Morris farm in the NE. ¼ sec. 29; the completion in October of a 150-barrel oil well by the Gypsy Oil Co. on the Lindersmith farm in the NW. ¼ sec.

28; the completion in November of a 75-barrel oil well, a joint test by the Sinclair and Astral oil companies in sec. 29; the completion in December of a 100-barrel oil well by the Gypsy Oil Co. on the W. B. Johnson farm in sec. 28; and the completion at various intervals during the year of half a dozen or so prolific gas wells in the same locality. At the end of 1917 the Fox district was ranked second only to the Blackwell district in Kay County as a source of natural gas, but as a source of petroleum it was regarded as a disappointment.

Facilities for marketing the oil produced in the Healdton district were improved in 1917 by the completion of additional pipe lines by the Magnolia Petroleum Co., by the laying of new lines into the field by the Texas Co., the Yarhola Pipe Line Co., and the Pierce Pipe Line Co., and by the erection of three refineries at Wilson by the Wilson, Nyanza, and Terminal Refining companies.

Cotton County.—As a consequence of wildcat drilling an important gas field, the areal limits of which remained undetermined at the end of the year, was opened in 1917 in Cotton County. The discovery well drilled by Keyes & Young was located in sec. 23, T. 1 S., R. 10 W. It was completed in April at a reported depth of 2,165 feet and was credited with an open flow capacity of 15,000,000 cubic feet of gas a day. Before the end of the year wells of equal or larger capacity had been completed in secs. 25 and 27 of the same township and arrangements had been made by the Lone Star Gas Co. to extend the mains it was laying from Alvord, Tex., to the Loco field in Stephens County to this unexpected source of supply.

Stephens County.—Aside from the completion of a number of prolific gas wells in the Loco gas field and from the prospect of marketing the gas available in that district in the cities and towns of northern Texas in 1918, afforded by the gas pipe line of the Lone Star Gas Co., to which reference is made in the foregoing paragraph, no developments of especial significance resulted from the moderate activity in drilling in Stephens County in 1917.

Pontotoc County.—A decided increase in activity in drilling in the shallow-sand Allen and Francis districts in northeastern Pontotoc County resulted in a substantial gain in the production of oil and in the demonstration of the existence of additional territory a mile or so east of the old Allen district, capable of yielding oil wells having initial capacities of 10 to 20 barrels each.

Marshall County.—Outside the Madill district, which for the last seven or eight years has been producing a small quantity of 47° Baumé gravity oil from a 5-foot sand reached at an average depth of 420 feet, the quest for oil in Marshall County in 1917 yielded only negative results. Deeper drilling in the test well of the Ardmill Oil Co. in sec. 17, T. 5 S., R. 5 E., in which encouraging showings of light oil were found last year, failed to result in any increased production, and the well was abandoned in February at a depth of 2,004 feet. Other unsuccessful tests completed during the year were well No. 1 of the Dundee Petroleum Co. in sec. 9, T. 6 S., R. 6 E., depth 2,270 feet, and well No. 1 of the Indian Chief Oil Co. in sec. 19, T. 7 S., R. 5 E., depth, 2,450 feet.

Love County.—Wildcat tests, unsuccessful as far as the discovery of either oil or gas are concerned, were completed in Love County in sec. 23, T. 6 S., R. 3 W., by the Interstate Petroleum Co., and in sec. 13, T. 7 S., R. 3 W., by the Pierce-Fordyce Oil Association, the well of the latter company being abandoned at a reported depth of 2,365 feet.

Garvin and Grady counties.—Aside from a showing of oil at 955 feet in a test well drilled by Nicholson & Mortimer in sec. 2, T. 2 N., R. 1 W., Garvin County, wildcat tests in Garvin and Grady counties in 1917 yielded only negative results. Other tests were completed and abandoned in sec. 24, T. 2 N., R. 1 W., and in sec. 27, T. 3 N., R. 5 W.

Caddo County.—Following the discovery of oil in small quantity in a wildcat test drilled last year near Cement, Caddo County, other tests were drilled in that locality in 1917. Of these, two wells drilled in sec. 35, T. 6 N., R. 10 W., and in sec. 28, T. 5 N., R. 12 W., were barren, and one well drilled by the Fortuna Oil Co. in sec. 31, T. 6 N., R. 9 W., produced gas from a sand reached at a depth of 2,340 feet, the initial open flow capacity of the well being rated at 35,000,000 cubic feet a day.

WESTERN OKLAHOMA.

Miscellaneous tests.—Unsuccessful tests for oil and gas were completed in 1917 in sec. 33, T. 26 N., R. 3 W., sec. 26, T. 27 N., R. 3 W., and sec. 34, T. 28 N., R. 7 W., Grant County; sec. 27, T. 29 N., R. 9 W., Alfalfa County; sec. 1, T. 25 N., R. 15 W., Woods County; sec. 8, T. 23 N., R. 9 W., Major County; secs. 4 and 32, T. 19 N., R. 3 W., and sec. 26, T. 16 N., R. 3 W., Logan County; sec. 24, T. 13 N., R. 10 W., sec. 2, T. 16 N., R. 10 W., and sec. 4, T. 19 N., R. 13 W., Blaine County; sec. 22, T. 16 N., R. 17 W., Dewey County; sec. 20, T. 12 N., R. 16 W., and sec. 32, T. 13 N., R. 20 W., Custer County; sec. 29, T. 4 N., R. 14 W., Comanche County; and sec. 8, T. 4 S., R. 17 W., Tillman County.

PETROLEUM MARKETED.

Petroleum marketed in Oklahoma in 1916 and 1917, in barrels.

Month.	Glenn.	Cushing.	Healdton.[a]	Other.	Total.
1916.					
January	528,265	2,664,713	1,128,671	4,119,580	8,441,229
February	614,390	2,819,033	1,280,485	4,049,330	8,763,238
March	838,580	3,060,818	1,448,646	4,283,694	9,631,738
April	562,855	2,769,112	1,401,251	3,888,215	8,621,433
May	657,389	3,090,739	1,419,564	4,187,394	9,355,086
June	650,594	3,588,851	1,037,221	3,770,794	9,047,460
July	530,418	4,175,153	811,353	3,233,236	8,750,160
August	556,107	4,052,448	920,898	2,945,378	8,474,831
September	579,463	3,842,208	843,605	3,496,422	8,761,698
October	593,220	3,650,646	1,168,359	3,987,258	9,399,483
November	646,137	3,403,004	1,137,578	3,611,131	8,797,850
December	524,561	2,794,323	1,003,300	4,705,325	9,027,509
	7,281,979	39,911,048	13,600,931	46,277,757	107,071,715
1917.					
January	625,650	2,220,587	1,208,872	4,509,192	8,564,301
February	548,888	2,032,282	1,395,238	3,953,482	7,929,890
March	667,256	2,365,986	1,732,558	4,709,078	9,474,878
April	682,620	2,137,396	1,681,492	4,437,097	8,938,605
May	682,135	1,997,591	1,668,261	4,615,612	8,963,599
June	687,855	2,136,937	1,662,861	4,508,189	8,995,842
July	722,411	2,730,864	1,713,531	4,396,807	9,563,613
August	704,464	2,096,677	1,685,876	4,554,890	9,041,907
September	614,097	2,157,225	1,615,869	4,625,780	9,012,971
October	613,399	2,420,647	1,444,918	5,081,068	9,560,032
November	608,141	2,427,499	1,334,118	4,773,336	9,143,094
December	749,329	2,015,937	1,209,936	4,343,537	8,318,739
	7,906,245	26,739,628	18,353,530	54,508,068	107,507,471

[a] Includes Wheeler.

Petroleum marketed from Glenn pool, 1913-1917, in barrels.

Month.	1913	1914	1915	1916	1917
January	792,336	839,483	464,627	528,265	625,650
February	718,580	769,809	421,922	614,390	548,888
March	807,022	871,334	459,546	838,580	667,256
April	823,645	849,316	455,184	562,855	632,620
May	850,607	897,397	508,786	657,389	682,135
June	816,789	852,901	462,224	650,594	687,855
July	787,274	828,350	551,222	530,418	722,411
August	734,476	535,027	555,514	556,107	704,464
September	773,847	431,051	518,546	579,463	614,097
October	817,628	584,178	534,608	593,220	613,399
November	753,115	604,397	520,012	646,137	608,141
December	794,551	614,346	541,437	524,561	749,329
	9,469,870	8,677,589	5,993,628	7,281,979	7,906,245

PIPE-LINE RUNS.

Pipe-line runs in Oklahoma in 1916 and 1917, in barrels.

1916.

Month.	Runs from wells.		Field fuel and rail shipments not included in pipe-line runs.	Total.
	Cosden, Gulf, Magnolia, Prairie, and Texas companies' trunk lines.	Private and other lines supplying refineries in Oklahoma and Kansas.		
January	5,808,612	2,455,743	176,874	8,441,229
February	5,882,197	2,676,716	204,325	8,763,238
March	6,386,278	3,034,344	211,116	9,631,738
April	5,641,952	2,743,312	236,169	9,621,433
May	6,023,875	3,035,803	295,408	9,355,086
June	5,754,993	3,006,389	286,078	9,047,460
July	5,314,322	3,143,437	292,401	8,750,160
August	5,159,011	3,060,475	255,345	8,474,831
September	5,150,206	3,372,274	239,218	8,761,698
October	5,286,663	3,875,565	237,255	9,399,483
November	4,786,612	3,819,674	191,564	8,797,850
December	5,525,370	3,336,636	165,503	9,027,509
	66,720,091	37,560,368	2,791,256	107,071,715

1917.

Month.	Runs from wells.		Field fuel and rail shipments not included in pipe-line runs.	Total.
	Cosden, Gulf, Magnolia, Prairie, Sinclair-Cudahy, and Texas companies' trunk lines.	Private and other lines supplying refineries in Oklahoma and Kansas.		
January	6,304,278	2,224,729	35,294	8,564,301
February	5,394,352	2,493,914	41,624	7,929,890
March	6,457,543	2,943,994	73,341	9,474,878
April	6,171,218	2,650,972	116,415	8,938,605
May	6,590,740	2,291,471	81,388	8,963,599
June	6,354,164	2,566,802	74,876	8,995,842
July	6,750,636	2,733,735	79,242	9,563,613
August	6,498,681	2,450,280	92,946	9,041,907
September	6,254,057	2,654,170	104,744	9,012,971
October	6,370,759	3,070,480	118,793	9,560,032
November	6,181,002	2,866,446	95,646	9,143,094
December	5,536,120	2,711,987	70,632	8,318,739
	74,863,550	31,658,980	984,941	107,507,471

OSAGE COUNTY.

Petroleum marketed in Osage County from Jan. 1, 1903, to Dec. 31, 1917, in barrels.

1903	56,905	1908	4,961,147	1913	9,009,996
1904	652,479	1909	4,516,524	1914	9,935,692
1905	3,421,478	1910	5,892,970	1915	8,604,389
1906	5,219,106	1911	11,707,676	1916	8,852,843
1907	5,143,971	1912	8,169,158	1917	11,214,986

Royalty received by Osage Nation on oil and gas from wells in Osage County, 1912–1917.

Year.	Oil.	Gas.	Total.	Year.	Oil.	Gas.	Total.
1912	$677,739	$3,895	$681,634	1915	$629,539	$13,689	$632,228
1913	1,033,530	5,943	1,039,473	1916	1,730,674	497,522	2,228,196
1914	993,770	10,252	1,004,022	1917	3,369,187	799,345	4,168,532

The following table shows the number of wells owned in Osage County by the Indian Territory Illuminating Oil Co. and its sublessees and successors:

Oil and gas wells in Osage County, 1903–1917.

Date.	Completed.	Productive.	Gas.	Dry.[a]	Date.	Completed.	Productive.	Gas.	Dry.[a]
Jan 1, 1903	30	17	2	11	Dec. 31, 1909	1,574	1,027	81	466
Dec 31, 1904	361	243	21	97	Dec. 31, 1910	1,735	1,175	82	478
June 10, 1905	544	355	34	155	Dec. 31, 1911	2,233	1,562	90	581
Dec. 31, 1905	704	462	45	197	Dec. 31, 1912	2,682	1,887	112	683
June 10, 1906	862	569	55	238	Dec. 31, 1913	3,307	2,323	145	839
Dec. 31, 1906	1,080	716	66	298	Dec. 31, 1914	3,785	2,654	172	959
June 30, 1907	1,155	779	67	309	June 30, 1916	4,211	2,838	227	1,146
Dec. 31, 1907	1,277	837	71	369	Dec. 31, 1916	4,430	2,968	274	1,188
Dec. 31, 1908	1,422	936	78	408	Dec. 31, 1917	5,246	3,546	344	1,356

[a] Wells that have been exhausted and abandoned in addition to wells that were dry when drilled in.

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade journal sources and differ somewhat from those on page 700, obtained from reports received directly from the oil producers:

Well record in Oklahoma in 1918 and 1917.

District and pool.	1916					1917				
	Wells completed.			Initial daily production (barrels).		Wells completed.			Initial daily production (barrels).	
	Oil.	Dry.	Total.[a]	Total.	Average per well.	Oil.	Dry.	Total.[a]	Total.	Average per well.
Cherokee, deep sand:										
Bartlesville, Hogshooter; Copan, Ramsey, Wann; Dewey	601	65	700	10,391	17.3	475	71	562	10,191	21.5
Bird Creek, Owasso, Collinsville, Vera	486	88	594	8,403	17.3	164	44	224	3,557	21.6
	1,087	153	1,294	18,794	17.3	639	115	786	13,748	21.5

[a] Including gas wells.

Well record in Oklahoma in 1916 and 1917—Continued.

District and pool.	1916					1917				
	Wells completed.			Initial daily production (barrels).		Wells completed.			Initial daily production (barrels).	
	Oil.	Dry.	Total.	Total.	Average per well.	Oil.	Dry.	Total.	Total.	Average per well.
Cherokee, shallow sand: Delaware, Alluwe, Chelsea	1,105	95	1,219	15,972	14.5	647	81	731	11,873	18.4
Pawnee: Cleveland	140	46	197	6,058	43.3	212	44	273	17,990	84.9
Creek:										
Bald Hill	413	96	522	13,655	33.1	470	109	609	20,596	43.8
Cushing	785	62	904	230,634	293.8	288	32	336	26,754	92.9
Glenn, Tancha, Sapulpa, Tulsa, Inola, Wicey, Kelleyville	781	140	988	49,268	63.1	804	321	1,208	62,919	78.3
Morris, Okmulgee	139	60	211	9,470	68.1	319	140	501	13,412	42.0
Muskogee, Wagoner, Broken Arrow	583	268	911	56,581	97.1	367	247	665	26,458	72.1
Shulter, McIntosh, Okfuskee, Depew	53	89	161	2,185	41.2	14	11	29	815	58.2
Mounds, Hamilton Switch	40	12	55	1,985	49.6	21	13	36	1,500	71.4
	2,794	727	3,752	363,778	130.2	2,283	873	3,384	151,454	66.8
Healdton[a]	663	17	685	83,940	126.6	456	47	519	43,313	95.2
Osage	227	28	281	24,580	10.8	530	66	665	57,388	108.3
Blaine County	......	......	......	......	......	2	1	3	30	15.0
Caddo County	......	......	......	......	......	1	3	5	12	12.0
Comanche County	28	3	31	338	12.1	4	2	6	40	10.0
Garfield County	1	1	2	50	50.0	70	22	96	11,679	166.8
Hughes County	......	4	4	......	......	......	......	......	......	......
Jefferson County	2	6	8	85	42.5	2	5	7	50	25.0
Kay County	30	9	52	8,060	268.7	69	23	109	33,710	488.6
Kingfisher County	......	......	......	......	......	1	......	1	15	15.0
Noble County	......	......	......	......	......	8	4	15	1,695	212.0
Payne County	......	......	......	......	......	78	6	90	20,812	266.8
Pittsburg County	1	1	6	10	10.0	......	3	7	......	......
Pontotoc County	6	5	18	120	20.0	25	18	48	505	20.2
Stephens County	2	5	7	110	55.0	......	4	4	......	....
Miscellaneous	......	15	21	......	......	......	48	49	......	....
	6,086	1,120	7,583	521,895	85.8	5,027	1,360	6,797	365,314	72.7

[a] Including other tests in Carter County.

Wells completed in Oklahoma, 1913–1917.

District.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Cherokee, deep	2,724	1,331	324	1,087	639	299	236	78	153	115	3,249	1,789	471	1,294	786
Cherokee, shallow	1,071	1,472	519	1,105	647	139	77	54	95	81	1,231	1,558	600	1,219	731
Cleveland	187	77	47	140	212	68	27	26	46	44	262	111	76	197	273
Creek	2,404	2,651	2,044	2,794	2,283	654	719	565	727	873	3,313	3,573	2,784	3,752	3,384
Healdton[b]	15	340	289	663	456	5	43	22	17	47	23	392	318	685	519
Osage	506	423	139	227	530	69	99	31	28	66	620	572	190	281	665
Blaine County	.....	.....	.....	.....	2	.....	.....	.....	.....	1	.....	.....	.....	.....	3
Caddo County	.....	.....	.....	.....	1	.....	.....	.....	.....	3	.....	.....	.....	.....	5
Comanche County	.....	5	5	28	4	.....	2	8	3	2	.....	14	18	31	6
Garfield County	.....	.....	.....	1	70	.....	.....	1	1	22	.....	.....	1	2	96
Hughes County	.....	.....	1	.....	.....	.....	4	5	4	.....	.....	4	6	4	.....
Jefferson County	.....	2	.....	2	2	.....	13	13	6	5	.....	15	13	8	7
Kay County	29	58	16	30	69	23	49	10	9	23	55	113	32	52	109
Kingfisher County	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Kiowa County	.....	33	.....	.....	.....	.....	1	.....	.....	1	.....	36	.....	.....	1
Marshall County	.....	3	2	.....	.....	.....	2	24	5	3	.....	9	37	6	3
Noble County	.....	.....	.....	.....	8	.....	.....	.....	.....	4	.....	.....	.....	.....	15
Payne County	.....	.....	.....	.....	78	.....	.....	.....	.....	6	.....	.....	.....	.....	90
Pittsburg County	.....	.....	.....	1	.....	.....	2	3	1	3	.....	4	6	6	7
Pontotoc County	.....	10	1	6	25	.....	10	10	5	18	.....	26	23	18	48
Stephens County	.....	.....	10	2	.....	.....	3	6	5	4	.....	7	18	7	4
Miscellaneous	29	5	.....	.....	.....	51	56	29	15	39	98	69	31	21	44
	6,965	6,410	3,397	6,086	5,027	1,308	1,343	885	1,120	1,360	8,851	8,292	4,624	7,583	6,797

[a] Including gas wells.

[b] Including other tests in Carter County.

Oil wells and dry holes drilled in Oklahoma in 1917.

District.	January.		February.		March.		April.		May.		June.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Cherokee, deep	35	7	44	4	42	11	55	12	50	7	51	7
Cherokee, shallow	37	4	53	2	35	3	51	8	40	8	44	8
Cleveland	21	2	7	......	3	......	15	1	17	3	18	4
Creek	175	34	241	57	129	29	147	55	183	103	165	75
Healdton	17	......	10	......	30	3	43	2	42	3	61	7
Osage	27	1	27	7	29	2	39	3	22	1	52	4
Blaine County	......	......	......	......	......	......	......	......	......	......	......	......
Caddo County	......	......	......	......	......	......	......	......	......	......	......	......
Comanche County	3	......	......	......	......	......	......	......	......	......	......	......
Garfield County	1	......	1	1	3	1	3	1	7	1	6	......
Jefferson County	......	......	......	......	......	......	......	......	......	......	......	......
Kay County	......	......	1	......	2	......	3	......	3	1	2	1
Kingfisher County	......	......	......	......	......	......	......	......	......	......	......	......
Noble County	......	......	......	......	......	......	......	......	......	......	1	......
Payne County	4	......	1	......	......	......	......	......	......	......	......	......
Pontotoc County	2	......	5	......	......	......	......	......	3	......	2	......
Miscellaneous	......	1	......	......	......	......	......	......	......	......	......	......
	322	49	390	71	273	49	356	82	367	127	402	106

District.	July.		August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Cherokee, deep	60	10	63	23	90	13	73	11	49	8	27	2	639	115
Cherokee, shallow	66	3	41	3	53	12	62	10	86	9	79	11	647	81
Cleveland	30	6	26	3	20	10	20	11	24	1	11	3	212	44
Creek	207	62	156	40	184	95	298	129	216	90	182	104	2, 283	873
Healdton	43	2	34	4	40	2	49	4	52	11	35	9	456	47
Osage	46	4	49	8	72	9	66	5	58	11	43	11	530	66
Blaine County	.....	.....	.....	.....	2	.....	.....	.....	.....	1	.....	.....	2	1
Caddo County	.....	.....	.....	.....	1	3	.....	.....	.....	.....	.....	.....	1	3
Comanche County	.....	.....	.....	.....	1	1	.....	.....	.....	1	.....	.....	4	2
Garfield County	8	2	5	.....	7	5	17	5	8	4	4	2	70	22
Jefferson County	.....	.....	.....	.....	1	.....	1	4	.....	.....	.....	1	2	5
Kay County	2	2	5	3	9	3	15	2	11	6	16	5	69	23
Kingfisher County	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Noble County	2	.....	1	.....	1	.....	.....	3	3	.....	.....	1	8	4
Payne County	.....	.....	16	1	9	1	24	3	12	.....	12	1	78	6
Pontotoc County	2	.....	.....	.....	.....	.....	.....	2	9	9	2	7	25	18
Miscellaneous	.....	.....	.....	.....	.....	21	.....	10	.....	11	.....	7	.....	50
	466	91	396	85	491	175	625	199	528	162	411	164	5, 027	1, 360

Wells completed in Oklahoma, 1913–1917.

Month.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
January	375	684	213	512	322	69	153	56	84	49	483	876	292	626	401
February	433	653	225	458	390	61	138	52	102	71	520	849	297	593	493
March	401	733	195	566	273	67	149	63	136	49	492	929	285	738	343
April	470	725	236	627	356	46	190	56	145	82	548	974	324	805	472
May	624	796	214	750	367	111	178	39	133	127	793	1, 044	275	945	537
June	664	660	219	679	402	135	116	51	106	106	885	829	285	802	533
July	647	531	205	663	466	180	101	45	78	91	884	668	263	757	577
August	691	469	216	527	396	130	81	58	92	85	864	588	287	649	498
September	626	438	178	362	491	97	72	82	74	175	775	527	292	467	716
October	656	282	364	345	625	125	44	81	71	199	830	372	485	454	871
November	669	186	497	286	528	122	52	164	41	162	846	278	711	349	741
December	709	253	635	311	411	165	69	138	58	164	931	358	828	398	615
	6, 965	6, 410	3, 397	6, 086	5, 027	1, 308	1, 343	885	1, 120	1, 360	8, 851	8, 292	4, 624	7, 583	6, 797

[a] Including gas wells.

Initial daily production of new wells completed in Oklahoma in 1917, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Cherokee, deep	584	769	830	964	854	899	1,132	1,218	1,984	2,176	1,284	1,054	13,748
Cherokee, shallow	668	1,210	1,307	2,155	894	800	813	790	583	929	793	931	11,873
Cleveland	925	215	245	1,405	1,055	3,240	5,235	975	1,495	1,205	1,275	720	17,990
Creek	15,088	27,490	14,117	8,015	10,531	9,629	12,083	12,33	9,737	15,195	8,331	9,904	152,454
Healdton	2,125	1,405	2,740	4,090	3,870	6,453	4,290	3,920	4,082	4,555	3,588	2,195	43,313
Osage	2,145	1,444	6,420	4,080	4,140	4,507	10,430	4,402	3,745	5,395	7,175	3,505	57,388
Blaine County									30				30
Caddo County									12				12
Comanche County	25								15				40
Garfield County	75	15	184	100	515	210	560	1,850	1,450	4,680	1,570	470	11,679
Jefferson County									25	25			50
Kay County		300	1,800	1,850	450	450	4,500	4,250	3,675	9,300	2,660	4,475	33,710
Kingfisher County									15				15
Noble County						150	600	50	80		365		1,695
Payne County	950	50						6,860	2,085	5,675	2,632	2,560	20,812
Pontotoc County	40	85			90	75	60				135	20	505
	22,625	32,983	27,643	22,659	22,399	26,413	39,703	37,099	29,013	49,135	29,808	25,834	365,314

Total and average initial daily production of new wells in Oklahoma, 1913–1917, by districts, in barrels.

District.	Total initial production.					Average per well.				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Cherokee, deep	67,505	19,986	7,926	18,794	13,748	24.8	15.0	24.5	17.3	21.5
Cherokee, shallow	17,672	16,172	10,595	15,972	11,873	16.5	11.0	20.4	14.5	18.3
Cleveland	15,787	3,905	1,328	6,058	17,990	84.4	50.7	28.3	43.3	84.8
Creek	193,796	797,060	913,321	363,778	152,454	80.6	300.7	446.8	130.2	66.8
Healdton	844	106,171	85,320	83,940	43,313	56.3	312.3	295.2	126.6	95.0
Osage	34,856	26,787	15,830	24,580	57,388	68.9	63.3	113.9	108.3	108.3
Blaine County					30					15.0
Caddo County					12					12.0
Comanche County		59	35	338	40		11.8	7.0	12.1	10.0
Garfield County				50	11,679				50.0	166.8
Hughes County			40					40.0		
Jefferson County		215		85	50		107.5		42.5	25.0
Kay County	2,964	5,417	1,630	8,060	33,710	102.2	93.4	101.9	268.7	488.6
Kingfisher County					15					15.0
Kiowa County		185					5.6			
Marshall County		15	10				5.0	5.0		
Noble County					1,695					201.9
Payne County					20,812					395.0
Pittsburg County				10					10.0	
Pontotoc County		172	5	120	505		17.2	5.0	20.0	20.2
Stephens County			130	110				13.0	55.0	
Miscellaneous	626	100				21.6	20.0			
	334,050	976,244	1,036,170	521,895	365,314	48.0	152.3	305.0	85.8	72.7

Total initial daily production of new wells in Oklahoma, 1913–1917, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1913	19,220	19,505	21,615	29,847	27,139	32,192	26,071	27,897	27,267	30,953	29,211	43,133	334,050	27,838
1914	27,785	40,344	60,201	61,233	102,674	128,886	84,652	91,886	92,453	81,357	71,488	133,285	976,244	81,354
1915	123,484	117,313	85,070	149,406	124,455	113,210	76,440	48,698	24,730	61,242	64,248	47,874	1,036,170	86,348
1916	32,867	56,386	43,347	40,971	63,180	86,181	59,114	35,759	24,753	30,910	21,365	27,062	521,895	43,491
1917	22,625	32,983	27,643	22,659	22,399	26,413	39,703	37,099	29,013	49,135	29,808	25,834	365,314	30,443

GULF OIL FIELD.

GENERAL STATEMENT.

The term Gulf field as used in this report includes that portion of the Gulf Coastal Plain of Texas and Louisiana in which petroleum is found in domes, associated with rock salt and gypsum. In this area the age of the oil-bearing strata ranges from Cretaceous to Quaternary and the reservoir rock is generally either porous dolomitic limestone or sandstone.

The output of petroleum in the Gulf field in 1917, which was 24,342,879 barrels, was greater by 2,574,783 barrels, or 12 per cent, than the output in 1916 and considerably greater than the output in any other year since 1905.

The average price received at the wells for this oil was $1.07 a barrel and the market value of the entire output was $26,087,587, a gain of 32 cents a barrel in average unit price and of $9,670,713, or 59 per cent, in total value, compared with 1916. The market value of the output in 1917 was greater than that of the output in any other year in the history of the Gulf field, and the average price per barrel at the wells was higher than in any other year since 1899, when the entire production amounted to only 530 barrels and consisted of lubricating oil obtained from shallow wells in Hardin and Nacogdoches counties, Tex.

The "posted" or open-market price for the leading grades of oil produced in the Gulf field, which was advanced to $1 a barrel on December 30, 1916, remained essentially unchanged throughout 1917.

Local conditions of excess supply of oil resulted in a decline of 10 cents a barrel in the price of Goose Creek grade, posted April 4, which remained in effect until an equivalent advance, posted August 31, restored the parity of that and other principal grades of Gulf oil. Edgerly grade, which advanced to 95 cents a barrel on December 29, 1916, maintained that level throughout 1917.

The quest for petroleum in the Gulf field resulted in the completion of 1,518 wells in 1917, compared with 1,176 in 1916. Of these 864, or 57 per cent, were oil wells credited with an average yield of 569 barrels each the first day of productive life, 54 were classed as gas wells, and 600, an average of 2 in every 5 drilled, were failures.

The principal features of the crude-oil industry in the Gulf field in 1917 include the increase in output of oil and the record prices received for that output already mentioned, the discovery of new sources of oil production at Damon Mound, Brazoria County, Tex., and at New Iberia, Iberia Parish, La., and the first general strike of oil-field workers in the history of the domestic petroleum industry. The prompt action of the United States Government in detailing troops to protect the oil properties affected prevented the ill-conceived strike, which was called November 1, from resulting in serious damage, though it did result in an appreciable decrease in the quantity of petroleum marketed from wells in the Gulf field in November and December, in the curtailment of necessary drilling in certain of the proved fields, and in the postponement of a few tests in wildcat territory. Through the efforts of Federal mediators the strike was terminated January 26, 1918, by an agreement between the strikers and the oil operators involved which effectually prevents the recurrence of similar disorders during the period of the war by providing an impartial board to settle complaints and grievances growing out of wages, hours, and conditions of labor.

PETROLEUM MARKETED.

Petroleum marketed in the Gulf field in 1916 and 1917, in barrels.

Month.	1916			1917		
	Coastal Texas.	Coastal Louisiana.	Total.	Coastal Texas.	Coastal Louisiana.	Total.
January	1,923,102	217,686	2,140,788	1,676,608	267,043	1,943,651
February	1,684,089	305,984	1,990,073	1,581,365	208,675	1,790,040
March	1,634,699	347,022	1,981,721	1,735,722	231,147	1,966,869
April	1,482,871	328,885	1,811,756	1,881,642	249,470	2,131,112
May	1,669,835	314,046	1,983,881	1,759,077	349,169	2,108,246
June	1,492,890	305,757	1,798,647	1,779,522	261,386	2,040,908
July	1,420,359	304,154	1,724,513	2,039,207	229,459	2,268,666
August	1,408,895	280,832	1,689,727	2,041,481	211,236	2,252,717
September	1,354,651	227,633	1,582,284	2,029,774	211,847	2,241,621
October	1,408,370	258,963	1,667,333	1,872,256	219,684	2,091,940
November	1,268,182	270,090	1,538,272	1,415,368	197,560	1,612,928
December	1,593,657	265,444	1,859,101	1,700,619	193,562	1,894,181
	18,341,600	3,426,496	21,768,096	21,512,641	2,830,238	24,342,879
Increase or decrease:						
Barrels	+872,452	+316,991	+1,189,443	+3,171,041	−596,258	+2,574,783
Per cent	+ 4.99	+ 10.19	+ 5.78	+ 17.29	− 17.40	+ 11.83

Petroleum marketed in the Gulf field, 1889–1917.

Year.	Production (barrels).	Percentage of total production.	Increase or decrease.		Value.	Yearly average price per barrel.
			Barrels.	Per cent.		
1889	48				$340	$7.084
1890	54		+ 6	+ 12.50	227	4.204
1891	54				227	4.204
1892	45		− 9	− 16.67	225	5.000
1893	50		+ 5	+ 11.11	210	4.200
1894	60		+ 10	+ 20.00	300	5.000
1895	50		− 10	− 16.67	250	5.000
1896	50				250	5.000
1897	50				250	5.000
1898	1,450		+ 1,400	+2,800.00	7,250	5.000
1899	530		− 920	− 63.45	2,650	5.000
1900	0		− 530	− 100.00	0	
1901	3,593,113	5.18	+ 3,593,113		630,752	.175
1902	18,014,404	20.29	+14,421,291	+ 401.36	3,766,683	.209
1903	18,371,383	18.29	+ 356,979	+ 1.98	7,418,393	.411
1904	24,631,269	21.03	+ 6,259,886	+ 34.07	8,817,454	.357
1905	36,526,323	27.11	+11,895,054	+ 48.29	8,791,983	.240
1906	20,524,162	16.23	−16,002,161	− 43.81	9,380,691	.457
1907	16,360,299	9.85	− 4,163,863	− 20.29	13,704,469	.837
1908	15,772,137	8.83	− 588,162	− 3.60	9,511,007	.603
1909	10,883,240	5.94	− 4,888,897	− 30.00	7,872,686	.723
1910	9,680,465	4.62	− 1,202,775	− 11.05	7,383,571	.763
1911	10,999,873	4.99	+ 1,319,408	+ 13.63	7,355,681	.669
1912	8,545,040	3.83	− 2,454,833	− 22.32	6,344,184	.742
1913	8,542,494	3.44	− 2,546	− .03	7,993,997	.936
1914	13,118,028	4.94	+ 4,575,534	+ 53.56	8,844,604	.674
1915	20,578,653	7.32	+ 7,460,625	+ 56.87	9,809,301	.477
1916	21,768,096	7.24	+ 1,189,443	+ 5.78	16,416,874	.754
1917	24,342,879	7.26	+ 2,574,783	+ 11.83	26,087,587	1.071
	282,254,299	6.64			160,142,096	.567

Petroleum marketed, value, and average price per barrel in the Gulf field, 1908-1917.

Year.	Coastal Texas.			Coastal Louisiana.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1908....	10,483,200	$6,221,636	$0.593	5,288,937	$3,289,371	$0.622	15,772,137	$9,511,007	$0.603
1909....	8,852,527	6,399,318	.723	2,030,713	1,473,368	.725	10,883,240	7,872,686	.723
1910....	7,929,863	6,100,359	.769	1,750,602	1,283,212	.733	9,680,465	7,383,571	.763
1911....	7,275,281	5,340,592	.734	3,724,592	2,015,089	.541	10,999,873	7,355,681	.669
1912....	6,459,550	4,739,898	.734	2,085,490	1,604,286	.769	8,545,040	6,344,184	.742
1913....	5,825,226	5,550,408	.953	2,717,268	2,443,589	.899	8,542,494	7,993,997	.936
1914....	10,617,062	7,164,393	.675	2,500,966	1,680,211	.672	13,118,028	8,844,604	.674
1915....	17,469,148	8,369,991	.479	3,109,505	1,439,310	.463	20,578,653	9,809,301	.477
1916....	18,341,600	13,925,362	.759	3,426,496	2,491,512	.727	21,768,096	16,416,874	.754
1917....	21,512,641	22,938,890	1.066	2,830,238	3,148,697	1.113	24,342,879	26,087,587	1.071

Petroleum marketed in the Gulf field, 1913-1917, in barrels.

Month.	1913	1914	1915	1916	1917
January	704,900	802,249	1,190,350	2,140,788	1,943,651
February	610,703	748,403	1,423,256	1,990,073	1,790,040
March	876,333	1,068,009	1,468,789	1,981,721	1,966,869
April	756,342	1,227,381	1,431,110	1,811,756	2,131,112
May	757,767	1,256,802	1,247,728	1,983,881	2,108,246
June	696,534	1,259,829	1,330,051	1,798,647	2,040,908
July	676,240	1,125,064	1,558,849	1,724,513	2,268,666
August	687,520	1,139,398	1,486,295	1,689,727	2,252,717
September	683,938	1,101,244	1,877,809	1,582,284	2,241,621
October	678,060	1,222,204	2,437,321	1,667,333	2,091,940
November	671,789	1,104,531	2,823,701	1,538,272	1,612,928
December	742,368	1,062,914	2,303,394	1,859,101	1,894,181
	8,542,494	13,118,028	20,578,653	21,768,096	24,342,879

Average daily production of petroleum in the Gulf field, 1913-1917, in barrels.

Month.	1913	1914	1915	1916	1917
January	22,739	25,879	38,398	69,058	62,698
February	21,811	26,728	50,831	68,623	63,930
March	28,269	34,452	47,380	63,926	63,447
April	25,211	40,913	47,704	60,392	71,037
May	24,445	40,542	40,249	63,996	68,008
June	23,218	41,994	44,335	59,955	68,030
July	21,814	36,292	50,285	55,629	73,183
August	22,178	36,755	47,945	54,507	72,668
September	22,798	36,708	62,594	52,743	74,721
October	21,873	39,426	78,623	53,783	67,482
November	22,393	36,818	94,123	51,276	53,764
December	23,947	34,288	74,303	59,971	61,103
Average	23,404	35,940	56,380	59,476	66,673

PIPE-LINE RUNS, DELIVERIES, AND STOCKS.

Pipe-line runs and deliveries to trade of petroleum from the Gulf field and stocks at end of each month in 1916 and 1917, in barrels.

Month.	1916			1917		
	Runs.	Deliveries.	Stocks.	Runs.	Deliveries.	Stocks.
Dec. 31, 1915			7,022,405			
January	2,140,788	731,574	8,431,619	1,943,651	1,704,027	9,554,025
February	1,990,073	1,510,162	8,911,530	1,790,040	1,638,164	9,705,901
March	1,981,721	1,348,747	9,544,504	1,966,869	1,701,040	9,971,730
April	1,811,756	1,313,844	10,042,416	2,131,112	1,854,831	10,248,011
May	1,983,881	896,528	11,129,769	2,108,246	2,101,179	10,255,078
June	1,798,647	2,485,943	10,442,473	2,040,908	2,329,534	9,966,452
July	1,724,513	1,926,414	10,240,572	2,268,666	2,612,410	9,622,708
August	1,689,727	1,876,461	10,053,838	2,252,717	2,823,467	9,051,958
September	1,582,284	1,945,330	9,690,792	2,241,621	2,443,221	8,850,358
October	1,667,333	1,652,445	9,705,680	2,091,940	1,893,813	9,048,485
November	1,538,272	1,989,313	9,254,639	1,612,928	1,649,163	9,012,250
December	1,859,101	1,799,339	9,314,401	1,894,181	2,521,617	8,384,814
	21,768,096	19,476,100		24,342,879	25,272,466	

PRICES.

Prices paid for Gulf oil per barrel in 1916 and 1917 by the principal pipe-line companies and dates on which the changes were made.

1916.

Date.	Coastal Texas.										
	Batson, Saratoga, Spindletop.		Dayton.	Goose Creek.	Humble.			Sourlake.			Markham.
	Gulf.	Sun.	Sun.	Gulf.	Gulf.	Sun.	Texas.	Gulf.	Sun.	Texas.	Texas.
Jan. 1	$0.65	$0.60	$0.60	$0.65	$0.60	$0.60	$0.60	$0.65	$0.60	$0.60	$0.60
Jan. 4	.75				.70		.70	.75		.70	.70
Jan. 5		.70	.70			.70			.70		
Jan. 8	.85				.80			.85			
Jan. 10		.80	.80			.80	.80		.80		
Jan. 11										.80	
July 1	.75				.70			.75			
July 14							.70			.70	
July 17	.70				.65			.70			
July 18		.70	.70			.70			.70		
July 27		.65	.65			.65			.65		
July 28							.65			.65	.65
Dec. 6	.80			.75	.75			.80			
Dec. 8		.75	.75			.75	.80		.75	.80	
Dec. 13				.80							
Dec. 14		.80	.80			.80			.80		
Dec. 20											.75
Dec. 28	.95			.90	.90			.95			
Dec. 29	1.05			1.00	1.00			1.05			
Dec. 30		1.00	1.00			1.00	1.00		1.00	1.00	

Prices paid for Gulf oil per barrel in 1916 and 1917 by the principal pipe line companies and dates on which the changes were made—Continued.

1916—Continued.

Date.	Coastal Louisiana.					
	Edgerly.	Jennings.		Vinton.		
	Gulf.	Gulf.	Texas.	Gulf.	Sun.	Texas.
Jan. 1	$0.50	$0.60	$0.55	$0.60	$0.60	$0.70
Jan. 4	.60	.70	.65	.70		.80
Jan. 5					.70	
Jan. 8	.70	.80		.80		
Jan. 10					.80	
May 1	.75	.90		.90		
July 1	.65					
July 14						.70
July 17		.70		.70		
July 18					.70	
July 26	.60	.65		.65		
July 27					.65	
July 28						.65
Dec. 8			.80		.75	.80
Dec. 11	.70	.75		.75		
Dec. 12	.75	.80		.80		
Dec. 14					.80	
Dec. 26	.85					
Dec. 28		.90		.90		
Dec. 29	.95	1.00		1.00		
Dec. 30			1.00		1.00	1.00

1917.

Date.	Coastal Texas.						Coastal Louisiana.		
	Batson, Saratoga, Spindletop.	Dayton.	Goose Creek.	Humble.	Sourlake.	Markham.	Edgerly.	Jennings.	Vinton.
Jan. 1	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$0.95	$1.00	$1.00
Apr. 4			.90						
Aug. 31			1.00						

Average monthly prices per barrel of petroleum in the Gulf field, 1916 and 1917.

1916.

Month.	Coastal Texas.						Coastal Louisiana.		
	Batson, Saratoga, Spindletop.	Dayton.	Goose Creek.	Humble.	Sourlake.	Markham.	Edgerly.	Jennings.	Vinton.
January	$0.76–$0.82	$0.76	$0.65	$0.76–$0.77	$0.76–$0.82	$0.69	$0.67	$0.64–$0.77	$0.76–$0.79
February	.80– .85	.80	.65	.80	.80– .85	.70	.70	.65– .80	.80
March	.80– .85	.80	.65	.80	.80– .85	.70	.70	.65– .80	.80
April	.80– .85	.80	.65	.80	.80– .85	.70	.70	.65– .80	.80
May	.80– .85	.80	.65	.80	.80– .85	.70	.75	.65– .90	.80– .90
June	.80– .85	.80	.65	.80	.80– .85	.70	.75	.65– .90	.80– .90
July	.73– .75	.75	.65	.68– .75	.73– .75	.69	.64	.65– .79	.74– .79
August	.65– .70	.65	.65	.65	.65– .70	.65	.60	.65	.65
September	.65– .70	.65	.65	.65	.65– .70	.65	.60	.65	.65
October	.65– .70	.65	.65	.65	.65– .70	.65	.60	.65	.65
November	.65– .70	.65	.65	.65	.65– .70	.65	.60	.65	.65
December	.77– .81	.77	.79	.76– .78	.77– .80	.69	.73	.77– .78	.77– .78
Average	.741	.749	.736	.766	.726	.695	.699	.754	.737

Average monthly prices per barrel of petroleum in the Gulf field, 1916 and 1917—Cont.

1917.

January	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$0.95	$1.00	$1.00
February	1.00	1.00	1.00	1.00	1.00	1.00	.95	1.00	1.00
March	1.00	1.00	1.00	1.00	1.00	1.00	.95	1.00	1.00
April	1.00	1.00	.91	1.00	1.00	1.00	.95	1.00	1.00
May	1.00	1.00	.90	1.00	1.00	1.00	.95	1.00	1.00
June	1.00	1.00	.90	1.00	1.00	1.00	.95	1.00	1.00
July	1.00	1.00	.90	1.00	1.00	1.00	.95	1.00	1.00
August	1.00	1.00	.90	1.00	1.00	1.00	.95	1.00	1.00
September	1.00	1.00	1.00	1.00	1.00	1.00	.95	1.00	1.00
October	1.00	1.00	1.00	1.00	1.00	1.00	.95	1.00	1.00
November	1.00	1.00	1.00	1.00	1.00	1.00	.95	1.00	1.00
December	1.00	1.00	1.00	1.00	1.00	1.00	.95	1.00	1.00
Average	1.00	1.00	.96	1.00	1.00	1.00	.95	1.00	1.00

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade-journal sources and differ somewhat from those on pages 701–702, obtained from reports received directly from the oil producers:

Wells completed in the Gulf field, 1913–1917.

District.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Coastal and southern Texas	325	323	306	647	771	255	130	230	355	519	592	464	541	1,030	1,340
Coastal Louisiana	81	72	73	104	93	56	45	26	41	81	138	118	101	146	178
	406	395	379	751	864	311	175	256	396	600	730	582	642	1,176	1,518

[a] Including gas wells.

Oil wells and dry holes drilled in the Gulf field in 1917.

District.	January.		February.		March.		April.		May.		June.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Coastal and southern Texas	48	26	53	35	78	29	73	38	88	68	83	64
Coastal Louisiana	9	3	7	4	9	6	8	4	9	9	7	5
	57	29	60	39	87	35	81	42	97	77	90	69

District.	July.		August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Coastal and southern Texas	83	47	59	40	63	71	74	47	35	24	34	30	771	519
Coastal Louisiana	9	14	6	9	9	9	6	4	6	9	8	5	93	81
	92	61	65	49	72	80	80	51	41	33	42	35	864	600

Wells completed in the Gulf field, 1913–1917.

Month.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
January	31	45	24	47	57	9	5	11	32	29	42	51	35	84	96
February	30	26	28	56	60	25	8	7	34	39	56	37	35	92	104
March	43	26	20	74	87	16	13	16	27	35	60	39	36	101	128
April	42	24	22	82	81	45	21	23	31	42	90	46	45	115	127
May	26	45	31	94	97	16	14	14	50	77	46	61	45	149	178
June	40	35	38	67	90	41	12	35	45	69	84	47	74	115	168
July	48	43	38	65	92	33	21	36	37	61	81	65	75	104	159
August	43	35	34	60	65	34	26	18	34	49	77	63	53	96	114
September	29	28	38	48	72	22	10	27	29	80	51	39	65	79	155
October	27	25	26	45	80	22	18	13	19	51	49	43	39	64	135
November	21	34	42	49	41	17	18	30	26	33	37	53	73	79	76
December	26	29	38	64	42	32	9	26	32	35	58	38	67	98	78
	406	395	379	751	864	311	175	256	396	600	730	582	642	1,176	1,518

[a] Including gas wells.

Initial daily production of new wells completed in the Gulf field in 1917, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Coastal and southern Texas	33,660	40,325	64,730	37,396	36,410	50,508	32,040	55,605	34,607	30,473	14,157	15,377	445,288
Coastal Louisiana	8,205	3,465	1,025	5,100	14,040	445	2,870	1,725	1,995	765	560	6,015	46,210
	41,865	43,790	65,755	42,496	50,450	50,953	34,910	57,330	36,602	31,238	14,717	21,392	491,498

Total initial daily production of new wells in the Gulf field, 1913–1917, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1913	15,712	4,447	27,571	10,300	8,335	5,525	4,275	4,584	2,087	3,459	1,066	7,357	94,718	7,893
1914	10,551	7,101	31,975	40,624	16,071	23,652	26,085	13,043	28,685	15,520	17,772	12,530	243,609	20,301
1915	15,680	15,398	6,485	8,020	13,285	20,265	18,300	16,875	40,053	68,815	89,050	25,500	337,726	28,144
1916	77,380	67,882	81,259	30,083	59,280	42,775	19,049	15,684	19,010	25,670	17,880	43,780	499,732	41,644
1917	41,865	43,790	65,755	42,496	50,450	50,953	34,910	57,330	36,602	31,238	14,717	21,392	491,498	40,958

Total and average initial daily production of new wells in the Gulf field, 1913–1917, by districts, in barrels.

District.	Total initial production.					Average per well.				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Coastal and southern Texas	38,978	160,695	292,541	388,422	445,288	119.9	497.5	956.0	600.3	577.5
Coastal Louisiana	55,740	82,914	45,185	111,310	46,210	688.1	1,151.6	619.0	1,070.3	496.9
	94,718	243,609	337,726	499,732	491,498	233.3	616.7	891.1	665.4	568.9

TEXAS.

GENERAL STATEMENT.

The contribution of Texas to the petroleum supply of the United States in 1917 was 32,413,287 barrels, a quantity greater by 4,768,682 barrels, or 17 per cent, than the output in 1916, and greater in fact than the output in any other year in the history of the local petroleum industry, which began in 1889. Of this record output the stratum division, including the oil districts in central and northern Texas, contributed 10,900,646 barrels, or 34 per cent, and the salt-dome division, including the oil fields of southeastern Texas, contributed the remaining 21,512,641 barrels, or 66 per cent, the relative contribution of each division being the same as in 1916. The greater part of the credit for this increase belongs to the Electra and Burkburnett districts in the stratum division and to the Goose Creek district in the salt-dome division, though the Strawn district in the former division and the Dayton and Spindletop districts in the latter division rendered slight assistance.

The average price received at the wells for all grades of oil marketed in Texas in 1917 was $1.32 a barrel, a gain of 39 cents in average unit price compared with 1916. The market value of the crude oil sold in 1917 was $42,891,555, a gain of $17,131,220, or 66.5 per cent, over the market value of the output in 1916. Of this sum the share credited to the stratum division was $19,952,665, or 46.5 per cent, and that to the salt-dome division was $22,938,890, or 53.5 per cent, the average unit price in the former division being $1.83 a barrel—56 cents higher than in 1916—and in the latter division $1.07 a barrel—31 cents higher than in 1916.

DEVELOPMENT.

Stimulated by the enhanced value of oil and by the opening of new territory of promise in both divisions, activity in drilling for oil in Texas in 1917 likewise attained record proportions. In all 2,381 wells drilled primarily for petroleum were completed in Texas in 1917, an increase of 668 wells, or 39 per cent, over the number completed in 1916. Of these 1,499, or 63 per cent, produced an average of 331 barrels of oil each the first 24 hours after completion, 73, or 3 per cent, produced gas only, and 809, an average of about 1 in every 3 drilled, were failures.

STRATUM DIVISION.

In the stratum division 1,041 wells were completed in 1917, a gain of 358 wells, or 52 per cent, compared with 1916. These completions included 728 oil wells, credited with an average yield of 70 barrels each the first day of productive life, 23 gas wells, and 290 dry holes, the ratio of dry holes to total completions being as 2 to 7.

Northern Texas.

Wichita County.—The steady gain in annual production that has marked the development of the petroleum resources of Wichita County in recent years was consistently maintained in 1917, the output in that year—9,541,636 barrels—being greater by 1,704,250 barrels, or 22 per cent, than the output in 1916. The Electra and

Burkburnett districts both shared in the credit for that increase. Electra's share though derived in part from the success that attended the deepening of old wells on the Stringer and Waggoner leases in the heart of the field came primarily from the successive completion of a number of wells with initial capacities of 1,000 to 2,000 barrels of oil a day in the prolific 1,920-foot sand found on the Piper and Sumner leases of the Magnolia Petroleum Co. in the western end of the district. New territory of promise for oil development was opened in February on Beaver Creek, about 8 miles southeast of Electra, by a well drilled by J. W. Culbertson on the Waggoner Brothers' ranch. This well, located only a few hundred feet from shallow wells drilled two or three years previously by the Beaver Oil Co., derived its production of 175 barrels a day from a sand found at a depth of about 1,500 feet. Subsequent drilling proved the territory to be "spotted" but resulted nevertheless in the completion of a number of oil wells of fair capacity in the immediate vicinity of the discovery well and between the new district and the main Electra field to the northwest.

The centers of interest in the Burkburnett district in 1917 were at the northwestern and the southeastern extremes of the field. In the former area new territory more or less discredited by earlier operations was proved prolifically productive of oil on the Prechel, Ramming, Serrein, and Ruyle leases southwest of Clara post office and northwest of the main field. Well No. 13 of the Humble Oil & Refining Co., on the Serrein lease, completed in August at a depth of 1,680 feet and credited with a yield of 2,000 barrels the first 24 hours after completion, was perhaps the record well of the year, though well No. 2 of Perkins & Snyder, completed in December on the same tract and at about the same depth, was a close second. Wells with initial output of 500 to 600 barrels were the average for the locality.

In the southeastern part of the district interest was well sustained throughout 1917 in the shallow-sand territory between the main field and the Cropper property several miles southeast of it. In this territory a great number of wells were completed at depths of 600 feet or less and credited with yields of 5 to 40 barrels of oil each the first 24 hours after completion. Near the old Eads wells, about midway between the Burkburnett and Electra districts, an especially rich area of shallow-sand production, termed the Sunshine Hill field, was found on the Ward and Todd tracts.

Wilbarger County.—Aside from the discovery of natural gas in initial volume estimated at 5,000,000 to 8,000,000 cubic feet a day in well No. 1 of the Producers Oil Co. on the Castleberry lease, 8 miles southeast of Vernon and about 4 miles west of the gas wells drilled by the same company on the Waggoner ranch last year, wildcat drilling in Wilbarger County in 1917 yielded no significant results.

Clay County.—Despite the completion of a number of new oil wells of fair initial capacity on the Dunn & Taylor tracts in the southeastern part of the Petrolia district, Clay County, the yield of petroleum from that district in 1917—282,420 barrels—was 6.5 per cent less than in 1916.

Shackelford County.—An output of 68,118 barrels from the Moran pool in Shackelford County in 1917 constitutes a loss of about 50 per cent in quantity compared with 1916. Only one well, a dry hole, was reported as having been completed in the Moran district in 1917.

Palo Pinto County.—Development in the Strawn district, Palo Pinto County, was active throughout 1917 and in the main yielded satisfactory results, though no significant extensions of productive territory were proved. The output of petroleum credited to that district increased from 175,147 barrels in 1916 to 340,950 barrels in 1917, a gain of about 95 per cent.

On the holdings of the Empire Gas & Fuel Co. (Doherty interests) in eastern Palo Pinto County a deep test on the Chestnut ranch, 10 miles southwest of Mineral Wells, resulted in October in the discovery of natural gas in volume estimated at 16,000,000 cubic feet a day at a depth of 4,030 feet. In the northeastern part of the county the Sinclair-Gulf Corporation, drilling on the Holt ranch 2 miles east of Graford, found natural gas in considerable volume at a depth of about 1,230 feet in two wells, the second of which yielded small quantities of oil, reported to test 39° Baumé gravity, from a sand found at a depth of 1,292 feet.

Parker County.—Additional drilling on the Morton ranch, near Millsap, in western Parker County, in 1917 resulted in the discovery by the Parker County Development Co. in October of commercial quantities of oil, reported to test 44.3° Baumé gravity, at a depth of about 2,100 feet in well No. 3. Well No. 1, completed on the Morton ranch in 1916, was a gas well, its initial capacity being rated at 5,000,000 cubic feet a day. Well No. 2, completed early in 1917, was also a gas well, of smaller capacity, however, than No. 1.

Stephens County.—Development in Stephens County in 1917 was centered in the vicinity of Caddo in the eastern part of the county, and near Breckenridge in the central part of the county, and was attended by fair success in both localities. On the Lee farm, east of Caddo, the Texas Pacific Coal & Oil Co. completed on November 9 a deep test that was credited with an output of 200 barrels of oil the first 24 hours after completion, and with 250 barrels of oil a day before the end of the month. Production was reported to be obtained from limestone at 3,084 to 3,105 feet. In the same locality a barren test, abandoned in December, was drilled to a depth of 3,700 feet by the Texas Pacific Coal & Oil Co. on the Winston farm. South of Breckenridge one or two oil wells of fair capacity were completed in the 3,100-foot sand discovered by the Producers Oil Co. on the Parks ranch last year, but on the Smith ranch half a mile south of the oil wells on the Parks ranch one test drilled to the deep sand revealed only gas, in volume, however, estimated at 12,000,000 to 15,000,000 cubic feet a day. On the McCauley ranch, 5 or 6 miles southeast of the Parks ranch, gas in fair volume and oil in small quantity were found at a depth of about 1,850 feet in August in a test drill by the Gulf Production Co.

Archer County.—Following the discovery of oil at about 1,640 feet on the Luke Wilson ranch, near Holliday, in 1916, some 51 wells were drilled in that locality in 1917.

Of these only 10 in the immediate vicinity of the Panther Oil Co.'s discovery well were successful. Additional tests near the producing well drilled in 1916 by the Coline Oil Co., 5 miles northwest of the Panther Oil Co.'s wells, resulted in dry holes only. The productive area of the Holliday pool, as proved to the end of 1917, amounted to about 60 acres.

Eastland County.—As a consequence of wildcat drilling southwest of the Strawn district an oil field of considerable potential importance was discovered late in 1917, in the northeastern part of Eastland County. The discovery well was drilled by the Texas Pacific Coal & Oil Co. on the McClesky tract, about a mile and a half south of Ranger. It was completed late in October at a reported depth of 3,450 feet and was credited with a yield of 400 barrels of oil the first 24 hours after completion. In November the well was drilled a few feet deeper and its production was increased to a rate of 2,000 barrels a day, though that rate had declined to 1,000 barrels a day by the end of December. A dozen or more test wells were started in the vicinity of this well before the end of 1917 and leases were being eagerly sought by oil companies for miles in every direction.

Callahan County.—The deep test drilled by Cosden & Co. on the Harwell farm, a mile and a half south of Putnam, in which gas in small volume was found in 1916, was abandoned in 1917 at a total depth of 3,500 feet.

Young County.—Wildcat drilling in Young County in 1917 resulted in the discovery of oil in small quantity at a reported depth of 2,180 feet in a test drilled by the North American Oil & Refining Co. near South Bend, and the discovery of gas in fair volume at a reported depth of 2,350 feet in a test drilled by the Empire Gas & Fuel Co. on the Lisle farm, about 5 miles northeast of the North American Co.'s test.

Coleman County.—Primary interest in oil development in Coleman County was centered in 1917 near Burkett in the northeastern part of the county, where the results of drilling were interpreted to indicate the presence of an oil pool of considerable importance. Well No. 2 on the Morris ranch, a joint test by the Magnolia Petroleum Co. and the Elizabeth Oil Co., was the discovery well. It was completed early in October and was credited with a yield of about 25 barrels of oil the first 24 hours of productive life, from a sand found at a reported depth of 2,096 feet. Well No. 1 on the Morris ranch was drilled near Goldsboro, about 26 miles northwest of No. 2, and was a failure. Little interest was taken in the new district, however, until November, when Well No. 3—only a short distance from No. 2—was completed at a reported depth of 3,438 feet and credited with an initial yield in excess of 100 barrels of oil a day. Other wells started in the vicinity remained uncompleted at the end of 1917.

In the old Trickham field, in the southeastern part of Coleman County, and on the Pope farm, 4 miles southeast of Santa Anna, additional oil and gas wells of small capacity were completed at depths of 1,000 to 1,600 feet during 1917. Elsewhere in the county the results of drilling were disappointing.

Brown County.—The quest for oil in Brown County in 1917 resulted in the opening of a rather extensive shallow-sand district in and directly south of Brownwood. In this territory, where wells with initial capacities of 5 to 10 barrels of oil a day were brought in at depths of 180 to 500 feet, some 60 or more wells were completed in the last three months of 1917. The gravity of the oil ranged from 38° to 40° Baumé, and sufficient production was obtained to warrant the erection of a small refinery at Brownwood by the Carson Oil & Refining Co., which began operations in the first half of 1918.

Tom Green County.—Aside from the discovery of natural gas in commercial volume at a reported depth of about 2,500 feet in a test drilled by the San Angelo Oil & Gas Co. on the Harris ranch, 6 miles north of San Angelo, wildcat operations in Tom Green County in 1917 were featureless.

Northeastern Texas.

Panola County.—The results of drilling in Panola County in 1917 were not such as to arouse enthusiasm in the possibilities of an important oil field in the vicinity of the oil well of small capacity completed last year on the Trosper lease near Bethany. The second well completed in the district, No. 1 of the Producers Oil Co. (now Texas Co.) on the Furrh lease, 4 miles west of the discovery well, was abandoned in February at a reported depth of 3,350 feet. The third well was that of the Gulf Production Co. on the Jehu Jernigan lease half a mile west of the discovery well, and it was completed in February as a 10-barrel oil well at a depth of 2,430 feet. The fourth well, drilled by the Bethany Oil Co. on the Saul Jernigan lease 1¼ miles south of the discovery well, yielded encouraging showings of both oil and gas but was abandoned as a failure, so far as commercial production was concerned, at a depth of 2,416 feet. The fifth well, drilled by Keen & Woolf, for Bell & Snyder on the Guill property, 12 miles south of the discovery well, was abandoned as a failure in August at a depth of about 2,400 feet.

Shelby County.—Drilling for petroleum in Shelby County in 1917 resulted in the discovery of oil in commercial quantities near Shelbyville in September. The discovery well was No. 2 of the Producers Oil Co. on holdings of the Pickering Lumber Co. and was situated about 3½ miles northeast of Shelbyville. The well came in at a depth of about 3,000 feet on September 9, and the first 24 hours after completion it made three flows of 35 barrels each of oil that was reported to test 37.5° Baumé gravity. Well No. 1 of the same company on the Pickering lease was abandoned as a failure at a reported depth of 4,120 feet in April.

In Marion, Cass, and Harrison counties the usual activity in drilling prevailed along the western margin of the Caddo district, but resulted in no significant developments.

Central Texas.

Navarro County.—Development work in the Corsicana and Powell districts, Navarro County, was at a standstill in 1917 and the output of petroleum declined accordingly, the loss in the Corsicana district being 2.5 per cent and that in the Powell district 9 per cent, compared with 1916.

Williamson County.—No new wells were drilled in the Thrall district in Williamson County in 1917, and the output of petroleum from that district was 59 per cent less than in 1916.

Limestone County.—Aside from the completion of a few gas wells in the Mexia gas field at depths of about 900 feet, the moderate activity in the quest for oil and gas in Limestone County in 1917 yielded no significant results. Five miles west of Mexia small quantities of oil were found in wells drilled by Anderson and others on the Echols farm, but commercial production was not developed.

Milam County.—Additional drilling in 1917 near Tracy, Milam County, resulted in the completion of a dozen or more 3 to 5 barrel oil wells and several dry holes in a productive sand found last year in that locality at a depth of about 400 feet.

McLennan County.—A few oil wells of small capacity—3 to 5 barrels a day each—were completed in 1917 at depths of 300 feet or less by W. H. Jones, on the Prather farm, 4 miles west of Waco.

Southern Texas.

Washington County.—In the Mill Creek district south of Brenham, Washington County, the discovery well completed in 1915 remained at the end of 1917 the only productive well in the field. In Austin County just south of the Mill Creek district an unsuccessful test was drilled to a depth of 4,055 feet by the Texas Co. on the Theilman ranch.

Bexar County.—The shallow-sand districts, Somerset, Alta Vista, and Mission, a few miles south and southwest of San Antonio, received a modicum of attention in 1917, and a number of oil wells of small capacity were completed.

The completion by Dr. F. L. Thomson of a 15-barrel oil well at a depth of about 1,300 feet, a mile southwest of the Somerset district, in December was the principal event of the year in that district. At the end of 1917 interest in oil development in Bexar County was centered in a wildcat test drilled by Brown & Kimbley on the Swearingen farm near Medina River, southwest of the Alta Vista district and about 12 miles south of San Antonio, which was reported to have developed a capacity for production to the extent of 12 to 15 barrels of 40° Baumé gravity oil a day at a depth of 1,235 feet.

McMullen County.—A revival of interest in the possibilities of the old Crowther district resulted in the organization of the Plymouth Oil Co., which in 1917 acquired the properties of the King-Crowther Corporation, including 15 shallow wells capable of producing a barrel or two of high-grade oil a day each, and planned an active development of the Crowther district in 1918.

Duval County.—Several oil wells of small capacity were completed at an average depth of 325 feet in the Piedras Pintas-Noleda district in 1917. Deep tests by the Sinclair-Gulf Corporation and the Empire Gas & Fuel Co. in the vicinity of the shallow producing wells failed to disclose evidence of deep-sand production.

Wildcat activity in Starr and Zapata counties, concerning which little specific information is available, is reported to have resulted in the discovery of oil in commercial quantities in one or more localities adjacent to the Rio Grande.

Westren Texas.

Pecos County.—Persistent efforts to discover oil in commercial quantities in Pecos County resulted in the drilling of two unsuccessful tests by the Republic Production Co. in Four-mile Canyon, 26 miles south of Girvin. The third well of that company in the same locality was reported to have attained a depth of about 2,300 feet at the end of 1917.

SALT-DOME DIVISION.

Coastal Texas.

The yield of crude petroleum from the numerous producing districts in southeastern Texas in 1917 was 21,512,641 barrels, a quantity greater by 3,171,041 barrels, or 17 per cent, than the yield in 1916. Its market value—$22,938,890—exceeded the market value of the output in 1916 by $9,013,528, or 65 per cent.

Credit for the gain noted in output of petroleum belongs primarily to the Goose Creek district, which together with the old Dayton and Spindletop districts and the new Damon Mound district, furnished enough new production to offset the diminished output charged to the other districts and to account for the net increase in the output of the entire division.

Humble.—Despite a loss of 3,535,974 barrels compared with 1916, an output of 7,389,831 barrels of oil in 1917 was sufficient, though barely so, to retain for the Humble pool, Harris County, its position of primary importance among the oil pools of coastal Texas. Of 354 wells completed in 1917 in that pool, 217 produced oil, the average initial yield being 258 barrels each, compared with 305 new oil wells with an average initial yield of 906 barrels each in 1916. Significant developments during 1917 included a substantial westward extension of the areal limits of "deep-sand" production, demonstrated by the completion in May by the Grant Oil Co. of a 2,500-barrel well at a depth of 2,800 to 2,900 feet, in the northeast corner of the Williams 10-acre tract in the southwestern part of the field; the disclosure of encouraging evidence of moderate production south of the prolific Stevenson lease, in wells drilled by the Humble-Texas Petroleum Co., on the Pyramid-Morris lease in the southeastern part of the field; and the completion by the Onalaska Oil Co. and other companies of wells in excess of 1,000 barrels of initial production at depths below 2,700 feet on the House tract, north of San Jacinto River, in the northern part of the field. Several unsuccessful deep tests a mile or more in advance of the proved area of the field to the south, southeast, and east, were completed and abandoned during 1917.

Goose Creek.—As anticipated in the report of this series for 1916 the Goose Creek pool in the southeastern part of Harris County was the chief center of interest and activity in coastal Texas in 1917. As a consequence of the success that attended development work there Goose Creek proved to be a close second to Humble in the matter of petroleum output, its yield in 1917, which was 7,300,279 barrels, constituting a gain of 6,902,888 barrels, or 1,737 per cent, over the output in 1916. Because of higher prices as well as of increased output the value of the petroleum marketed from the Goose Creek field in 1917—$8,264,791—was 2,725 per cent greater than the market value of the output in 1916. Of 443 wells completed in that district during the year in review, 274, or 62 per cent, were oil wells credited with an average initial yield of 1,181 barrels each, 28 were gas wells, and 141, an average of 1 in every 3 drilled, were failures. Development of the pool was directed both areally and vertically with excellent results, the field being extended westward across Goose Creek and southward across Tabbs Bay to Hogg Island and prolific production being obtained at varying depths to 3,700 feet. The feature well of the year was No. 11 Sweet of the Simms-Sinclair interests, completed August 4, at a depth of about 3,050 feet. This well ran wild for three days, spouting oil at an estimated rate of 35,000 barrels a day, then sanded up and was finally brought in under control in March, 1918, as a 1,500-barrel producer. In the shallow waters of Tabbs Bay between the mainland and Hogg Island several prolific wells were completed, the best of which, No. 4 State-land, was completed near the end of July by the Gulf Production Co., and was credited with an initial production of 12,000 barrels from a depth of about 3,080 feet.

Sourlake.—Third rank among the oil fields of coastal Texas in 1917 is accorded to the Sourlake pool in Hardin County, the output of which—4,763,004 barrels—was less by 160,328 barrels, or 3 per cent, than the output in 1916. Of 178 new wells completed in that district, 132, or 74 per cent, were oil wells credited with an average yield of 329 barrels each the first 24 hours after completion, compared with 114 new oil wells credited with an average initial yield of 595 barrels each in 1916. Moderate areal extensions of the field were proved both to the northeast and to the south, but the principal feature of development in 1917 was the discovery by the Yount-Lee Oil Co. of productive sands at a depth of about 4,200 feet on the Crosbie and the Gilbert-Martin leases in the southern part of the field.

Batson.—Fourth rank among the oil pools of southeastern Texas was retained in 1917 by the Batson pool, Hardin County, despite a decline of 7 per cent in yield, compared with 1916. The quantity of petroleum marketed from the Batson field in 1917 was 692,417 barrels and its market value was $806,282. Slight territorial extensions were proved to the northwest, but to the north and northeast the results of advance tests were disappointing. Efforts of the Paraffine Oil Co. to demonstrate a southeastward extension of "deep sand" production to its prairie tract a mile in advance of the proved field yielded encouraging but inconclusive results.

Saratoga.—Developments in the Saratoga pool, Hardin County, were featureless in 1917. The output of crude oil amounted to 682,797 barrels and was 98,331 barrels, or 13 per cent, less than in 1916, but its market value, $643,064, was $76,175, or 13 per cent, greater than the market value of the output in 1916.

Spindletop.—An increase of drilling in the old Spindletop pool in Jefferson County was attended with favorable results and the output of oil from the field increased from 340,441 barrels in 1916 to 380,039 barrels in 1917, a gain of about 12 per cent. North of the field a deep test drilled by Henderson, Hooks, and others in the La Salle townsite was abandoned in July at a reported depth of 3,800 feet.

Brazoria County.—The persistence of the Texas Exploration Co. in drilling for oil in the northwestern part of Brazoria County was rewarded in 1917 by the opening of a new salt-dome pool of considerable potential importance at Damon Mound. The first oil well of real consequence in this pool was completed and put in service as a gas well in February, but unexpectedly began producing oil at the rate of 300 barrels a day about the middle of April. This flow was maintained for 14 days but ceased as abruptly as it had begun when the well became clogged with sand. When cleaned and again completed on May 9, the flow of oil obtained was estimated at 5,000 barrels a day. This well, No. 3 on the Bryan lease, was completed at a reported depth of 1,450 feet. It is about 1 mile southeast of well No. 1 on the Wisdom lease, in which small quantities of 32° Baumé oil were found at a shallower depth in December, 1915. The oil from the Bryan well was reported to test 24° Baumé gravity and to be dark green in color. Subsequent completions in 1917 were about evenly divided between dry holes and wells of moderate production, but at the end of the year the new field had some 8 or 10 producing wells and a daily output of about 2,000 barrels of oil. Oil from this field was marketed in the last three months of the year through a 6-inch pipe line 12 miles long, built by the Rio Bravo Oil Co., from Damon Mound to Pledger, on the Southern Pacific Railroad. In other parts of Brazoria County unsuccessful tests were reported to have been completed and abandoned in 1917 as follows:

May—Producers Oil Co.; No. 3 Mound; at Hoskins Mound; depth, 1,475 feet.
Producers Oil Co.; No. 5 Mound; at Hoskins Mound; depth, 875 feet.
Producers Oil Co.; No. 5 Kiser; at West Columbia; depth, 2,300 feet.
July—Palmetto Oil Co.; No. 1; at Austin's Bayou; depth, 2,200 feet.
Producers Oil Co.; No. 7 Mound; at Hoskins Mound; depth, 1,700 feet.
August—Producers Oil Co.; No. 6 Kiser; at West Columbia; depth, 1,435 feet.
September—Producers Oil Co.; No. 2 Smith; at West Columbia; depth, 3,275 feet.

Encouragement to further exploration at West Columbia was provided late in 1917 by the completion of an oil well of small capacity at a reported depth of 2,802 feet on the Hogg lease, by the Tyndall-Wyoming Oil Co.

Matagorda County.—Despite unusual activity in drilling in the Markham pool, Matagorda County, the new production obtained was insufficient to offset the declining yield of the older wells and the output of the field as a whole decreased from 158,338 barrels in 1916 to 128,011 barrels in 1917, a loss of 19 per cent. Of 28 wells completed during the year, 12 were oil wells credited with an average initial yield of 66 barrels each, 3 were gas wells, and 13 were failures. Deeper drilling by the Clem Oil Co. in the heart of the field was attended by moderate success, and about the margins of the field semiwildcat drilling resulted in the completion of a gas well with an estimated open-flow capacity of 15,000,000 cubic feet a day on the Gray tract nearly a mile north of the pool and of an oil well with an initial flow reported at 100 barrels a day on the Kountze tract about the same distance south of the old pool. Both tests were drilled by the Producers Oil Co., the gas well being completed at a reported depth of 2,900 feet and the oil well at about 3,400 feet. The results of other deep tests in the vicinity of the Markham pool were less encouraging than those obtained in the Gray and Kountze tests.

Encouragement for additional drilling at Big Hill was provided by the completion by J. C. Knox and others, in September, of a well on the Ryman tract that was reported to yield 500 barrels of fluid, about 20 barrels of which was oil.

Unsuccessful tests were reported completed and abandoned in Matagorda County in 1917 as follows:

October—Magnolia Petroleum Co.; No. 1 Wadsworth; depth, 3,400 feet.
November—Magnolia Petroleum Co.; No. 1 Fisher; depth, 2,725 feet.

Orange County.—The production of petroleum in Orange County came in 1917 as in other recent years from the Terry or Bland pool, the entire production of which prior to 1917 was obtained from one well, completed four years ago by the Rio Bravo Oil Co. In August, 1917, an oil well, No. 1 Joshua Bland, was completed by the Bland

Oil Co., near the discovery well. Its reported depth was 3,096 feet and its daily output when first pumped in September was reported to consist of 175 barrels of fluid, 35 barrels of which was oil.

Liberty County.—Despite the fact that the results of drilling in the Dayton pool, Liberty County, include 12 failures and only three oil wells, the output of oil from that district increased from 8,571 barrels in 1916 to 9,995 barrels in 1917, a gain of 17 per cent. Interest in drilling in Liberty County in 1917 was centered in the early part of the year in tests between Day Lake and Trinity River, south of Dayton, which yielded encouraging showings of oil at shallow depths, 400 to 500 feet, but failed to find commercial production at greater depths. Near the end of the year interest was transferred to the eastern part of the county and centered on a test at Big Hill, drilled by the Republic Production Co., on property of the Houston Oil Co., near Hull. This interest was occasioned by showings of oil at a depth of about 2,200 feet. Efforts to develop commercial production by deepening the well were unsuccessful, rock salt having been reported to have been entered at about 2,700 feet.

San Patricio County.—In the Corpus Christi district on the north side of Nueces Bay the results of drilling in 1917 included the completion and abandonment at 3,988 feet of well No. 5 White Point, by the Gulf Production Co., near the site of the ill-fated gas wells drilled there in 1915 and 1916, followed by the temporary abandonment of the district by that company, and the completion by the Southern Gas Co. of a 5,000,000-foot gas well on the Siederman lease, 8 miles west of Portland. Near Angelita, about 8 miles west of White Point and about 18 miles northwest of Corpus Christi, Ramsey Bros. and others abandoned an unsuccessful test drilled to a depth of about 4,000 feet.

Chambers County.—At Barbers Hill, Chambers County, a joint test (No. 4 Collier), drilled by the Gulf Production Co. and the Humble Oil Co., resulted in the completion in April of a well that pumped 3 or 4 barrels of 32° Baumé oil from a depth of about 1,600 feet. At Lake Charlotte, near Wallisville, in the northern part of the county, an unsuccessful test drilled by the Llanos Oil Co. was reported abandoned in January at a depth of 1,882 feet after having encountered showings of oil at 940 feet and at 1,440 feet.

Miscellaneous wildcat tests.—Unsuccessful tests of interest because of their location were reported completed and abandoned in 1917 in other parts of coastal Texas as follows:

ANDERSON COUNTY.

April—Producers Oil Co.; Southern Pine Lumber Co.'s land, near Palestine; depth, 4,325 feet.

May—Producers Oil Co.; No. 1, Royal-Davey near Palestine; depth, 4,035 feet.

BRAZOS COUNTY.

August—Bryan and Brazos County Gas & Petroleum Co.; on Navasota River, 12 miles east of Bryan; depth, 1,580 feet.

FORT BEND COUNTY.

June—Blue Ridge Development Co.; at Blue Ridge; depth, 900 feet; rock salt.
September—Arcola Production Co.; No. 1 House Plantation at Arcola; depth, 3,300 feet.
December—Arcola Production Co.; No. 2 House, at Arcola; depth, 2,300 feet.

GALVESTON COUNTY.

May—Marrs, McLean, and others; on west side of High Island; depth, 3,100 feet.
July—Thaman Park Oil Co.; at Dickinson; depth, 2,200 feet.
November—Empire Gas & Fuel Co.; at Texas City; depth, 3,435 feet.
December—Marrs, McLean, and others; No. 3 Martin Dunham Survey, at High Island; depth, 2,250 feet.

HARDIN COUNTY.

March—Forrest-David Oil Co.; No. 1 McShane, 1 mile east of Grayburg; depth, 2,000 feet.
July—Forrest-David Oil Co.; No. 2 McShane; depth, 2,250 feet.
November—Forrest-David Oil Co.; No. 3 McShane; depth, 3,200 feet.

HARRIS COUNTY.

February—Chastian Oil Co.; at Cross Timbers; depth, ——— feet.
March—Miller Oil Co.; No. 1 McCormick Survey, east of San Jacinto battle ground; depth, 2,480 feet.
Apex Oil Co.; on Green's Bayou, 5 miles south of Rollwood; depth, 4,560 feet.
April—Spring Creek Petroleum Co.; on Fisher Survey, near Spring; depth, 3,100 feet.
May—W. B. Root and others; on McCormick Survey, near San Jacinto battle ground; depth, 1,500 feet.
Taylor Lake Oil Co.; No. 1 Curry; near Seabrook; depth, 2,805 feet.
Atlantic & Gulf Petroleum Co.; No. 3 Bodman, at Westfield; depth, 3,085 feet.
Gulf Production Co.; No. 2 Warren Ranch, at Hockley; depth, 800 feet.
July—Peoples Oil & Gas Co.; No. 1 Ruhl, 2 miles southeast of Humble pool; depth, 3,520 feet.
August—Laura Koppe Oil Co.; No. 1 Westcott, at Cross Timbers; depth, 2,300 feet.
September—Ober-Culver Development Co.; No. 1, Callahan League; depth, 3,200 feet.
Harris County Petroleum Co.; No. 1 Flynn, near Aldine; depth, 2,200 feet.
Northern Development Co.; near Japan siding, northeast of Humble; depth, 2,800 feet.
October—Burt & Griffith; at Dyersdale; depth, 3,800 feet.
Reynolds Petroleum Co.; No. 1 Asbury, north of Humble pool; depth, 3,400 feet.
Gulf Production Co.; No. 3 Warren Ranch., at Hockley; depth, 3,280 feet.
Atlantic & Gulf Petroleum Co.; No. 4 Bodman, at Westfield; depth, 3,415 feet.
Harris County Petroleum Co.; No. 2 Flynn, near Aldine; depth, 1,100 feet.
November—Burt & Griffith; at Mount Houston; depth, 3,740 feet.
December—Miller Oil Co.; No. 2 McCormick Survey, near San Jacinto battle ground; depth, 3,570 feet.
Rucker Oil & Refining Co.; No. 2 Skinner, at Cypress; depth, 2,900 feet.
Southern Sulphur Co.; No. 1, at Pierce Junction; depth, 1,089 feet.

JASPER COUNTY.

January—G. E. Codman and others; in southeast corner Texas & New Orleans survey No. 82; depth, 3,500 feet.

JEFFERSON COUNTY.

April—Carter Oil Co. (Abercrombie and others); 1 mile south of Nome; depth, 3,414 feet.
August—Carter Oil Co.; No. 2 Maubles, near Nome; depth, 3,500 feet.

MONTGOMERY COUNTY.

June—South Texas Petroleum Co.; No. 2 Stimson, near Dobbin; depth, 1,190 feet.
September—Black Hawk Oil Co.; No. 1 Stimson, near Splendora; depth, 3,150 feet.
November—South Texas Petroleum Co.; No. 3 Stimson, near Dobbin; depth, 1,200 feet.
Rucker Oil & Refining Co.; No. 1 Bruce, near Pauli; depth, 1,500 feet.
December—Rucker Oil & Refining Co.; No. 2 Bruce, near Pauli; depth, 900 feet.

WALLER COUNTY.

September—Continental Oil Co.; near Hempstead; depth, 2,520 feet.

PETROLEUM MARKETED.

Petroleum marketed in Texas, 1908–1917, in barrels.

Year.	Northern Texas.										Coastal Texas.	
	Corsicana.	Powell.	Petrolia (Henrietta).	Marion County.	Wichita County.	Moran.	Thrall.	Strawn.	Other.	Total.	Spindletop.	Saratoga.
1908	211,117	421,659	85,963	....	....	....	....	....	4,525	723,264	1,747,537	1,634,786
1909	180,764	383,137	113,485	....	....	....	....	....	4,554	681,940	1,388,107	1,183,559
1910	137,331	450,188	126,531	251,717	....	....	....	....	3,636	969,403	1,182,436	1,024,348
1911	128,526	373,055	168,965	677,689	899,579	....	....	....	3,379	2,251,193	965,939	925,777
1912	233,282	251,240	197,421	362,870	4,227,104	....	....	....	3,590	5,275,507	822,916	1,116,655
1913	158,830	282,476	344,868	262,392	8,131,624	....	....	....	4,062	9,184,252	716,374	937,720
1914	133,811	282,279	550,585	180,584	8,227,968	68,191	....	....	7,704	9,451,122	580,130	889,743
1915	143,275	237,410	349,857	123,464	5,833,951	109,016	613,182	50,498	12,900	7,473,553	338,266	864,266
1916	135,263	215,729	302,145	64,971	7,837,386	135,608	432,695	175,147	4,061	9,303,005	340,441	781,128
1917	131,828	196,855	282,420	57,952	9,541,636	68,118	176,887	340,950	104,000	10,900,646	380,039	682,797

Year.	Coastal Texas—Continued.									Total.
	Sourlake.	Matagorda County.	Batson.	Humble.	Dayton.	Goose Creek.	Orange County.	Other.	Total.	
1908	1,595,060	62,640	1,593,570	3,778,521	39,901	....	....	31,185	10,483,200	11,206,464
1909	1,703,798	29,103	1,206,214	3,237,060	17,647	....	....	87,039	8,852,527	9,534,467
1910	1,518,723	455,999	1,113,767	2,495,511	9,582	....	....	129,497	7,929,863	8,899,266
1911	1,364,880	561,828	1,023,493	2,426,220	4,344	....	....	2,800	7,275,281	9,526,474
1912	1,175,108	613,292	844,563	1,829,923	12,151	43,898	....	1,044	6,459,550	11,735,057
1913	1,348,053	294,553	741,350	1,504,880	13,329	249,641	17,706	1,620	5,825,226	15,009,478
1914	5,209,208	164,192	775,804	2,799,458	18,791	134,748	43,208	1,780	10,617,062	20,068,184
1915	4,114,622	137,841	703,686	11,061,802	10,378	119,336	21,697	47,254	17,469,148	24,942,701
1916	4,923,332	158,338	744,915	10,925,805	8,571	397,391	17,758	43,921	18,341,600	27,644,605
1917	4,763,004	128,011	692,417	7,389,831	9,995	7,300,279	7,023	159,245	21,512,641	32,413,287

Petroleum marketed in Texas, 1908–1917.

Year.	Northern Texas.		Coastal Texas.		Total.	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.
1908	723,264	$479,072	10,483,200	$6,221,636	11,206,464	$6,700,708
1909	681,940	393,732	8,852,527	6,399,318	9,534,467	6,793,050
1910	969,403	505,396	7,929,863	6,100,359	8,899,266	6,605,755
1911	2,251,193	1,213,960	7,275,281	5,340,592	9,526,474	6,554,552
1912	5,275,507	4,112,815	6,459,550	4,739,898	11,735,057	8,852,713
1913	9,184,252	9,125,185	5,825,226	5,550,408	15,009,478	14,675,593
1914	9,451,122	7,778,455	10,617,062	7,164,393	20,068,184	14,942,848
1915	7,473,553	4,656,934	17,469,148	8,369,991	24,942,701	13,026,925
1916	9,303,005	11,834,973	18,341,600	13,925,362	27,644,605	25,760,335
1917	10,900,646	19,952,665	21,512,641	22,938,890	32,413,287	42,891,555

Petroleum marketed in Texas in 1916 and 1917, by districts, with increase or decrease.

District.	1916			1917			Increase or decrease.	
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Barrels.	Per cent.
Northern Texas:								
Corsicana	135,263	$167,967	$1.242	131,828	$233,591	$1.172	− 3,435	− 2.54
Marion County	64,971	80,305	1.236	57,952	108,284	1.869	− 7,019	− 10.80
Moran	135,608	180,666	1.332	68,118	123,641	1.815	− 67,490	− 49.77
Petrolia	302,145	419,043	1.387	282,420	517,025	1.831	− 19,725	− 6.53
Powell	215,729	136,147	.631	196,855	181,985	.924	− 18,874	− 8.75
Strawn	175,147	227,071	1.296	340,950	695,925	2.041	+ 165,803	+ 94.67
Thrall	432,695	523,898	1.211	176,887	351,542	1.987	− 255,808	− 59.12
Wichita County	7,837,386	10,095,423	1.288	9,541,636	17,541,605	1.838	+1,704,250	+ 21.75
Other	4,061	4,453	1.097	104,000	199,067	1.914	+ 99,939	+2,460.95
	9,303,005	11,834,973	1.272	10,900,646	19,952,665	1.830	+1,597,641	+ 17.17
Coastal Texas:								
Batson	744,915	552,116	.741	692,417	806,282	1.164	− 52,498	− 7.05
Dayton	8,571	6,419	.749	9,995	10,282	1.028	+ 1,424	+ 16.60
Goose Creek	397,391	292,537	.736	7,300,279	8,264,791	1.132	+6,902,888	+1,737.05
Humble	10,925,805	8,369,072	.766	7,389,831	7,474,602	1.011	−3,535,974	− 32.36
Matagorda County	158,338	109,999	.695	128,011	128,239	1.002	− 30,327	− 19.15
Orange County	17,758	11,892	.670	7,023	5,474	.780	− 10,735	− 60.45
Saratoga	781,128	566,889	.726	682,797	643,064	.942	− 98,331	− 12.59
Sourlake	4,923,332	3,715,157	.755	4,763,004	4,944,032	1.038	− 160,328	− 3.26
Spindletop	340,441	269,269	.791	380,039	506,752	1.333	+ 39,598	+ 11.60
Other	43,921	32,012	.729	159,245	155,372	.976	+ 115,324	+ 262.57
	18,341,600	13,925,362	.759	21,512,641	22,938,890	1.066	+3,171,041	+ 17.29
Total Texas	27,644,605	25,760,335	.932	32,413,287	42,891,555	1.323	+4,768,682	+ 17.25

Petroleum marketed in Texas in 1916 and 1917, in barrels.

1916.

Month.	Northern Texas.									
	Corsicana.	Marion County.	Moran.	Petrolia (Henrietta).	Powell.	Strawn.	Thrall.	Wichita County.	Other.[a]	Total.
January	10,518	8,256	12,540	31,051	15,939	7,276	51,953	473,437	744	611,714
February	11,391	7,750	9,723	31,642	16,599	10,548	50,656	464,482	360	603,151
March	12,254	6,021	15,968	30,696	17,549	17,652	51,361	539,451	783	691,735
April	13,654	5,483	14,927	26,613	16,805	24,463	44,523	569,600	360	716,428
May	11,742	5,527	14,969	28,785	19,688	22,503	41,199	667,948	410	812,771
June	11,417	5,269	13,674	26,035	19,538	17,884	39,932	722,835	409	856,993
July	11,259	5,005	13,065	19,819	17,793	20,090	34,395	767,795	120	889,391
August	11,028	4,917	9,905	22,258	19,071	12,217	30,732	754,540	170	864,838
September	11,220	4,172	9,456	21,802	18,205	11,593	24,270	709,855	170	810,743
October	10,907	4,446	8,179	23,348	17,833	9,262	24,142	742,781	170	841,068
November	9,711	4,097	6,630	20,198	18,967	8,401	18,306	714,022	160	800,492
December	10,162	4,028	6,572	19,898	17,742	13,258	21,226	710,640	155	803,681
	135,253	64,971	135,608	302,145	215,729	175,147	432,695	7,837,386	4,061	9,303,005

Month.	Coastal Texas.											Total.
	Batson.	Dayton.	Goose Creek.	Humble.	Matagorda County.[b]	Orange County.	Saratoga.	Sourlake.	Spindletop.	Other.[c]	Total.	
January	53,383	576	6,315	1,402,531	15,297	1,923	69,619	343,754	28,040	1,664	1,923,102	2,534,816
February	52,111	446	13,345	1,189,659	9,570	1,541	66,344	323,698	25,873	1,502	1,684,089	2,287,240
March	51,553	450	13,551	1,114,883	12,407	1,777	71,665	337,650	28,786	1,977	1,634,699	2,326,434
April	50,985	395	11,136	969,770	9,734	1,826	64,479	350,560	30,911	2,075	1,482,871	2,199,299
May	56,005	1,073	10,086	1,072,850	10,816	1,619	68,094	418,897	28,216	2,179	1,669,835	2,482,606
June	61,235	1,681	13,777	878,090	24,987	1,856	61,794	425,587	30,291	3,592	1,492,890	2,349,883
July	58,415	611	17,946	781,212	14,990	1,796	61,756	451,033	28,607	3,993	1,420,359	2,309,750
August	71,199	884	21,425	795,785	13,314	1,862	68,384	402,481	29,792	3,769	1,408,895	2,273,733
September	70,563	423	67,516	720,869	12,985	1,678	64,853	382,273	28,254	5,237	1,354,651	2,165,394
October	78,557	626	54,017	718,873	11,878	249	64,335	434,580	29,059	6,196	1,408,370	2,249,438
November	69,086	709	55,540	625,435	11,676	786	60,217	413,064	25,868	5,801	1,268,182	2,068,674
December	71,823	697	112,737	664,848	10,684	845	59,588	639,755	26,744	5,936	1,593,657	2,397,338
	744,915	8,571	397,391	10,925,805	158,338	17,758	781,128	4,923,332	340,441	43,921	18,341,600	27,644,605

1917.

Month.	Northern Texas.									
	Corsicana.	Marion County.	Moran.	Petrolia (Henrietta).	Powell.	Strawn.	Thrall.	Wichita County.	Other.[d]	Total.
January	9,031	5,962	6,516	18,762	16,605	21,800	18,507	716,247	283	813,713
February	8,832	5,884	4,402	16,848	16,397	30,819	13,576	641,503	283	738,544
March	9,479	6,279	6,757	25,595	17,558	25,973	19,443	714,129	283	825,506
April	20,667	5,748	5,864	24,740	17,369	30,030	14,462	693,325	1,002	813,207
May	9,861	5,861	6,906	25,529	18,782	43,364	15,212	742,329	750	868,594
June	9,074	5,478	5,843	21,298	15,852	48,121	13,896	765,725	656	885,933
July	9,976	5,392	5,484	23,019	15,965	43,092	13,501	819,290	2,743	938,462
August	9,611	4,911	5,027	26,035	16,948	35,467	15,162	891,466	3,049	1,007,676
September	9,887	5,084	4,435	25,593	15,040	24,667	13,920	878,619	18,254	995,499
October	16,508	4,382	6,504	26,266	16,089	18,014	14,047	884,452	16,624	1,002,886
November	9,321	661	5,449	24,529	15,640	10,866	13,074	892,638	26,251	998,429
December	9,581	2,310	4,931	24,206	14,610	8,737	12,087	901,913	33,822	1,012,197
	131,828	57,952	68,118	282,420	196,855	340,950	176,887	9,541,636	104,000	10,900,646

Month.	Coastal Texas.										Total.
	Batson.	Dayton.	Goose Creek.	Humble.	Matagorda County.[b]	Orange County.	Saratoga.	Sourlake.	Spindletop.	Other.[e]	Total.	
January	70,656	687	195,515	685,043	9,234	811	64,646	621,766	25,227	3,023	1,676,608	2,490,321
February	60,584	433	305,330	651,189	9,220	384	58,625	467,140	25,719	2,741	1,581,365	2,319,909
March	62,495	1,473	361,022	706,597	13,519	510	61,636	497,229	28,600	2,641	1,735,722	2,561,228
April	60,907	489	633,132	662,860	13,209	702	65,188	414,123	27,846	3,186	1,881,642	2,694,849
May	63,601	985	507,673	658,276	12,084	805	69,263	414,107	29,035	3,248	1,759,077	2,627,671
June	59,018	929	631,077	564,330	13,383	788	64,852	410,350	31,727	3,068	1,779,522	2,665,455
July	63,798	952	881,340	583,607	14,392	872	67,209	390,644	32,788	3,605	2,039,207	2,977,669
August	62,122	769	903,222	582,571	11,819	859	64,016	382,669	29,687	3,747	2,041,481	3,049,157
September	59,125	407	915,955	616,523	9,244	764	61,729	330,366	32,141	3,520	2,029,774	3,025,273
October	58,151	1,039	709,643	639,115	7,717	528	61,963	329,987	38,086	26,027	1,872,256	2,875,142
November	31,671	1,043	502,047	545,074	5,362	....	16,246	226,831	40,334	46,760	1,415,368	2,413,797
December	40,289	789	754,323	494,646	8,828	....	27,424	277,792	38,849	57,679	1,700,619	2,712,816
	692,417	9,995	7,300,279	7,389,831	128,011	7,023	682,797	4,763,004	380,039	159,245	21,512,641	32,413,287

[a] Includes Archer and McLennan counties.
[b] Markham and Big Hill.
[c] Includes Bexar, Duval, McMullen, Nacogdoches, and Washington counties.
[d] Includes Archer, Brown, Coleman, Jack, McLennan, and Stephens counties and Millsap and Ranger pools.
[e] Includes, Bexar, Brazoria, Duval, McMullen, and Washington counties.

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade-journal sources, and differ somewhat from those on page 701, obtained from reports received directly from the oil producers:

Wells completed in central and northern Texas, 1913–1917.

District.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Archer County				2	10				1	41				3	51
Brown County					3		1			1		2			4
Coleman County				5	3				1	2				7	6
Corsicana[b]	3	10	1	2		1	5				4	15	1	2	
Eastland County					1		2	1				3	1		2
Jack County			2	1	1				2	1			2	3	2
Marion County	16	8	13	7		6	2	5	9	1	22	10	18	16	1
Moran	1	3	9	2		4	3	12	4	1	6	12	21	6	1
Panola County				1	1				1	5				3	6
Parker County					1					2					3
Petrolia[c]	122	80	4	6	8	45	32	1	3	9	171	126	8	17	20
Stephens County				2	4				1	9				4	14
Strawn[d]			40	51	65			35	27	22			89	98	100
Thrall[e]			112	49				103	15				216	64	
Wichita County	435	394	124	372	631	125	169	29	65	184	561	567	156	441	816
Wilbarger County			1										1	1	
Young County			1							1			1		1
Miscellaneous	4	2				27	7	12	16	11	35	9	14	18	14
	581	497	307	500	728	208	221	198	145	290	799	744	528	683	1,041
Coastal and southern Texas	325	323	306	647	771	255	130	230	355	519	592	464	541	1,030	1,340
Total Texas	906	820	613	1,147	1,499	463	351	428	500	809	1,391	1,208	1,069	1,713	2,381

[a] Including gas wells.
[b] Including Powell.
[c] Including Henrietta.
[d] Including other tests in Palo Pinto County.
[e] Including other tests in Williamson County.

Oil wells and dry holes drilled in central and northern Texas in 1917.

District.	January.		February.		March.		April.		May.		June.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Archer County	2	2			1	6	1	3	1	6	2	5
Brown County												
Coleman County			1		1							1
Eastland County												
Jack County	1			1								
Marion County												
Moran				1								
Panola County		1		3	1							
Parker County		1								1		
Petrolia			1	3	1					1		
Stephens County			1	1				1		1	1	2
Strawn	5	2	9	3	4	5	13	1	10	1	7	2
Wichita County	29	1	34	4	40	12	48	13	64	11	80	16
Miscellaneous		1						1		2		3
	37	8	46	16	48	23	62	19	75	23	90	29
Coastal and southern Texas	48	26	53	35	78	29	73	38	88	68	83	64
Total Texas	85	34	99	51	126	52	135	57	163	91	173	93

Oil wells and dry holes drilled in central and northern Texas in 1917—Continued.

District.	July.		August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Archer County		1	1	3	1	2		4	1	9			10	41
Brown County							1			1	2		3	1
Coleman County							1	1					3	2
Eastland County							1						1	
Jack County													1	1
Marion County								1						1
Moran														1
Panola County		1											1	5
Parker County			1										1	2
Petrolia	2				1		1	2		1	2	2	8	9
Stephens County		1			1				1	1		2	4	9
Strawn	7	2	5	1			5	5					65	22
Wichita County	50	20	49	16	61	34	59	17	73	25	44	15	631	184
Miscellaneous		1		2				2						12
	59	26	56	22	64	36	68	32	75	37	48	19	728	290
Coastal and southern Texas	83	47	59	40	63	71	74	47	35	24	34	30	771	519
Total Texas	142	73	115	62	127	107	142	79	110	61	82	49	1,499	809

Wells completed in central and northern Texas, 1913–1917.

Month.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
January	38	64	14	34	37	27	24	6	12	8	66	89	20	49	50
February	31	49	22	44	46	25	23	9	8	16	57	74	31	55	65
March	35	95	20	37	48	12	39	7	16	23	47	138	28	59	72
April	55	79	34	54	62	16	22	17	11	19	73	106	53	69	81
May	57	46	37	56	75	18	26	28	13	23	76	73	66	75	101
June	61	44	30	62	90	19	14	31	14	29	80	60	63	79	121
July	47	23	12	41	59	17	18	13	17	26	66	42	29	60	86
August	56	29	29	24	56	20	11	22	9	22	77	42	52	37	81
September	41	16	23	40	64	9	6	15	16	36	50	25	39	58	101
October	48	20	19	31	68	10	18	16	12	32	59	40	37	44	103
November	68	22	33	38	75	25	12	16	8	37	93	36	55	47	113
December	44	10	34	39	48	10	8	18	9	19	55	19	55	51	67
	581	497	307	500	728	208	221	198	145	290	799	744	528	683	1,041

[a] Including gas wells.

Initial daily production of new wells completed in central and northern Texas in 1917, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Archer County	175		125	125	25	120		15	5		100		690
Brown County										10		70	80
Coleman County		50	20							90			160
Eastland County										510			510
Jack County	20												20
Panola County			6										6
Parker County								100					100
Petrolia		105	50				325		300	35		235	1,050
Stephens County		25				125			50		200		400
Strawn	185	370	70	365	340	165	109	145		50			1,799
Wichita County	3,484	2,311	2,448	1,139	4,187	5,493	3,401	5,062	2,675	7,353	4,244	4,516	46,313
	3,864	2,861	2,719	1,629	4,552	5,903	3,835	5,322	3,030	8,048	4,544	4,821	51,128
Coastal and southern Texas	33,660	40,325	64,730	37,396	36,410	50,508	32,040	55,605	34,607	30,473	14,157	15,377	445,288
Total Texas	37,524	43,186	67,449	39,025	40,962	56,411	35,875	60,927	37,637	38,521	18,701	20,198	496,416

Total and average initial daily production of new wells in central and northern Texas, 1913–1917, by districts, in barrels.

District.	Total initial production.					Average per well.				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Archer County				60	690				30.0	69.0
Brown County					80					26.7
Coleman County				150	160				30.0	53.3
Corsicana [a]	12	23	2	20		4.0	2.3	2.0	10.0	
Eastland County					510					510.0
Jack County			15	2	20			7.5	2.0	20.0
Marion County	5,250	390	1,445	735		328.1	48.8	111.2	105.0	
Moran	200	690	995	40		40.0	210.0	110.6	20.0	
Panola County				15	6				15.0	6.0
Parker County					100					100.0
Petrolia [b]	2,676	1,958	273	285	1,050	21.9	24.5	68.3	47.5	131.3
Stephens County				105	400				52.5	100.0
Strawn			1,245	2,010	1,799			31.1	39.4	27.7
Thrall			43,170	2,053				385.4	41.9	
Wichita County	49,286	21,917	5,488	44,253	46,313	113.3	55.6	44.3	119.0	73.4
Wilbarger County			10					10.0		
Young County			20					20.0		
Other	11	25				2.2	12.5			
	57,435	25,003	52,663	49,728	51,128	98.9	50.3	171.5	99.5	70.2
Coastal and southern Texas	38,978	160,695	292,541	388,422	445,288	119.9	497.5	956.0	600.3	577.5
Total Texas	96,413	185,698	345,204	438,150	496,416	106.4	226.4	563.1	382.0	331.2

[a] Including Powell. [b] Including Henrietta.

Total initial daily production of new wells in central and northern Texas, 1913–1917, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov	Dec.	Total.	Monthly average.
1913	2,726	3,366	2,986	1,909	6,258	9,720	7,391	4,593	5,605	5,092	5,291	2,498	57,435	4,786
1914	5,401	4,217	3,785	2,731	2,306	2,229	965	1,138	1,184	261	622	164	25,003	2,084
1915	507	1,300	6,250	9,558	11,365	9,940	4,455	3,655	1,720	785	1,748	1,380	52,663	4,389
1916	2,540	2,784	3,119	4,168	4,809	10,841	9,941	1,927	2,336	1,809	4,303	1,151	49,728	4,144
1917	3,864	2,861	2,719	1,629	4,552	5,903	3,835	5,322	3,030	8,048	4,544	4,821	51,128	4,261

Wells completed in coastal and southern Texas, 1913–1917.

District.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Batson	51	51	36	75	41	16	9	7	16	13	69	60	43	92	55
Bexar County			5	6	6			1	4	4			6	10	10
Brazoria County				2	12				14	35				17	49
Burleson County					1				1	2				1	3
Chambers County				1	3			2	4	6			2	5	9
Dayton [b]		2	1	6	3			7	13	12		2	8	19	15
Duval County			3	6	5				1	7			3	8	12
Goose Creek	27	34	6	42	274	24	10	5	15	141	51	44	11	60	443
Humble	89	46	106	305	217	54	33	69	150	129	144	80	176	471	354
Matagorda County	8	1	8	12	12	13			11	13	21	4	8	23	28
Nacogdoches County				1					1					2	
Orange County		3			1		5	5	3	3		8	5	3	4
Saratoga	49	17	34	55	35	28	4	11	12	12	78	21	45	67	49
Shelby County					1		1		1	2		1		2	4
Sourlake	64	140	93	114	132	18	44	52	32	46	85	184	146	146	178
Spindletop	29	24	11	22	28	40	7	3	13	18	69	32	14	35	46
Washington County			2					1	4	1			4	4	1
Wilson County			1					1					2		
Miscellaneous	8	5				62	17	66	60	75	75	28	68	65	80
	325	323	306	647	771	255	130	230	355	519	592	464	541	1,030	1,340
Central and northern Texas	581	497	307	500	728	208	221	198	145	290	799	744	528	683	1,041
Total Texas	906	820	613	1,147	1,499	463	351	428	500	809	1,391	1,208	1,069	1,713	2,381

[a] Including gas wells. [b] Including other tests in Liberty County.

Oil wells and dry holes drilled in coastal and southern Texas in 1917.

District.	Jan.		Feb.		Mar.		Apr.		May.		June.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Batson	3	......	2	2	4	4	5	1	6	2	6	......
Bexar County	......	......	......	......	......	......	......	......	......	......	......	......
Brazoria County	......	3	......	2	......	......	......	......	1	3	......	5
Burleson County	......	......	......	......	......	......	......	1	1	......	1	1
Chambers County	......	2	......	3	1	......	1	......	1	......	......	1
Dayton [a]	......	1	......	1	......	1	......	......	1	2	......	2
Duval County	......	1	......	1	......	......	......	......	......	2	......	1
Goose Creek	8	3	11	1	22	3	27	9	26	26	37	19
Humble	19	10	25	12	18	9	23	8	25	18	16	16
Matagorda County	1	......	......	1	2	......	1	......	2	......	3	1
Orange County	......	......	......	......	......	......	......	1	......	......	......	......
Saratoga	......	1	1	3	5	1	4	2	5	2	5	......
Shelby County	......	......	......	......	......	1	......	1	......	......	......	......
Sourlake	15	1	12	6	22	3	10	5	19	4	12	4
Spindletop	2	......	2	1	4	5	2	1	2	1	3	2
Washington County	......	......	......	......	......	......	......	......	......	......	......	......
Miscellaneous	......	4	......	2	......	2	......	9	......	8	......	12
	48	26	53	35	78	29	73	38	88	68	83	64
Central and northern Texas	37	8	46	16	48	23	62	19	75	23	90	29
Total Texas	85	34	99	51	126	52	135	57	163	91	173	93

District.	July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Batson	7	......	3	......	3	1	2	2	......	......	......	1	41	13
Bexar County	......	......	......	......	......	2	3	1	3	1	......	......	6	4
Brazoria County	1	5	4	3	2	3	1	7	1	3	2	1	12	35
Burleson County	......	......	......	......	......	......	......	......	......	......	......	......	1	2
Chambers County	......	......	......	......	......	......	......	......	......	......	......	......	3	6
Dayton [a]	......	......	......	......	......	3	1	......	......	......	1	2	3	12
Duval County	1	......	......	1	3	1	1	......	......	......	......	......	5	7
Goose Creek	37	15	22	14	22	34	36	6	14	8	12	3	274	141
Humble	18	10	16	9	16	12	11	11	14	3	16	11	217	129
Matagorda County	2	1	......	1	......	3	1	4	......	2	......	......	12	13
Orange County	......	1	......	1	1	......	......	......	......	......	......	......	1	3
Saratoga	4	1	3	......	6	1	2	1	......	......	......	......	35	12
Shelby County	......	......	......	......	1	......	......	......	......	......	......	......	1	2
Sourlake	11	7	10	6	6	4	13	4	2	......	......	2	132	46
Spindletop	2	3	1	1	3	2	3	......	1	1	3	1	28	18
Washington County	......	......	......	......	......	......	......	1	......	......	......	......	......	1
Miscellaneous	......	4	......	4	......	5	......	10	......	6	......	9	......	75
	83	47	59	40	63	71	74	47	35	24	34	30	771	519
Central and northern Texas	59	26	56	22	64	36	68	32	75	37	48	19	728	290
Total Texas	142	73	115	62	127	107	142	79	110	61	82	49	1,499	809

[a] Including other tests in Liberty County.

Wells completed in coastal and southern Texas, 1913–1917.

Month.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
January	26	38	22	41	48	6	3	11	27	26	34	42	33	73	84
February	25	18	25	47	53	18	4	4	32	35	43	24	29	81	93
March	32	22	17	66	78	16	7	15	25	29	49	29	32	91	113
April	33	20	15	74	73	30	18	18	29	38	66	39	33	105	114
May	20	37	24	90	88	15	8	13	48	68	38	47	37	143	160
June	31	27	30	57	83	31	10	32	36	64	65	37	62	96	155
July	36	37	25	56	83	27	18	34	33	47	63	56	60	91	134
August	31	32	26	49	59	30	20	17	29	40	61	54	44	80	99
September	25	21	32	39	63	20	8	23	26	71	45	30	55	67	137
October	23	23	20	37	74	21	16	11	15	47	44	39	31	52	125
November	19	26	37	39	35	16	13	28	26	24	35	40	66	68	61
December	24	22	33	52	34	25	5	24	29	30	49	27	59	83	65
	325	323	306	647	771	255	130	230	355	519	592	464	541	1,030	1,340

[a] Including gas wells.

Initial daily production of new wells completed in coastal and southern Texas in 1917, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Batson	150	250	400	140	175	735	220	50	215	60			2,395
Bexar County										33	32		65
Brazoria County					5,000		500	7,900	162	500	200	350	14,612
Burleson County						5							5
Chambers County			40	40	5								85
Dayton [a]					15					5		5	25
Duval County							30		25	10			65
Goose Creek	15,250	26,550	45,850	30,600	25,450	42,125	25,050	37,825	27,140	25,870	7,585	14,200	323,495
Humble	6,520	7,115	5,475	1,655	2,055	5,705	4,655	7,325	6,280	2,695	6,130	447	56,057
Matagorda County	75		250	30	55	185	160			40			795
Orange County									25				25
Saratoga		50	235	305	840	220	95	545	90	210			2,590
Shelby County									25				25
Sourlake	11,610	6,260	12,285	4,610	2,720	1,383	1,195	1,950	475	765	200		43,453
Spindletop	55	100	195	16	95	150	135	10	170	285	10	375	1,596
	33,660	40,325	64,730	37,396	36,410	50,508	32,040	55,605	34,607	30,473	14,157	15,377	445,288
Central and northern Texas	3,864	2,861	2,719	1,629	4,552	5,903	3,835	5,322	3,030	8,048	4,544	4,821	51,128
Total Texas	37,524	43,186	67,449	39,025	40,962	56,411	35,875	60,927	37,637	38,521	18,701	20,198	496,416

[a] Including other tests in Liberty County.

Total and average initial daily production of new wells in coastal and southern Texas, 1913–1917, by districts, in barrels.

District.	Total initial production.					Average per well.				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Batson	5,980	2,191	931	11,479	2,395	117.3	43.0	25.9	153.1	58.4
Bexar County			185	390	65			37.0	65.0	10.8
Brazoria County				14	14,612				7.0	1,209.3
Burleson County					5					5.0
Chambers County				10	85				10.0	28.3
Dayton		400	20	134	25		200.0	20.0	22.3	8.3
Duval County			80	385	65			26.7	64.2	13.0
Goose Creek	3,130	2,375	710	23,250	323,495	115.9	69.9	118.3	553.6	1,180.6
Humble	8,119	22,842	266,830	276,355	56,057	91.2	496.6	2,517.3	906.1	258.3
Matagorda County	380	25	2,375	5,520	795	47.5	25.0	296.8	460.0	66.3
Nacogdoches County				10					10.0	
Orange County		350			25		116.7			25.0
Saratoga	7,883	900	2,510	2,098	2,590	160.9	52.9	73.8	38.1	74.0
Shelby County					25					25.0
Sourlake	11,443	130,341	18,695	67,855	43,453	178.8	931.0	201.0	595.2	329.2
Spindletop	1,778	1,191	160	922	1,596	61.3	49.6	14.5	41.9	57.0
Washington County			40					20.0		
Wilson County			5					5.0		
Miscellaneous	265	80				33.1	16.0			
	38,978	160,695	292,541	388,422	445,288	119.9	497.5	956.0	600.3	577.5
Central and northern Texas	57,435	25,003	52,663	49,728	51,128	98.9	50.3	171.5	99.5	70.2
Total Texas	96,413	185,698	345,204	438,150	496,416	106.4	226.4	563.1	382.0	331.2

Total initial daily production of new wells in coastal and southern Texas, 1913–1917, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1913	1,147	3,652	10,936	2,305	5,595	3,195	1,335	1,147	1,757	2,186	1,016	4,707	38,978	3,248
1914	5,026	3,696	20,075	25,249	12,816	16,907	15,923	12,823	12,773	12,320	14,172	8,915	160,695	13,391
1915	15,180	14,458	3,385	3,300	11,220	12,640	13,475	13,880	36,133	61,030	88,100	19,740	292,541	24,378
1916	49,515	55,732	60,959	24,008	56,020	36,580	14,149	10,834	11,970	23,425	12,580	32,650	388,422	32,369
1917	33,660	40,325	64,730	37,396	36,410	50,508	32,040	55,605	34,607	30,473	14,157	15,377	445,288	37,107

LOUISIANA.

GENERAL STATEMENT.

The contribution of Louisiana to the petroleum supply of the United States in 1917 was 11,392,201 barrels, a decline of 3,855,937 barrels, or 25 per cent, compared with 1916. This loss, which is partly responsible for Louisiana's decline from fifth to sixth rank among the States that produce oil, is chargeable primarily to the oil fields of Red River Parish in the northern division, though adjacent fields in De Soto and Sabine parishes in that division and all the older pools of the Coastal division shared to some extent in the diminished output. Of the output in 1917, the fields of the northern division furnished 8,561,963 barrels, or 75 per cent, and the salt-dome pools of the coastal division 2,830,238 barrels, or 25 per cent. Compared with the output in 1916 the loss in 1917 was about 28 per cent in the northern division and 17 per cent in the southern.

The average price received at the wells for all grades of petroleum produced in Louisiana in 1917 was $1.60 a barrel and the market value of the entire output was $17,224,602, a gain of 64 cents in avarage market price and of $2,554,828, or 17 per cent, in gross market value, compared with 1916. The average market price of the product of the northern division increased from $1.03 a barrel in 1916 to $1.64 a barrel in 1917, a net gain of 61 cents, or 59 per cent, and despite the diminished quantity of oil the market value of the output in 1917 exceeded that of the output in 1916 by $1,897,643, or about 16 per cent. The average market price of the oil produced in the coastal division increased from 73 cents a barrel in 1916 to $1.11 a barrel in 1917, a net gain of 38 cents, or 52 per cent, and the market value of the output exceeded that of the output in 1916 by $657,185, or 26 per cent.

DEVELOPMENT.

Despite the effects of a stringency in drilling supplies and of an ill-advised strike of oil-field workers in November, activity in drilling for oil in Louisiana in 1917 was only slightly less than in 1916. In all 635 wells were completed during the year compared with 666 in 1916 and 565 in 1915. Of these new wells 395, or 62 per cent, produced an average of 267 barrels of oil each the first 24 hours after completion, 60 produced gas only, and 180, an average of 2 in every 7 drilled, were failures. Wildcat drilling remote from known areas of oil or gas production was a feature of drilling operations in both divisions of the Louisiana field.

NORTHERN OR STRATUM DIVISION.

In the oil districts of northern Louisiana 457 wells were completed in 1917, a decline of 63 wells, or 12 per cent, compared with 1916. Included in this total are 302 oil wells, credited with an average output of 196 barrels each the first day of productive life, 56 gas wells, and 99 failures, the ratio of failures to the total number of wells completed being approximately as 2 to 9.

Caddo Parish.—As a consequence primarily of the success that attended active development of the Ferry Lake lease of the Gulf Refining Co., the output of petroleum in the Caddo district—5,483,638 barrels—was slightly greater in 1917 than in 1916. On that property alone some 58 wells, credited with initial yields ranging all the way from 25 barrels to 4,000 barrels of oil each a day, and 2 dry holes were completed in 1917. South of Ferry Lake the new territory opened in 1916 west, southwest, and east of Mooringsport was actively developed in 1917, the proved area of the territory to the east of Mooringsport being materially extended farther east in consequence. Principal interest in the Caddo district, however, resulted from the opening of new territory of much apparent value in the Pine Island subdivision of the Caddo district lying east of Lewis and northeast of Oil City. The discovery well in this area was completed near the end of April by the Elton Oil & Gas Co., on the Hobbs lease in sec. 21, T. 21 N., R. 15 W., and was credited with a yield of 50 barrels of 30° Baumé gravity oil the first 24 hours after completion, at a depth of about 2,200 feet. The second well on the same lease was completed early in July and was credited with an initial daily output of 100 barrels. Subsequent drilling in 1917 extended the proved area of the new field into secs. 28 and 27 of the same township, south and southeast of the discovery well, and demonstrated that toward the north its limits lay south of sec. 16. That the new field is of much potential importance was shown on December 6 by the completion of a 10,000-barrel gusher by the Texas Co. in its first well on the Heilperin lease in sec. 28. Before the end of 1917 numerous tests were started in the territory northeast and east of the proved area as far as the eastern boundary of Caddo Parish.

In the southeastern part of Caddo Parish numerous gas wells of large capacity were drilled in the vicinity of Shreveport, the Hart's Island-Cedar Grove district, in T. 17 N., R. 13 W., proving especially valuable gas territory. South of that district one well completed by the Producers Oil Co. (now Texas Co.) on property of the Huron Land Co., in sec. 18, T. 15 N., R. 12 W., and credited with an initial open-flow capacity of 9,000,000 cubic feet of gas a day, was interpreted as proof of a westward extension of the Elm Grove Gas field in Bossier Parish.

De Soto Parish.—The output of petroleum from the pools in De Soto Parish decreased from 1,657,216 barrels in 1916 to 1,370,889 barrels in 1917, a net loss of 286,327 barrels, or 17 per cent. Development was restricted almost entirely to the Grand Bayou territory opened last year between the Naborton and the Crichton districts and to a considerable extent to the property of the Grand Bayou Plantation Co., in sec. 25, T. 13 N., R. 12 W., and to the Williams lease, in secs. 29, 31, and 32 of the adjoining township to the east.

In the northern end of De Soto Parish a wildcat test drilled by Little & Birch on State land in Wallace Lake, sec. 5, T. 15 N., R. 13 W., was abandoned in August, a failure at 2,600 feet, and another drilled by the Arkansas Natural Gas Co. on the White lease, in sec. 14 of the same township, was abandoned in December, a failure at 2,490 feet.

In the vicinity of Logansport in the western part of De Soto Parish the result of costly efforts to develop an oil field in the vicinity of the well of small capacity completed early in 1916 on the Bland lease in sec. 11, T. 11 N., R. 16 W., was failure. Unsuccessful tests were completed in that locality in 1917 as follows:

March—Producers Oil Co.; No. A-8 Sample; sec. 17, T. 11 N., R. 15 W.; depth, 3,050 feet.
April—Oriole Oil Co.; No. 1 Nash; sec. 24, T. 12 N., R. 16 W.; depth, 2,000 feet.
November—Producers Oil Co.; No. 1 Bland; sec. 2, T. 11 N., R. 16 W.; depth, 3,400 feet.
December—Atlas Oil Co.; No. 1 Sallings; sec. 14, T. 10 N., R. 15 W.; depth, 3,150 feet.
Federal Petroleum Co.; No. 1 Hatcher; sec. 27, T. 9 N., R. 14 W. (Sabine Parish); depth, 3,200 feet.

Red River Parish.—Drilling in adjacent territory failed to make good the decline resulting from the rapid exhaustion of the Crichton district, and the output of petroleum in Red River Parish decreased from 4,691,323 barrels in 1916 to 1,664,955 barrels in 1917, a loss of about 65 per cent in a single year. Although a few wells were completed in 1917 in the Crichton and Gusher Bend districts the greater part of the moderate activity in drilling was centered in the Grand Bayou district and in wildcat tests. Two miles southwest of the Gusher Bend district, wildcat drilling resulted in 1917 in the completion of one 30-barrel oil well and one dry hole on the Jenkins lease, in sec. 11, T. 12 N., R. 11 W., and a mile farther to the southwest in the opening of new territory on the Wemple lease, in sec. 15 of the same township. At the south end of the parish oil and gas were found in small quantities in wells drilled by the Lake End Oil Co. in sec. 31, T. 11 N., R. 9 W., and sec. 36 of the adjoining township to the west, and tests wholly unsuccessful were completed by the Arkla Oil Co. on the Wardlaw tract, sec. 19, T. 12 N., R. 9 W. (depth, 1,800 feet), and by the Jackson Oil & Gas Co. on the Robinson tract, sec. 26, T. 13 N., R. 10 W. (depth, 2,450 feet).

Bossier Parish.—Active development in 1917 of the Elm Grove district in the southern part of Bossier Parish resulted not only in supplemental proof of the enormous resources of natural gas in that district but in the completion of 5 oil wells in secs. 13 and 24, T. 16 N., R. 12 W., and in sec. 19 of the adjoining township to the east, in the eastern part of the field. The oil was reported to come from the lower members of the Annona Chalk at a depth of about 1,550 feet. As a consequence of this development, Bossier Parish is credited with a production of 36,188 barrels of oil in 1917 as against none in previous years.

Facilities for marketing the gas available in the Elm Grove district were provided in 1917 by the Louisiana Gas & Fuel Co., which in August completed a trunk pipe line from the field to Shreveport, a distance of about 16 miles.

In the northern part of Bossier Parish considerable activity in drilling resulted from the completion in July by the Dallas Co. of its third wildcat test near Plain Dealing. This well, located on the Scoville-Gaines lease, in sec. 21, T. 22 N., R. 13 W., was completed at a depth of 2,828 feet and was credited with an output of 910 barrels of fluid, 60 per cent of which was oil testing about 30° Baumé gravity, the first 24 hours after its completion. Subsequent tests a few hundred feet from the discovery well were barren and by the end of 1917 the area had been practically abandoned.

Webster Parish.—Unsuccessful tests for oil were completed in Webster Parish in 1917 by W. H. Baker on the Crichton lease in sec. 23, T. 18 N., R. 10 W., depth, 2,995 feet; and by the Atlas Oil

Co. on the north shore of Lake Bistineau, sec. 28, T. 17 N., R. 10 W., depth, 2,490 feet.

Bienville Parish.—On the east side of Lake Bistineau an unsuccessful test, 2,660 feet deep, was drilled in 1917 by the Arkansas Natural Gas Co. on the Sheehee lease, in sec. 11, T. 16 N., R. 10 W.

Natchitoches Parish.—Unsuccessful wildcat tests were drilled in Natchitoches Parish in 1917 by the Longbridge Oil Co. on the Chew lease, in sec. 37, T. 11 N., R. 6 W.; by the De Soto Oil & Refining Co. on the Wilson lease, in sec. 27, T. 13 N., R. 7 W.; by the Indian Oil & Gas Co. on the Boren lease, in sec. 36, T. 9 N., R. 8 W.; and by the Vogeler Oil Co. on the Russell lease, in sec. 34, T. 10 N., R. 7 W.

Winn Parish.—In Winn Parish unsuccessful wildcat tests were completed by the Pardee Oil Co. in No. 1 Gee, sec. 30, T. 11 N., R. 2 W., depth, 3,150 feet; and by A. J. Yoke in No. 1 Giddings, sec. 15, T. 10 N., R. 5 W., depth, 1,800 feet.

Claiborne Parish.—On the Moore farm near Homer, in sec. 22, T. 21 N., R. 7 W., Claiborne Parish, one unsuccessful test was completed by the Atlas Oil Co. in 1917.

Catahoula Parish.—In sec. 9, T. 10 N., R. 6 E., Catahoula Parish, an unsuccessful test was completed in April, 1917, by the Producers Oil Co.

Northeastern Louisiana.—Developments in 1917 in the territory north of Monroe and adjacent to the common corner of Morehouse, Ouachita, and Union parishes fully confirmed the evidence of an important gas field in that locality disclosed by a few tests drilled in 1916 but failed to adduce any evidence that the territory possesses value for petroleum. Unsuccessful wildcat tests drilled by the Standard Oil Co. (Louisiana) on the Richardson lease, in sec. 33, T. 19 N., R. 10 E., and by the Atlas Oil Co. on the community lease, in sec. 8 of the same township, in West Carroll Parish, east of the Monroe-Bastrop gas field, were abandoned at depths of 3,025 and 2,675 feet, respectively, in 1917.

SOUTHERN OR SALT-DOME DIVISION.

The quantity of petroleum marketed from the oil pools of southern Louisiana in 1917 was 2,830,238 barrels, a decline of 596,258 barrels, or 17 per cent, from the output in 1916. Its market value—$3,148,697—on the other hand was $657,185, or 26 per cent greater than that of the output in 1916. All districts, except of course the new one opened in Iberia Parish in 1917, shared in the responsibility for the diminished output. Activity in drilling resulted in the completion of 178 wells in 1917, a gain of 32 wells, or 22 per cent, over the number completed in southern Louisiana in 1916. Of these wells 93, or 52 per cent, were oil wells credited with an average yield of 497 barrels each the first day of productive life, 4 were gas wells, and 81, an average of 5 in every 11 drilled, were failures. The number of new oil wells completed in 1917 was 11 less than the number in 1916 and their average initial yield of oil was 573 barrels less. The ratio of dry holes to total completions in 1916 was as 2 to 7.

Vinton.—With an output of 1,595,366 barrels of oil in 1917, a decrease of only 44,781 barrels, or 3 per cent, compared with 1916, the Vinton pool in Calcasieu Parish easily maintained the leading position among the oil pools of southern Louisiana. Of 51 wells drilled in 1917 at Vinton, 33 produced an average of 653 barrels of oil each the first 24 hours after completion, 2 produced gas only, and 16 were failures. Aside from the completion in May, by the Gulf Coast Oil Co., of a 7,000-barrel oil well in its No. 7 Vincent, in the southeastern part of the field, and the subsequent completion of several other wells of only moderate capacity in the same locality, operations in the Vinton district were featureless during the year.

Edgerly.—The quantity of petroleum marketed from the Edgerly pool in Calcasieu Parish in 1917—805,609 barrels—was less by 446,929 barrels, or 36 per cent, than the output in 1916. Of 42 new wells drilled, 32 produced an average of 663 barrels of oil each the first 24 hours after completion, and 10 were failures. Wells having initial capacities of 3,000 to 5,000 barrels a day were completed by the Gulf Refining Co. on its Bright-Penn lease, but elsewhere the new oil wells completed were of average or less than average initial capacity. On the Hewett tract northeast of the Edgerly field one unsuccessful test was drilled to a reported depth of 3,190 feet, by the Lyons-Gulf Coast Oil Development Co., and on lands 7 miles southeast of the field a test with equally unencouraging results was drilled to a reported depth of 3,235 feet by the Mistletoe Oil Co.

In other parts of Calcasieu Parish unsuccessful wildcat tests were completed in 1917, as follows:

Gulf Sulphur Co.; in sec. 15, T. 9 S., R. 10 W.; depth, 3,005 feet.
Mutual Sulphur Co.; in sec. 30, T. 9 S., R. 10 W.; depth, 3,300 feet.
Tri-State Oil Co.; in sec. 30, T. 9 S., R. 10 W.; depth, 3,600 feet.
Big Woods Oil & Mineral Co.; in sec. 12, T. 9 S., R. 12 W.; depth, 2,710 feet.
Chopique Oil Co.; in sec. 10, T. 11 S., R. 12 W.; depth, 3,010 feet.
W. C. Mowrey; near Stark, north of Lake Charles; depth, 1,800 feet.
Phoenix Sulphur Co.; in sec. 28, T. 9 S., R. 10 W.; depth, 1,800 feet.

Jennings.—The contribution of the Jennings pool, in western Acadia Parish, to the petroleum output of coastal Louisiana in 1917 was 399,469 barrels, a decline of 117,205 barrels compared with 1916. Of 38 new wells completed at Jennings, 25 were oil wells credited with an average initial yield of 72 barrels each, and 13 were failures.

Anse la Butte.—With no new oil wells to the credit of the Anse la Butte pool in St. Martins Parish, in 1917, the output of oil from that pool decreased from 12,818 barrels in 1916 to 4,900 barrels in 1917, a decline of 62 per cent. Three unsuccessful deep tests were drilled at Anse la Butte in 1917.

Welsh.—The Geological Survey was unable to obtain record of any oil having been marketed from the Welsh pool in Jefferson Davis Parish in 1917. One oil well, credited with an initial yield of 10 barrels, and two dry holes comprise the drilling record at Welsh in 1917.

Iberia Parish.—Following the discovery of "paraffin dirt" in August, 1916, on the shores of Little Bayou, about 5 miles east of New Iberia, Iberia Parish, land was leased and drilling for oil was begun in that locality in December, 1916. Early in 1917 oil in small quantities was found at a depth of about 1,071 feet by the New Iberia Oil Co., and at about 1,200 feet by the Gulf Refining Co. Subsequent drilling resulted in May in the completion by the Gulf Refining Co. of a 1,500-barrel oil well at 2,863 feet, on the Bernard tract; and in September in the completion of a 200-barrel well at about 3,000 feet on the Sabastier tract; and before the end of the year, in the completion of 13 dry holes in the vicinity of the two successful wells. About 24,894 barrels of oil were marketed from the new district in 1917.

Terrebonne Parish.—Important discoveries of greater immediate interest to the natural-gas industry than to the petroleum industry were made in 1917 in the east-central part of Terrebonne Parish. These consisted of two monster gas wells completed by the Terrebonne Oil & Gas Co. (Hunter & McCormick), in what was termed the Montegut field, about 18 miles southeast of Houma. The wells, one completed in April, the other in June, are about 2,500 feet deep, and when completed were credited with open-flow capacities in excess of 50,000,000 cubic feet of gas a day. Both ran wild several days before being securely capped. The open-flow pressure of the gas in well No. 2 was gaged at 192 pounds to the square inch and its closed pressure was estimated at 1,200 pounds to the square inch. Before the end of 1917 gas from this well was being utilized locally by the Terrebonne Sugar Co., and plans were being developed for piping the gas to industrial plants in the vicinity of New Orleans, about 50 miles northeast of the field.

MISCELLANEOUS WILDCAT TESTS.

Unsuccessful tests for oil in various parts of coastal Louisiana were reported completed and abandoned in 1917 as follows:

CAMERON PARISH.

July: Consolidated Oil Industries Co.; No. 1 Foreman, on Johnsons Bayou; sec. 32, T. 14 S., R. 14 W.; depth, 3,220 feet.

September: Mermenton Mining & Mineral Land Co.; No. 1 Thereot; sec. 32, T. 14 S., R. 5 W.; depth, 2,650 feet.

December: Mermenton Mining & Mineral Land Co.; No. 2 fee land; sec. 32, T. 14 S., R. 5 W.; depth, 2,620 feet.

JEFFERSON DAVIS PARISH.

July: Welsh Petroleum Co.; near Welsh; depth, 2,600 feet.

PLAQUEMINE PARISH.

December: Gulf Development Co., No. 1 Hero; sec. 8, T. 15 S., R. 24 E.; depth, 2,600 feet.

ST. LANDRY PARISH.

August: Concordia Oil & Gas Co.; near Opelusas; depth, —— feet.

ALLEN PARISH.

August: Barnes Bayou Petroleum Co.; depth, 1,500 feet.

PETROLEUM MARKETED.

Petroleum marketed in Louisiana, 1908–1917, in barrels.

Year.	Northern Louisiana.					
	Caddo.	De Soto.	Red River.	Sabine.	Bossier.	Total.
1908	499,937					499,937
1909	1,028,818					1,028,818
1910	5,090,793					5,090,793
1911	6,995,828					6,995,828
1912	7,177,949					7,177,949
1913	9,781,560					9,781,560
1914	7,572,254	a 3,834,593	401,622			11,808,469
1915	6,471,879	1,797,175	6,802,349	10,631		15,082,034
1916	5,463,682	1,657,216	4,691,323	9,421		11,821,642
1917	5,483,638	1,370,889	1,664,955	6,293	36,188	8,561,963

Year.	Coastal Louisiana.							State total.
	Jennings.	Welsh.	Anse la Butte.	Vinton.	Edgerly.	New Iberia.	Total.	
1908	5,111,577	31,555	145,805				5,288,937	5,788,874
1909	1,966,614	26,169	37,930				2,030,713	3,059,531
1910	1,625,159	54,724	44,018	26,701			1,750,602	6,841,395
1911	1,180,177	27,901	62,411	2,454,103			3,724,592	10,720,420
1912	1,105,711	22,140	25,000	932,639			2,085,490	9,263,439
1913	790,648	31,144	6,612	1,888,864			2,717,268	12,498,828
1914	412,036	18,629	18,623	1,465,302	586,376		2,500,966	14,309,435
1915	434,815	16,451	20,982	1,234,227	1,403,030		3,109,505	18,191,539
1916	516,674	4,319	12,818	1,640,147	1,252,538		3,426,496	15,248,138
1917	399,469		4,900	1,595,366	805,609	24,894	2,830,238	11,392,201

a Includes Sabine.

Petroleum marketed in Louisiana in 1916 and 1917, in barrels.

1916.

Month.	Northern Louisiana.				
	Caddo.	De Soto.	Red River.	Sabine.	Total.
January	439,747	108,211	601,705	327	1,149,990
February	414,599	112,335	546,691	709	1,074,334
March	457,947	137,418	539,676	1,290	1,136,331
April	452,376	130,358	483,887	688	1,067,309
May	494,679	176,594	427,327	1,104	1,099,704
June	477,497	183,688	380,154	998	1,042,337
July	482,925	170,587	343,587	717	997,816
August	474,683	144,918	327,265	1,032	947,898
September	447,114	123,630	305,977	331	877,052
October	453,336	129,892	292,160	896	876,284
November	427,111	123,672	224,403	850	776,036
December	441,668	115,913	218,491	479	776,551
	5,463,682	1,657,216	4,691,323	9,421	11,821,642

Month.	Coastal Louisiana.						State total.
	Anse la Butte.	Edgerly.	Jennings.	Vinton.	Welsh.	Total.	
January	1,315	85,893	34,423	95,689	366	217,686	1,367,676
February	2,501	110,058	28,442	163,160	1,823	305,984	1,380,318
March	3,143	108,519	29,425	205,277	658	347,022	1,483,353
April	899	116,602	40,146	170,946	292	328,885	1,396,194
May	899	108,950	48,730	155,164	303	314,046	1,413,750
June	1,055	124,276	48,146	131,987	293	305,757	1,348,094
July	589	113,908	51,732	137,925		304,154	1,301,970
August	896	112,220	52,280	115,146	290	280,832	1,228,730
September	375	75,183	41,589	110,486		227,633	1,104,685
October	433	93,351	46,559	118,326	294	258,963	1,135,247
November	279	100,894	48,815	120,102		270,090	1,046,126
December	434	102,684	46,387	115,939		265,444	1,041,995
	12,818	1,252,538	516,674	1,640,147	4,319	3,426,496	15,248,138

Petroleum marketed in Louisiana in 1916 and 1917, in barrels—Continued.

1917.

Month.	Northern Louisiana.					
	Bossier.	Caddo.	De Soto.	Red River.	Sabine.	Total.
January	1,530	399,338	114,833	210,790	996	727,487
February	1,738	341,717	100,775	167,487	324	612,041
March	2,597	432,311	130,580	172,349	312	738,149
April	2,207	449,764	131,477	159,794	1,186	744,428
May	3,379	507,107	144,306	162,303	336	817,431
June	3,338	480,258	188,167	140,374	327	812,464
July	4,051	578,249	134,143	138,145	337	854,925
August	3,165	588,640	117,980	137,383	639	847,807
September	3,845	573,234	105,863	131,633	332	814,907
October	3,737	576,367	109,409	129,682	604	819,799
November	3,283	208,715	26,809	40,974	327	280,108
December	3,318	347,938	66,547	74,041	573	492,417
	36,188	5,483,638	1,370,889	1,664,955	6,293	8,561,963

Month.	Coastal Louisiana.						State total.
	Anse la Butte.	Edgerly.	Jennings.	New Iberia.	Vinton.	Total.	
January	513	109,012	39,484	....	118,034	267,043	994,530
February	358	77,511	31,677	....	99,129	208,675	820,716
March	513	85,789	31,725	....	113,120	231,147	969,296
April	358	72,821	30,822	....	145,469	249,470	993,898
May	358	74,811	31,799	....	242,201	349,169	1,166,600
June	358	53,892	29,037	3,736	174,363	261,386	1,073,850
July	358	58,142	29,536	6,584	134,839	229,459	1,084,384
August	358	57,058	35,305	3,844	114,671	211,236	1,059,043
September	358	59,406	32,378	3,373	116,332	211,847	1,026,754
October	358	55,576	34,635	1,854	127,261	219,684	1,039,483
November	652	52,405	36,623	3,041	104,839	197,560	477,668
December	358	49,186	36,448	2,462	105,108	193,562	685,979
	4,900	805,609	399,469	24,894	1,595,366	2,830,238	11,392,201

Petroleum marketed in Louisiana in 1916 and 1917, with increase or decrease.

District.	1916			1917			Increase or decrease.	
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Barrels.	Per cent.
Northern Louisiana:								
Bossier	....	....	......	36,188	$53,375	$1.474	+ 36,188	....
Caddo	5,463,682	$6,123,053	$1.121	5,483,638	9,220,234	1.681	+ 19,956	+ 0.37
De Soto	1,657,216	1,999,217	1.206	1,370,889	2,450,543	1.798	− 286,327	−17.28
Red River	4,691,323	4,044,865	.862	1,664,955	2,340,616	1.406	−3,026,368	−64.51
Sabine	9,421	11,127	1.181	6,293	11,137	1.770	− 3,128	−33.20
	11,821,642	12,178,262	1.030	8,561,963	14,075,905	1.644	−3,259,679	−27.57
Coastal Louisiana:								
Anse la Butte	12,818	12,818	1.000	4,900	8,575	1.750	− 7,918	−61.77
Edgerly	1,252,538	875,812	.699	805,609	916,005	1.137	− 446,929	−35.68
Jennings	516,674	389,453	.754	399,469	460,402	1.153	− 117,205	−22.68
New Iberia	....	....	......	24,894	24,894	1.000	+ 24,894	....
Vinton	1,640,147	1,209,110	.737	1,595,366	1,738,821	1.090	− 44,781	− 2.73
Welsh	4,319	4,319	1.000	....	....	......	− 4,319	....
	3,426,496	2,491,512	.727	2,830,238	3,148,697	1.113	− 596,258	−17.40
Total Louisiana	15,248,138	14,669,774	.962	11,392,201	17,224,602	1.600	−3,855,937	−25.29

Petroleum marketed, value, and average price per barrel in the Caddo field, 1906–1917.

Year.	Caddo, La.			Marion County, Tex.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1906	3,358	$2,183	$0.650				3,358	$2,183	$0.650
1907	50,000	38,863	.777				50,000	38,863	.777
1908	499,937	214,048	.428				499,937	214,048	.428
1909	1,028,818	549,081	.533				1,028,818	549,081	.533
1910	5,090,793	2,292,349	.451	251,717	$102,842	$0.409	5,342,510	2,395,191	.448
1911	6,995,828	3,653,725	.522	677,689	365,067	.539	7,673,517	4,018,792	.524
1912	7,177,949	5,419,541	.755	362,870	290,974	.802	7,540,819	5,710,515	.757
1913	9,781,560	9,812,342	1.003	262,392	261,965	.998	10,043,952	10,074,307	1.003
1914	7,572,254	7,177,535	.948	180,584	175,922	.974	7,752,838	7,353,457	.948
1915	6,471,879	4,597,558	.710	123,464	88,079	.713	6,595,343	4,685,637	.710
1916	5,463,682	6,123,053	1.121	64,971	80,305	1.236	5,528,653	6,203,358	1.122
1917	5,483,638	9,220,234	1.681	57,952	108,284	1.869	5,541,590	9,328,518	1.683
	55,619,696	49,100,512	.883	1,981,639	1,473,438	.744	57,601,335	50,573,950	.878

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade-journal sources and differ somewhat from those on pages 701–702, obtained from reports received directly from the oil producers.

Wells completed in Louisiana, 1913–1917.

District.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Northern Louisiana:															
Avoyelles									1					1	
Bienville										3					3
Bossier				2	5		3	5	22	8		3	5	39	32
Caddo	356	208	67	194	241	92	54	32	54	37	[b]518	291	107	269	298
Claiborne										2				2	6
De Soto		77	23	29	28		24	17	25	21	(c)	123	49	64	54
Grant										2					2
Jackson										1					1
Lincoln															1
Morehouse															1
Natchitoches					1				4	3				4	4
Ouachita															3
Rapides						1	3		1		1	3		1	
Red River		257	99	27	14		7	30	33	17		21	296	139	47
Sabine		2			3		3	5			(c)	7	7		
Tensas									1					1	
Webster										3					3
Winn										2					2
	356	302	349	324	302	93	94	89	141	99	519	448	464	520	457
Coastal Louisiana:															
Allen										2					2
Anse la Butte	5	3	1	1		1		3	3	3	6	3	4	4	3
Calcasieu	4					1	2	2		11	5	2	2		11
Cameron						2	1		3	4	2	1		3	4
Edgerly		30	35	44	32		16	2	7	10		46	38	51	42
Evangeline						1					1				
Iberia					2					13					15
Jefferson Davis									1	1				1	1
Jennings	19	12	16	28	25	9	9	6	14	13	28	21	22	42	38
Pine Prairie	2					4					6				
Plaquemine										1					1
St. Landry										1					1
St. Martin										2					2
Terrebonne										2	1				4
Vinton	45	22	19	31	33	34	12	11	12	16	79	35	31	44	51
Welsh	6	5	2		1	4	5	2	1	2	10	10	4	1	3
	81	72	73	104	93	56	45	26	41	81	138	118	101	146	178
Total Louisiana	437	374	422	428	395	149	139	115	182	180	657	566	565	666	635

a Including gas well. b Including De Soto and Sabine parishes. c Included in Caddo.

Oil wells and dry holes drilled in Louisiana in 1917.

District.	Jan.		Feb.		Mar.		Apr.		May.		June.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Northern Louisiana:												
Bienville		1		1								
Bossier		2	1	2	1			1	1			2
Caddo	13	4	13	3	13	3	19	2	32	7	23	2
Claiborne				1				1				
De Soto	3	3	2		3	4	2	2	7	3	4	
Grant				1								1
Jackson				1								
Natchitoches								1				1
Red River	3	4	5	1	1	4	3	2	7	1		2
Webster												
Winn										1		1
	19	14	21	10	18	10	24	9	47	12	27	9
Coastal Louisiana:												
Allen												
Anse la Butte										1		
Calcasieu						1		1				
Cameron										1		
Edgerly	6		2	1	4	3	3		3	1	1	1
Iberia						1		2	1	2		2
Jefferson Davis												
Jennings	2		1	2	1	1	2		2	3	4	1
Plaquemine												
St. Landry												
St. Martin										1		
Terrebonne												
Vinton	1	3	4	1	4		3	1	3		2	1
Welsh												
	9	3	7	4	9	6	8	4	9	9	7	5
Total Louisiana	28	17	28	14	27	16	32	13	56	21	34	14

District.	July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
	Oil	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Northern Louisiana:														
Bienville		1												3
Bossier		1			1				1				5	8
Caddo	30	6	29	3	26	6	28	1	6	1	9		241	37
Claiborne														2
De Soto	1	1	4	1	1		1	2		3		2	28	21
Grant														2
Jackson														1
Natichitoches		1	1										1	3
Red River	2	1	3	2	1		1		1				27	17
Webster				1								2		3
Winn														2
	33	11	37	7	29	6	30	3	8	4	9	4	302	99
Coastal Louisiana:														
Allen				1		1								2
Anse la Butte						1		1						3
Calcasieu		4		1				1		1		2		11
Cameron		1						1				1		4
Edgerly	2	2	3		1		1		2	2	4		32	10
Iberia		1		4	1	1							2	13
Jefferson Davis		1												1
Jennings	3				4	2	2	1	2	3	2		25	13
Plaquemine												1		1
St. Landry				1										1
St. Martin						1								2
Terrebonne										2				2
Vinton	3	3	3	2	3	3	3		2	1	2	1	33	16
Welsh	1	2											1	2
	9	14	6	9	9	9	6	4	6	9	8	5	93	81
Total Louisiana	42	25	43	16	38	15	36	7	14	13	17	9	395	180

Wells completed in Louisiana, 1913–1917.

Month.	Oil.					Dry.					Total completed.[a]				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
January	36	28	18	30	28	12	5	5	16	17	53	38	24	53	51
February	25	33	25	42	28	10	10	12	13	14	44	48	41	65	54
March	28	44	23	48	27	9	12	6	14	16	44	60	30	66	50
April	45	35	39	35	32	16	12	12	10	13	65	50	54	47	53
May	39	49	42	44	56	5	18	2	9	21	49	74	45	63	83
June	23	50	49	42	34	17	17	16	12	14	44	69	67	59	52
July	51	33	48	39	42	15	10	8	14	25	73	46	57	55	69
August	37	29	43	38	43	10	12	13	24	16	54	47	59	65	62
September	43	20	40	40	38	12	8	8	21	15	58	36	48	67	56
October	34	12	32	25	36	11	12	10	26	7	51	29	42	53	50
November	34	19	30	24	14	14	11	13	7	13	51	33	46	34	28
December	42	22	33	21	17	18	12	10	16	9	71	36	52	39	27
	437	374	422	428	395	149	139	115	182	180	657	566	565	666	635

[a] Including gas wells.

Initial daily production of new wells completed in Louisiana in 1917, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Northern Louisiana:													
Bossier	......	60	60	......	10	......	......	......	10	......	100	......	240
Caddo	470	915	1,155	3,340	3,350	2,635	5,833	4,395	9,975	4,390	2,480	10,515	49,453
De Soto	385	170	2,040	150	371	3,535	25	95	40	65	......	......	6,876
Natchitoches	......	......	......	......	......	......	......	2	......	......	......	......	2
Red River	365	800	85	140	770	......	251	120	25	110	35	......	2,701
	1,220	1,945	3,340	3,630	4,501	6,170	6,109	4,612	10,050	4,565	2,615	10,515	59,272
Coastal Louisiana:													
Edgerly	7,800	1,250	385	550	4,065	40	2,100	1,275	1,500	400	150	1,700	21,215
Iberia	......	......	......	......	1,500	......	......	......	150	......	......	......	1,650
Jennings	205	75	30	200	325	155	295	......	75	90	110	240	1,800
Vinton	200	2,140	610	4,350	8,150	250	465	450	270	275	300	4,075	21,535
Welsh	......	......	......	......	......	......	10	......	......	......	......	......	10
	8,205	3,465	1,025	5,100	14,040	445	2,870	1,725	1,995	765	560	6,015	46,210
Total Louisiana	9,425	5,410	4,365	8,730	18,541	6,615	8,979	6,337	12,045	5,330	3,175	16,530	105,482

Total and average initial daily production of new wells in Louisiana, 1913–1917, by districts, in barrels.

District.	Total initial production.					Average per well.				
	1913	1914	1915	1916	1917	1913	1914	1915	1916	1917
Northern Louisiana:										
Bossier	......	......	......	175	240	......	......	......	87.5	48.0
Caddo	[a]151,955	19,241	14,320	16,221	49,453	426.8	92.5	213.7	83.6	205.2
De Soto	......	70,612	8,190	13,425	6,876	......	917.0	356.1	462.9	281.3
Natchitoches	......	......	......	......	2	......	......	......	......	2.0
Red River	......	12,185	175,551	25,050	2,701	......	870.4	683.1	253.0	100.0
Sabine	......	155	55	......	......	......	51.7	27.5	......	......
	151,955	102,193	198,116	54,871	59,272	426.8	338.4	567.7	169.4	196.3
Coastal Louisiana:										
Anse la Butte	2,362	340	50	300	......	472.4	113.3	50.0	300.0	......
Calcasieu	1,780	......	......	......	......	445.0	......	......	......	......
Edgerly	......	38,785	32,960	42,725	21,215	......	1,292.8	941.7	971.0	663.0
Iberia	......	......	......	......	1,650	......	......	......	......	825.0
Jennings	4,813	592	3,390	5,195	1,800	253.3	49.3	211.9	185.5	72.0
Pine Prairie	80	......	......	......	......	40.0	......	......	......	......
Vinton	46,605	43,070	8,715	63,090	21,535	1,035.7	1,957.7	458.7	2,035.2	652.6
Welsh	100	127	70	......	10	16.7	25.4	35.0	......	10.0
	55,740	82,914	45,185	111,310	46,210	688.1	1,151.6	619.0	1,070.3	496.9
Total Louisiana	207,695	185,107	243,301	166,181	105,482	475.3	494.9	576.5	388.3	267.0

[a] Including De Soto and Sabine parishes.

Total initial daily production of new wells in Louisiana, 1913–1917, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1913	21,064	12,410	27,220	28,860	26,986	13,966	15,675	22,626	6,580	11,163	3,447	17,698	207,695	17,308
1914	8,570	10,155	36,305	22,493	17,057	26,212	17,742	10,785	17,367	4,805	6,390	7,226	185,107	15,426
1915	4,890	11,985	23,535	23,365	21,355	20,975	29,341	26,230	34,270	17,705	14,400	15,250	243,301	20,275
1916	35,580	20,010	31,965	9,040	8,711	10,695	9,905	7,145	11,245	3,010	7,325	11,550	166,181	13,848
1917	9,425	5,410	4,365	8,730	18,541	6,615	8,979	6,337	12,045	5,330	3,175	16,530	105,482	8,790

ROCKY MOUNTAIN OIL FIELD.

GENERAL STATEMENT.

The Rocky Mountain field embraces all areas of production of petroleum in Colorado, Wyoming, and Montana, as well as a number of areas of prospective production in Utah and New Mexico. Petroleum in this field is obtained from strata of Carboniferous and Cretaceous age, the oil occurring generally in sandstone layers, though found occasionally in limestone and rarely in fracture zones in shale. Anticlinal and dome structures are the most favored places of accumulation of oil, though areas of commercial production have been found in this field on monoclinal and terrace structures. The oils from older strata range in gravity from 18° to 24° Baumé, are of asphalt base, and are utilized chiefly for fuel; those from the Cretaceous rocks range between 32° and 48° Baumé, are of paraffin base, and are in wide demand for refining.

Final statistics of production in the oil districts of Wyoming, Colorado, and Montana indicate an output in 1917 of 9,199,310 barrels. The fact that this quantity is greater by 2,723,021 barrels, or 42 per cent, than the output in 1916, and greater by 4,745,310 barrels, or 107 per cent, than the output in 1915, ably demonstrates the growing importance of this field as a contributor to the petroleum supply of the United States and amply justifies the confidence in the potentialities of this region held by its pioneer developers.

The average price received at the wells for all grades of Rocky Mountain oil in 1917 was $1.23 a barrel, a gain of 32 cents, or 35 per cent, over the average in 1916. The market value of the oil sold was $11,322,248, a gain of $5,417,010, or 92 per cent, over the market value of the output in 1916. All revisions of market quotations affecting grades of oil produced in the Rocky Mountain field were upward. Grass Creek-Elk Basin grade, the class which includes the greater part of the oil sold in the open market in this field opened the year at $1.10 a barrel and advanced to $1.20 on January 2, to $1.30 on January 8, to $1.35 on January 30, to $1.40 on March 23, to $1.45 on July 6, to $1.50 on July 12, and reached its closing price of $1.70 a barrel on August 21, the total advance during the year amounting to 60 cents a barrel, a gain of about 54 per cent on the price in effect at the beginning of the year.

PETROLEUM MARKETED.

Petroleum marketed in the Rocky Mountain field in 1916 and 1917, in barrels.

Month.	1916				1917			
	Colorado.	Wyoming.	Montana.	Total.	Colorado.	Wyoming.	Montana.	Total.
January	19,406	347,145	....	366,551	11,869	589,075	10,954	611,898
February	13,552	235,344	....	248,896	10,324	643,504	10,504	664,332
March	13,510	492,720	....	506,230	9,541	740,304	11,040	760,885
April	19,507	471,944	....	491,451	10,184	779,486	9,676	799,346
May	23,556	503,426	....	526,982	10,396	740,778	9,186	760,360
June	17,228	530,222	323	547,773	10,179	735,077	8,076	753,332
July	14,126	534,826	1,840	550,792	10,655	726,936	7,224	744,815
August	10,219	637,708	9,376	657,303	11,122	751,932	7,157	770,211
September	9,967	639,182	2,854	652,003	9,352	809,690	6,671	825,713
October	11,022	617,220	10,910	639,152	8,843	840,561	6,632	856,036
November	12,545	594,066	10,924	617,535	8,715	775,011	6,297	790,023
December	32,597	630,334	8,690	671,621	10,051	846,326	5,982	862,359
	197,235	6,234,137	44,917	6,476,289	121,231	8,978,680	99,399	9,199,310

Petroleum marketed in the Rocky Mountain field, 1887–1917.

Year.	Quantity (barrels).	Percentage of total production.	Increase or decrease.		Value.	Yearly average price per barrel.
			Barrels.	Per cent.		
1887	76,295	0.27	....	....	$76,295	$1.000
1888	297,612	1.07	+ 221,317	+ 29.01	267,851	.900
1889	316,476	.90	+ 18,864	+ 6.34	280,210	.885
1890	368,842	.80	+ 52,366	+ 16.54	309,827	.840
1891	665,482	1.22	+ 296,640	+ 80.42	559,005	.840
1892	824,000	1.63	+ 158,518	+ 23.82	692,160	.840
1893	594,390	1.22	− 229,610	− 27.86	497,581	.838
1894	518,115	1.05	− 76,275	− 12.83	319,572	.617
1895	441,687	.83	− 76,428	− 14.75	363,650	.823
1896	364,328	.59	− 77,359	− 17.51	342,001	.939
1897	388,584	.64	+ 24,256	+ 6.66	361,322	.930
1898	449,858	.80	+ 61,274	+ 15.77	405,772	.902
1899	395,838	.69	− 54,020	− 12.01	443,030	1.119
1900	322,835	.50	− 73,003	− 18.44	361,584	1.120
1901	465,920	.66	+ 143,085	+ 44.32	498,831	1.071
1902	403,154	.45	− 62,766	− 13.47	528,454	1.311
1903	492,885	.48	+ 89,731	+ 22.26	494,443	1.003
1904	513,305	.43	+ 20,420	+ 4.14	658,829	1.284
1905	384,692	.28	− 128,613	− 25.06	389,151	1.012
1906	334,582	.26	− 50,110	− 13.03	311,675	.932
1907	341,190	.205	+ 6,608	+ 1.98	294,696	.863
1908	397,428	.22	+ 56,238	+ 16.48	374,323	.942
1909	330,917	.18	− 66,511	− 16.74	352,618	1.066
1910	355,224	.17	+ 24,307	+ 7.35	336,938	.949
1911	413,621	.185	+ 58,397	+ 16.44	352,141	.851
1912	1,778,358	.80	+1,364,737	+329.95	998,131	.561
1913	2,595,321	1.04	+ 816,963	+ 45.94	1,362,011	.525
1914	3,783,148	1.43	+1,187,827	+ 45.77	1,880,086	.497
1915	4,454,000	1.585	+ 670,852	+ 17.73	2,400,503	.539
1916	6,476,289	2.153	+2,022,289	+ 45.40	5,905,238	.912
1917	9,199,310	2.74	+2,723,021	+ 42.05	11,322,248	1.231
	38,743,686	.91	....	....	33,740,206	.871

Petroleum marketed, value, and average price per barrel in the Rocky Mountain field, 1908–1917, by States.

Year.	Colorado.			Wyoming.			Montana.			Total.		
	Quantity (barrels).	Value.	Average price per barrel	Quantity (barrels).	Value.	Average price per barrel	Quantity (barrels).	Value.	Average price per barrel	Quantity (barrels).	Value.	Average price per barrel.
1908	379,653	$346,403	$0.913	a17,775	$27,920	$1.570				397,428	$374,323	$0.942
1909	310,861	318,162	1.023	a20,056	34,456	1.718				330,917	352,618	1.066
1910	239,794	243,402	1.015	a115,430	93,536	.810				355,224	336,938	.949
1911	226,926	228,104	1.005	a186,695	124,037	.664				413,621	352,141	.851
1912	206,052	199,661	.973	1,572,306	798,470	.507				1,778,358	998,131	.561
1913	188,799	174,779	.926	2,406,522	1,187,232	.493				2,595,321	1,362,011	.525
1914	222,773	200,894	.902	3,560,375	1,679,192	.472				3,783,148	1,880,086	.497
1915	208,475	183,485	.880	4,245,525	2,217,018	.522				4,454,000	2,400,503	.539
1916	197,235	217,139	1.100	6,234,137	5,644,080	.905	44,917	$44,019	$0.98	6,476,289	5,905,238	.912
1917	121,231	128,100	1.057	8,978,680	11,047,876	1.230	99,399	146,272	1.472	9,199,310	11,322,248	1.231

a Includes Utah.

Petroleum marketed in the Rocky Mountain field, 1914–1917, in barrels.

Month.	1914	1915	1916	1917
January	216,558	356,351	366,551	611,898
February	179,011	270,688	248,896	664,332
March	246,825	370,698	506,230	760,885
April	318,235	214,858	491,451	799,346
May	394,112	263,115	526,982	760,360
June	239,295	409,386	547,773	753,332
July	307,244	411,504	550,792	744,815
August	398,804	451,764	657,303	770,211
September	406,472	388,863	652,003	825,713
October	394,274	469,690	639,152	856,036
November	362,773	409,596	617,535	790,023
December	319,545	437,487	671,621	862,359
	3,783,148	4,454,000	6,476,289	9,199,310

Average daily production of petroleum in the Rocky Mountain field, 1914–1917, in barrels.

Month.	1914	1915	1916	1917
January	6,986	11,495	11,824	19,713
February	6,393	9,664	8,889	23,726
March	7,962	11,958	16,330	24,545
April	10,608	7,162	16,382	26,645
May	12,713	8,487	16,999	24,528
June	7,980	13,646	18,259	25,111
July	9,911	13,274	17,767	24,026
August	12,864	14,573	21,203	24,846
September	13,549	12,962	21,733	27,524
October	12,719	15,151	20,618	27,614
November	12,092	13,653	20,585	26,334
December	10,308	14,112	21,665	27,818
Average	10,365	12,203	17,743	25,203

PIPE-LINE RUNS, DELIVERIES, AND STOCKS.

Pipe-line runs and deliveries to trade of petroleum from the Rocky Mountain field and stocks at end of each month in 1916 and 1917, in barrels.

Month.	1916			1917		
	Runs.	Deliveries.	Stocks.	Runs.	Deliveries.	Stocks.
Dec. 31, 1915			425,184			
January	366,551	321,709	470,026	611,898	453,756	903,323
February	248,896	346,578	372,344	664,332	689,243	878,412
March	506,230	435,196	443,378	760,885	871,004	768,293
April	491,451	478,221	456,608	799,346	700,342	867,297
May	526,982	527,478	456,112	760,360	782,444	845,213
June	547,773	519,733	484,152	753,332	767,820	830,725
July	550,792	472,872	562,072	744,815	874,464	701,076
August	657,303	527,492	691,883	770,211	854,968	616,309
September	652,003	596,444	747,442	825,713	865,273	576,749
October	639,152	585,188	801,406	856,036	851,787	581,008
November	617,535	637,092	781,849	790,023	876,153	494,878
December	671,621	708,289	745,181	862,359	841,896	515,341
	6,476,289	6,156,292		9,199,310	9,429,150	

PRICES.

Prices of Wyoming petroleum in 1916 and 1917, per barrel.

1916		1917		
Date.	Wyoming.	Date.	Grass Creek and Elk Basin.	Big Muddy.
Jan. 1	$0.75	Jan 1	$1.10	
Mar. 16	1.00	Jan. 2	1.20	$0.85
May 19	1.10	Jan. 8	1.30	.95
Aug. 4	1.00	Jan. 30	1.35	
Aug. 25	.90	Mar. 23	1.40	
Dec. 2	1.00	July 6	1.45	1.00
Dec. 13	1.10	July 12	1.50	1.05
		Aug. 21	1.70	1.15

COLORADO.

GENERAL STATEMENT.

The production of petroleum in Colorado in 1917 was less by 76,004 barrels, or 39 per cent, than the output in 1916. It amounted to only 121,231 barrels, of which 114,664 barrels, or 94.5 per cent, came from wells in the Florence district, Fremont County, and the remaining 5.5 per cent from wells in the Boulder district, Boulder County, and from a seep of oil commercially developed by the Urado Oil Co. in Garfield County. Compared with 1916, the output of the Florence district in 1917 was less by 76,822 barrels, or 40 per cent, whereas that of the Boulder district was greater by 98 barrels, or about 2 per cent.

The average price received for Colorado oil at the wells in 1917 was $1.06 a barrel, an average decrease of 4 cents compared with 1916; oil from the Boulder district commanded an average price of $1.97 a barrel and that from the Florence district only $1 a barrel. The market value of the entire output in 1917 was $128,100, a decline of $89,039, or 41 per cent, compared with 1916.

Both the quantity and the value of petroleum produced in Colorado in 1917 were less than in any other year since 1887, the first year of commercial production of petroleum in the State.

The rather disappointing showing of Colorado in terms of actual production of oil in 1917 fails to reflect the interest manifest in the oil resources of that State or to indicate the scope of the campaign of wildcat drilling undertaken in that year. Geologic investigations and leasing of lands were carried on in many parts of the State, and at the end of the year a number of drilling rigs were in actual operation testing the oil possibilities either real or fancied in several widely separated localities.

In the vicinity of Denver drilling was continued in the test of the Mid-Colorado Oil Co., at Aurora, which was reported in October to have attained a depth in excess of 3,500 feet. At Arvada, also near Denver, a test begun during the year was reported to be drilling at about 1,500 feet at the end of 1917.

In northeastern Colorado tests were started in 1917 by the Eagle Oil Co., near Greeley, Weld County, by the Sterling Oil Co., at Padroni, Logan County, by the Akron Oil & Gas Co., near Akron, Washington County, and by the Morgan County Oil & Gas Co., near Fort Morgan, Morgan County. In Kit Carson County, along the Nebraska boundary, tests were started by the Five Fields Oil Co. near Seibert and by the Flagler Oil & Gas Co. at Flagler; and in Lincoln County a test was started by the Lincoln County Oil & Development Co. near Hugo.

In southeastern Colorado tests were in progress at the end of 1917 by the Columbine Oil Co., by the Eureka Oil Co., and by the Overland Petroleum Co., near Pueblo, Pueblo County; by the Mustang Oil Co. in Las Animas County; along the New Mexico boundary, by the Red Rock Oil & Gas Co., near La Junta, Otero County, and by the Kawood Oil Co., about 30 miles south of La Junta.

In western Colorado one test was drilled on Little Butcherknife Creek, some 10 miles west of Steamboat Springs in Routt County; and tests were begun on the Iles, Hulett & Shager ranches near Axial, Moffat County. Near De Beque, Mesa County, a well drilled by the Glenrock-De Beque Oil & Gas Co. encountered in September a strong flow of water at 1,640 feet, which prevented further progress during 1917.

Interest in petroleum development in Colorado in 1917 was diverted in considerable measure to the deposits of oil shale in Garfield and Rio Blanco counties and substantial progress was made in laying the foundations for a shale-oil industry. Many companies were organized for the purpose of shale development and in the aggregate a large area of shale land was entered under the mining laws. Experimental plants for the recovery of oil and other by-products from the shale were erected and operated by the Oil Shale & Mining Co., near De Beque, and by various experimenters in Denver, Salt Lake City, and Detroit. As a consequence plans were essentially perfected for the erection in 1918 of commercial plants at points in Colorado and in Utah near the sources of shale supply.

PETROLEUM MARKETED.

Petroleum marketed in Colorado in 1916 and 1917, by districts, in barrels.

Month.	1916			1917		
	Boulder.	Florence.	Total.	Boulder.	Florence.	Total.[a]
January	368	19,038	19,406	868	10,941	11,869
February	635	12,917	13,552	461	9,803	10,324
March	377	13,133	13,510	423	9,058	9,541
April	380	19,127	19,507	621	9,503	10,184
May	368	23,188	23,556	423	9,913	10,396
June	764	16,464	17,228	423	9,696	10,179
July	374	13,752	14,126	423	10,172	10,655
August	595	9,624	10,219	423	10,639	11,122
September	500	9,467	9,967	423	8,869	9,352
October	585	10,437	11,022	423	8,360	8,843
November	434	12,111	12,545	482	8,173	8,715
December	369	32,228	32,597	454	9,537	10,051
	5,749	191,486	197,235	5,847	114,664	121,231

[a] Includes Garfield County.

Petroleum marketed, value, and average price per barrel in Colorado, 1908–1917, by districts.

Year.	Boulder.			Florence.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1908	84,174	$124,794	$1.482	295,479	$221,609	$0.750	379,653	$346,403	$0.913
1909	85,709	129,812	1.514	225,062	187,900	.834	[a] 310,861	318,162	1.023
1910	42,186	63,420	1.503	193,482	174,332	.901	[b] 239,794	243,402	1.015
1911	37,973	50,393	1.327	187,341	175,763	.938	[b] 226,926	228,104	1.005
1912	15,304	19,130	1.250	190,498	180,281	.946	[c] 206,052	199,661	.969
1913	11,796	15,366	1.303	176,693	159,103	.900	[c] 188,799	174,779	.926
1914	6,515	9,117	1.399	215,548	191,067	.886	[d] 222,773	200,894	.902
1915	6,376	9,679	1.518	202,069	173,506	.859	[a] 208,475	183,485	.880
1916	5,749	9,902	1.722	191,486	207,237	1.082	197,235	217,139	1.101
1917	5,847	11,510	1.969	114,664	115,150	1.004	[a] 121,231	128,100	1.057

[a] Includes a small production in Garfield County.
[b] Includes production in Garfield and Rio Blanco counties.
[c] Includes production in Rio Blanco County.
[d] Includes production in Mesa and Rio Blanco counties.

FIELD REPORT.

Field report for oil industry in Colorado in 1916 and 1917.

County.	Wells.									Acreage.					
	1916					1917				1916			1917		
	Productive Jan. 1.	Completed. Oil.	Completed. Dry.	Abandoned.	Productive Dec. 31.	Completed. Oil.	Completed. Dry.	Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.	Fee.	Lease.	Total.
Adams							1				2,920	2,920			
Boulder	14	1	1	1	14			2	12	2,511	98	2,609	2,629	93	2,722
Delta							1								
Fremont	55	1	3		56	2	10	3	55	6,846	17,320	24,166	5,425	20,420	25,845
Garfield	1		1		1		2		1	1,400		1,400	1,440		1,440
Larimer			1												
Rio Blanco	23	1		10	14	1	1		15	4,800	800	5,600	2,320		2,320
Routt							1								
San Miguel							1								
Washington							1						3,440		3,440
	93	3	6	11	85	3	17	5	83	15,557	21,138	36,695	15,254	20,513	35,767

WYOMING.

GENERAL STATEMENT.

The steady increase in production of crude material that has characterized the trend of the petroleum industry in Wyoming in recent years was fully maintained in 1917, as a consequence of which Wyoming advanced from tenth place in 1916 to seventh in 1917 in the rank of oil-producing States. The quantity of petroleum produced and marketed from wells in Wyoming in 1917 was 8,978,680 barrels, a gain of 2,744,543 barrels, or 44 per cent, over the output in 1916. The average price received at the wells for this production was $1.23 a barrel and the market value of the entire output was $11,047,876, a gain of 32 cents in average price and of $5,403,796, or 96 per cent, in total market value, compared with 1916.

DEVELOPMENT.

Natrona County.—The combined output of the Salt Creek, West Salt Creek, and Shannon districts in Natrona County in 1917 was 3,910,511 barrels, or 44 per cent of the output credited to the entire State. Although this quantity is less by 22,892 barrels than the production of the same districts in 1916, it indicates no failure of the productive capacity of the fields in Natrona County, but merely a restraint on production dictated by the limited capacity of the tributary refineries and by the increased output of other districts that must be cared for at the same refineries. The results of field operations in 1917 furnish, on the other hand, conclusive evidence that the petroleum supply of the Salt Creek district alone has scarcely been touched. After the discovery by the New York Oil Co. in 1916 of commercial quantities of petroleum in the "Second Wall Creek sand," in the NW. ¼ sec. 27, T. 40 N., R. 79 W., at about 260 feet below the regular Wall Creek sand, further quest of the lower sand was made in 1917. As a result that sand was proved productive of oil on the Hjorth property, in the SE. ¼ sec. 32 of the same township, 2 miles southwest of the first lower-sand well, and on the Williams lease in the S. ½ sec. 11 of the township to the south and about 2 miles southeast of the first lower-sand well. The evidence disclosed by these wells seems to justify the opinion reached by many well-informed observers that the pool of oil in the lower sand is larger in area on the west side of the Salt Creek district at least than the pool in the Wall Creek sand proper. The fact that in the wells thus far drilled to the lower sand in the West Salt Creek district the regular Wall Creek sand has been found to be saturated with salt water lends support to that opinion. Whether or not the same condition holds on the east side of the Salt Creek district has not yet been determined. In 1917 one well that furnished some evidence on the subject was drilled by the Midwest Refining Co., for the Western Exploration Co., on the Edgett lease in sec. 29, T. 40 N., R. 78 W. This well, which was completed late in December at a depth of about 3,000 feet, is reported to have found salt water in both the regular and the second Wall Creek sands. At the end of 1917 interest in the Salt Creek district was centered in a test on the lease of E. T. Williams, in sec. 11, T. 39 N., R. 79 W., which was being drilled in quest of the "third" Wall Creek sand, believed to lie at a depth of about 3,200 feet in that locality.

The first casing-head gasoline plant in Wyoming was installed by the Midwest Refining Co. in the Salt Creek field in 1917, though actual operation did not begin until 1918. This plant, which consisted of six units capable of handling from 1,000,000 to 1,500,000 cubic feet of gas a day, was connected with the company's petroleum refinery at Casper by a 4-inch welded-joint pipe line 42 miles long.

In the Powder River district 12 to 15 miles northwest of Salt Creek the net result of operations in 1917 was the completion of three gas wells of good capacity and the discovery of encouraging showings of black oil in a fourth, all located in T. 41 N., R. 81 W.

Outside the recognized districts in Natrona County wildcat drilling resulted in 1917 in the reported discovery of encouraging showings of oil at 1,100 feet, 2,640 feet, and 2,850 feet in a test drilled by the Midwest Refining Co. for the Mantua Oil Co. in sec. 10, T. 37 N., R. 85 W., and of gas in one or more wells near Powder River station in T. 36 N., R. 85 W., and in the discovery of gas in considerable volume at moderate depth in wells drilled by the Curtis Petroleum and New York Oil Cos., and by the Ohio Oil Co. adjacent to Poison Spider Creek, some 20 miles southwest of Casper. In the southern part of Natrona County, showings of oil were reported in August at a depth of about 1,100 feet in a test drilled by the Bates Park Oil Co., in T. 30 N., R. 81 W.

Converse County.—Although Converse County supplied only 8 per cent of the marketed production of petroleum credited to Wyoming in 1917 and was fourth in rank among the oil producing counties of the State in that year the attention it received from oil operators was greater than that received by any other county in the State. The center of attraction was the Big Muddy district along North Platte River near the western boundary of the county, the discovery of which was the principal feature of oil developments in Wyoming in 1916. During 1917 the proved area of the field was materially extended to the west and southwest. Although the greater proportion of the wells completed in 1917 were in secs. 2, 3, 4, 5, 8, 9, and 10, T. 33 N., R. 76 W., a sufficient number of advance tests were drilled along the flanks of the dominant anticline of the field to demonstrate the productivity of the territory as far west as the SE. $\frac{1}{4}$ sec. 6 of that township, as far southwest as the east line of secs. 14 and 23, T. 33 N., R. 77 W., and as far south as the southwest corner of sec. 21, T. 33 N., R. 76 W. To the end of 1917 some 88 productive oil wells had been drilled in the Big Muddy field, 12 of which were producing from the Wall Creek sand at depths of 3,000 to 3,400 feet, the remainder, except for half a dozen or so producing from stray sands, deriving their production from the Shannon sand encountered at depths of about 1,000 feet. The proved area of the field at the end of 1917 aggregated about 7,000 acres and the potential capacity of its productive wells about 5,000 barrels a day.

Marketing facilities were provided in 1917 by the Illinois Pipe Line Co., which in June completed a 6-inch pipe line to Casper, a distance of 15 miles.

The success of operations in the Big Muddy district resulted in a revival of the quest for commercial production of oil in the vicinity of Douglas, 25 miles east of Big Muddy. Although a number of wells were drilled near Careyhurst and along La Prele Creek between that place and Douglas the results were in the main disappointing.

Fremont County.—Despite the fact that the quantity of petroleum marketed from Fremont County in 1917 was 20 per cent less than in 1916, substantial progress was made in determining the potentialities of the productive districts in that county. The principal activity in drilling was in the Lander district north of the Popo Agie, the producing area of which was extended to the north as a consequence of the year's operations. In the old Dallas district south of the Popo Agie and about 6 miles southeast of Lander activity was negligible on account of litigation affecting the productive properties.

In the Plunkett district, 8 miles north of Lander, considerable new work was started, but aside from the usual small flow of high-gravity oil from the shale at relatively shallow depths, nothing of consequence was found. No oil was marketed from this district in 1917.

That the production of oil from the districts near Lander will increase in 1918 was insured by the construction late in 1917 by the Wind River Refining Co. of a small refinery at Wyopo, the shipping point for these districts on the Chicago & Northwestern Railway, 3½ miles northeast of Lander.

In the Pilot Butte district, opened by the Hall Oil Co., in 1915, some 25 miles due north of Lander, a few additional wells were drilled in 1917, though activity was retarded by the absence of marketing facilities. The merger of the Hall Oil Co., with the Glenrock Petroleum Co., during the year is interpreted as an indication that this district will receive a more active development in 1918 and that marketing facilities will probably be provided in the near future in the form of a pipe line to Riverton, 30 miles down Wind River from the field. The potential capacity of the 12 wells in the field at the end of 1917 was estimated between 500 and 1,500 barrels a day.

At the end of 1917 interest in Fremont County was centered in a test that was drilled by the Producers & Refiners Corporation, on Sand Draw, in sec. 10, T. 32 N., R. 95 W., which was reported to have struck a flow of gas estimated at 10,000,000 cubic feet a day, in a sand reached at a depth of 2,420 feet. This significant discovery is located about 30 miles a little south of east of Lander and about 25 miles south of Riverton.

Sweetwater County.—As a consequence of the persistence of the Bair Oil Co. and of its successors, West & Hazlett, the Lost Soldier district in the northeastern part of Sweetwater County demonstrated a capacity for oil production that warrants classing it as an oil field of actual promise. Well No. 8, Bair Oil Co., completed in November at a reported depth of 285 feet, was rated as a 1,200-barrel well and well No. 9, completed in December, West & Hazlett, was rated as a 1,000-barrel well at the same depth. Before the end of 1917 the erection of a 37,500-barrel storage tank in the field was begun by West & Hazlett and a pipe line to Rawlins, 50 miles distant, was projected.

Uinta County.—As in other years a small quantity of high-grade, paraffin-base oil was produced in 1917 in the Spring Valley district near Evanston, and marketed by tank car to the Utah Oil & Refining Co., at Salt Lake City.

Lincoln County.—Interest in the possibilities of petroleum in Lincoln County resulted in considerable activity in the way of preliminary examinations and leasing, and in the actual starting of test wells in the old Labarge and Fossil districts and in the Big Piney district some 40 to 50 miles north of Fossil.

Albany County.—In southeastern Wyoming considerable interest was aroused near the end of 1917 by the discovery of viscous black oil of about 19° Baumé gravity in test wells drilled by the Wyoming Apex Oil Co. on the Big Hollow anticline in Albany County, about 15 miles west of Laramie. Of 10 test wells drilled in that locality four are reported to be capable of producing small quantities of this oil, which is so dense as to be pumped only with difficulty. At the end of the year plans were being perfected by the Apex Refining & Drilling Co. to refine and market this oil, which was believed to be especially valuable for the manufacture of lubricants.

Niobrara County.—A promising source of black oil of about 26° Baumé gravity was discovered by Norbeck & Nicholson in June in a test well drilled in sec. 9, T. 36 N., R. 62 W., on Old Woman's Creek, in Niobrara County. The well was completed at a reported depth of 1,730 feet and its initial capacity was estimated at about 30 barrels. Confirmation of the value of the discovery was furnished by the completion of a well of similar capacity at a corresponding depth in sec. 16 of the same township, in October. The new field lies about 25 miles northeast of Lusk, on the Chicago & Northwestern Railway, and derives its production from Paleozoic strata. No facilities for marketing the product of the wells were provided in 1917.

BIG HORN BASIN.

Hot Springs County.—Nothing of an unusual nature disturbed the orderly development of the Grass Creek district in 1917. The production, which amounted to 2,756,402 barrels, constituted 31 per cent of the output of the entire State and was 101 per cent greater than in 1916.

A new field of considerable promise as a source of black oil was discovered in August, 1917, in the southeastern part of T. 43 N., R. 94 W., about 8 miles east of Thermopolis, in the eastern part of Hot Springs County. Oil is found in this field, which is known as the Warm Springs district, in Paleozoic rocks at depths of 900 to 1,000 feet and the wells range in capacity from 10 to 25 barrels a day when completed. To the end of 1917 six successful wells had been completed in this new district, and plans were under way for a refinery at Thermopolis and for a pipe line from the field to the refinery.

Park County.—The production of crude petroleum in Park County in 1917, which amounted to 1,530,264 barrels, was 112 per cent greater than the output in 1916 and was a consequence chiefly of the continued success of operations in the Elk Basin district along the Montana boundary. At the end of 1917 this district, including the portion in Montana, contained some 45 producing wells and had a steady production of about 4,000 barrels of oil a day. In the vicinity of Cody prospecting was continued in 1917, but resulted in no important developments. In southern Park County, a gas well variously estimated as to initial open-flow capacity as high as 80,000,000 cubic feet a day was reported to have been completed in October by the Ohio Oil Co., in Little Buffalo Basin.

Big Horn County.—Operations in quest of petroleum in the Greybull, Basin, Torchlight, and Byron districts in Big Horn County in 1917 were devoid of unusual consequences and the output of petroleum was 56 per cent less than in 1916. The failure of the near-by fields to provide sufficient oil for capacity operation of the plant of the Greybull Refining Co. (purchased in 1917 by the Midwest Refining Co.), at Greybull, resulted in the extension by the Illinois Pipe Line Co., of its Grass Creek pipe line from Chatham, its former railroad terminal, down Big Horn River to Greybull, a distance of about 50 miles.

Washakie County.—Though unsuccessful in its primary object, the quest for petroleum in Washakie County in 1917 resulted in the opening of a gas field of promise in the northern part of that county about 18 miles northeast of Worland. The discovery well, located in sec. 31, T. 49 N., R. 90 W., was credited with an initial capacity of 4,000,000 cubic feet of gas a day and was completed at a reported depth of 1,075 feet by the Ohio Oil Co. in October. Before the end of the year a second well rated as an 8,000,000-foot gasser had been completed by the same company in that locality and three tests had been started on adjoining acreage by other companies.

PETROLEUM MARKETED.

Petroleum marketed in Wyoming in 1916 and 1917, by counties, in barrels.

Month.	Big Horn.	Fremont.	Natrona.	Hot Springs.	Park.	Converse.	Other.[a]	Total.
1916.								
January	11,900	1,368	307,023	26,606			248	347,145
February	8,608	1,437	186,696	37,949			654	235,344
March	13,864	1,437	421,957	54,622			840	492,720
April	15,789	9,773	368,651	76,891			840	471,944
May	17,332	9,691	368,734	107,125			544	503,426
June	14,488	9,834	356,976	122,242	26,138		544	530,222
July	14,771	6,211	317,551	133,863	61,886		544	534,826
August	12,212	5,351	363,841	162,146	93,322		836	637,708
September	10,412	2,440	311,327	187,274	126,889		840	639,182
October	8,900	3,475	296,154	173,368	134,779		544	617,220
November	7,437	6,017	301,527	129,810	148,731		544	594,066
December	4,141	5,530	332,966	157,911	129,243		543	630,334
	139,854	62,564	3,933,403	1,369,807	720,988	([b])	7,521	6,234,137
1917.								
January	2,889	3,809	286,902	160,160	119,647	15,325	343	589,075
February	2,395	3,425	312,588	164,391	141,095	19,425	185	643,504
March	6,230	3,047	351,616	193,053	165,893	20,257	208	740,304
April	4,620	7,847	375,680	206,075	164,867	20,217	180	779,486
May	6,735	5,089	325,096	227,543	147,716	27,854	745	740,778
June	7,432	4,339	307,733	241,595	129,592	44,007	379	735,077
July	7,038	4,836	309,640	255,969	103,001	45,950	502	726,936
August	6,268	4,650	317,045	263,820	117,942	41,914	293	751,932
September	5,609	3,811	338,383	262,053	119,856	79,540	438	809,690
October	4,395	3,453	358,997	251,277	111,379	110,732	328	840,561
November	3,504	4,556	286,884	258,958	108,936	111,901	272	775,011
December	4,925	935	339,947	271,508	100,340	128,310	361	846,326
	62,040	49,797	3,910,511	2,756,402	1,530,264	665,432	4,234	8,978,680

[a] Converse and Uinta counties in 1916; Uinta County in 1917. [b] Included in other.

Petroleum marketed, value, and average price per barrel in Wyoming, 1914–1917, by districts.

Year.	Big Horn.			Fremont.			Natrona.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1914	96,178	$96,178	$1.00	27,395	$21,362	$0.780	3,421,325	$1,541,494	$0.451
1915	140,978	133,457	.946	27,660	15,051	.544	3,971,128	1,985,564	.500
1916	139,854	150,884	1.079	62,564	87,275	1.395	3,933,403	3,363,364	.855
1917	62,040	101,549	1.637	49,797	31,113	.625	3,910,511	3,723,291	.952

Year.	Hot Springs.			Park.			Converse.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1914	....	....	....	....	....	....	(a)	(a)	....
1915	98,723	$74,126	$0.751	....	....	....	(a)	(a)	....
1916	1,369,807	1,336,840	.976	720,988	$695,571	$0.965	(a)	(a)	....
1917	2,756,402	4,190,774	1.523	1,530,264	2,266,794	1.481	665,432	$726,738	$1.092

Year.	Other.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1914	[b] 15,477	[b] $20,158	$1.302	3,560,375	$1,679,192	$0.472
1915	[c] 7,038	[c] 8,820	1.254	4,245,525	2,217,018	.522
1916	[d] 7,521	[d] 10,146	1.349	6,234,137	5,644,080	.905
1917	[e] 4,234	[e] 7,617	1.780	8,978,680	11,047,876	1.230

[a] Included in "Other."
[b] Converse, Crook, and Uinta counties.
[c] Converse, Park, and Uinta counties.
[d] Converse and Uinta counties.
[e] Uinta County.

FIELD REPORT.

Field report for oil industry in Wyoming in 1916 and 1917.

County.	Wells.									Acreage.					
	Productive Jan. 1.	1916				1917				1916			1917		
		Completed.		Abandoned.	Productive Dec. 31.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.	Fee.	Lease.	Total.
		Oil.	Dry.			Oil.	Dry.								
Big Horn	59	51	4	....	110	6	11	33	83	527	8,039	8,566	219	6,869	7,088
Carbon	....	....	....	....	....	8	2	....	8	....	....	....	....	5,680	5,680
Converse	8	13	3	4	17	68	19	2	83	927	3,468	4,395	2,440	7,723	10,163
Crook	12	....	....	....	12	....	....	....	12	760	800	1,560	760	800	1,560
Fremont	28	9	3	....	37	11	3	10	38	815	12,610	13,425	183	11,808	11,991
Hot Springs	37	59	5	....	96	80	....	....	176	40	7,024	7,064	....	2,512	2,512
Natrona	112	16	3	2	126	25	10	13	138	5,590	5,212	10,802	6,460	46,765	53,225
Niobrara	....	....	....	....	....	19	1	....	19	....	....	....	....	5,320	5,320
Park	2	25	....	....	27	8	3	....	35	320	19,298	19,618	320	3,120	3,440
Sweetwater	....	....	....	....	....	....	1	....	....	....	....	....	....	630	630
Uinta	35	1	....	4	32	....	....	1	31	7,600	1,760	9,360	7,640	800	8,440
	293	174	18	10	457	225	50	59	623	16,579	58,211	74,790	18,022	92,027	110,049

MONTANA.

GENERAL STATEMEMT.

The quantity of petroleum marketed from wells in Montana in 1917 was 99,399 barrels, a gain of 54,482 barrels, or 121 per cent, over the output in 1916. The average price received for this oil at the wells was $1.47 a barrel and the market value of the output was $146,272, a gain of 49 cents in average unit price and of $102,253, or 232 per cent, in total market value compared with 1916.

The entire production came as in 1916 from wells in Carbon County, situated in the north end of the Elk Basin district.

After drilling for more than a year the test of the Texas Co., near Red Lodge, Carbon County, was abandoned in November, 1917, at a reported depth of 3,300 feet.

Showings of oil were reported in shale at various depths in a test well drilled by the Beaverhead-Alberta Oil & Gas Co., in the NE. ¼ sec. 35, T. 8 S., R. 9 W. Montana meridian, and in a similar well drilled by the National Oil Co., 7 miles south of the Beaverhead-Alberta test, both of which were in Beaverhead County.

At the end of 1917 wildcat tests were drilling near Laurel and Hesper, Yellowstone County; near Silesia, Carbon County; near Livingston, Park County; near Dillon and Dell, Beaverhead County; near Gilman, Lewis and Clark County; near Malta and Saco, Phillips County; near Plentywood, Sheridan County; near Glendive, Dawson County; in Crazy Woman's Pocket and near Roundup, Musselshell County; and in Dead Man's Basin, Meagher County.

PETROLEUM MARKETED.

Petroleum marketed in Montana in 1916 and 1917, in barrels.

Month.	1916	1917	Month.	1916	1917
January		10,954	August	9,376	7,157
February		10,504	September	2,854	6,671
March		11,040	October	10,910	6,632
April		9,676	November	10,924	6,297
May		9,186	December	8,690	5,982
June	323	8,076			
July	1,840	7,224	Total	44,917	99,399

UTAH.

The petroleum situation in Utah remained essentially unchanged in 1917, though projects for active development in the Vernal, San Juan, San Rafael, Virgin River, Juab, and Great Salt Lake districts received much favorable attention.

CALIFORNIA OIL FIELD.

GENERAL STATEMENT.

Evidence that the year 1917 was a successful one for the petroleum industry in California is provided by the fact that the output of 93,877,549 barrels of crude oil in that year was greater by 2,925,613 barrels, or 3 per cent, than the output in 1916, and was only 6 per cent below the record output of 99,775,327 barrels established in 1914. The substantial gain in the output of petroleum in California in 1917 stands as a distinct credit to the oil industry of that State, which, in addition to its continual handicap of Federal litigation, was hampered in that year by shortage of drilling material and by labor unrest. The gratifying increase recorded was made possible by the development of relatively shallow territory in the districts in San Joaquin Valley, by the completion of a few prolific deep-sand wells in the Whittier-Fullerton district, by the discovery of new and important sources of production at Casmalia, Santa Barbara County, and on the Merced ranch, Los Angeles County, and by the persistent and effectual work of the California State Mining Bureau in the protection and reclamation of oil properties from destruction by salt water.

The average price received at the wells for the crude oil marketed in California in 1917 was 92 cents a barrel, a price greater by 33 cents than the average in 1916, and appreciably greater than the average in any other year since 1900. The market value of the entire output was $86,161,764, a gain of $32,459,031, or 60 per cent, over the market value of the output in 1916. The market for crude petroleum in California in 1917 was strong throughout the year and revisions of price quotations were all upward. The year opened with a basic price of 73 cents a barrel for heavy oil (oils above 17.9° Baumé commanding a premium of 1 to 3 cents per barrel for each successive increase of one full degree Baumé), which had become effective on November 21, 1916. Subsequent revisions in the basic price included advances of 5 cents a barrel on May 11, of 10 cents a barrel on June 7, and of 10 cents a barrel on June 28, a total gain of 25 cents a barrel in the course of the year.

As in 1916, the stimulus of advancing prices was insufficient to increase production to the point of satisfying the persistent demand for California oil and further drafts on stocks were required. Stocks of crude oil held by pipe-line companies decreased from 39,398,351 barrels on December 31, 1916, to 28,427,292 barrels on December 31, 1917, a loss of 28 per cent, and stocks held in field tanks by producing companies decreased from 6,761,000 barrels to 4,316,922 barrels, a loss of 36 per cent in the same period. The total depletion of surface reserves of crude oil in California in 1917 was 13,415,137 barrels, or 29 per cent of the supply on hand at the beginning of the year, and the gross quantity of oil in reserve at the end of the year was 32,744,214 barrels.

Activity in drilling for oil in California in 1917 resulted in the completion of 734 wells, compared with 645 in 1916. Of these wells, 686, or 93 per cent, were oil wells, the remaining 48 wells, or 7 per cent, being failures.

DEVELOPMENT.

SAN JOAQUIN VALLEY DIVISION.

Despite an increase from 507 in 1916 to 563 in 1917 in the number of oil wells brought in, the output of petroleum from the oil fields that border San Joaquin Valley was 1 per cent less in 1917 than in 1916. The output in 1917 was 68,912,728 barrels and the net decrease, for which the Midway, Sunset, and Kern River districts were responsible, was 644,192 barrels.

Coalinga.—Increased activity in drilling that resulted in the completion of 104 oil wells in 1917, compared with 54 in 1916, accounts for the increase of 12 per cent in the output of crude oil credited to the Coalinga district in 1917. New work in 1917 was well distributed over both the Eastside and Westside fields but resulted in no developments of especial significance.

In the Devil's Den district, south of the Coalinga field, a brief revival of interest followed the reported discovery of oil at a depth of about 2,000 feet in a wildcat well, in sec. 2, T. 25 S., R. 19 E. Mount Diablo meridian, drilled by the Crescent Petroleum Co. This interest subsided, however, when further drilling demonstrated that nothing of greater significance than a tar sand had been found.

Lost Hills.—The output of petroleum from the Lost Hills district, Kern County—4,249,039 barrels—was 24 per cent greater than the output in 1916. Some 72 new oil wells were completed in that district in 1917, compared with 101 in 1916. Practically all the new work in 1917 was in the shallower northern part of the district and the greater part of it was either in sec. 24, T. 26 S., R. 20 E. or across the boundary in sec. 19 of the adjoining township to the east, in territory that furnished wells ranging in initial capacity from 40 to 150 barrels of oil a day at depths of 300 to 900 feet.

Belridge.—In the Belridge district, Kern County, statistics of which are included with those of the McKittrick district, drilling was especially active on the leases of the General Petroleum Co. and the Marina Oil Co., in secs. 2 and 3, T. 29 S., R. 21 E., where more than 40 wells ranging in initial capacities from 25 to 100 barrels of oil a day were completed at depths of 850 to 1,050 feet during the year. In the new territory opened in 1916 in the southeastern part of T. 27 S., R. 20 E., about 6 miles northwest of the Belridge field, 6 wells ranging in depth from 2,660 feet to 4,477 feet were completed, one each in sections 26, 27, 33, 34, 35, and 36 of that township. The initial capacity of these deep wells averaged about 200 barrels each.

McKittrick.—The combined petroleum yield of the McKittrick and Belridge districts in 1917 was 5,024,320 barrels, an increase of 556,652 barrels, or 12 per cent, over the output in 1916. In the McKittrick district proper the number of new oil wells completed averaged about two a month. Nearly all of these were located in the northern end of the field where wells of 35 to 75 barrels initial capacity at depths of 900 feet to 1,300 feet are the rule. Of more than usual interest was the reported discovery of a small quantity of light-gravity oil, 40° to 42° Baumé, at a depth of about 3,900 feet in a wildcat test drilled by the Standard Oil Co. (California) in the NW. ¼ sec. 27, T. 29 S., R. 21 E., between the Belridge and McKittrick districts.

In the old Temblor Ranch district, west of Belridge, one oil well of small capacity was completed at the shallow depth of 227 feet in 1917.

Midway.—The combined output of 209 new oil wells, completed in 1917 in the Midway district, Kern County, was insufficient to offset the decline in yield of the older wells and the consequence was a decrease of 9 per cent in the output of the district compared with 1916. The output in 1917 was 28,829,674 barrels, and the decrease referred to amounted to 3,010,687 barrels. Field operations in the Midway district resulted in no developments of especial note. The record well of the year was No. 31 of the Southern Pacific Co., on sec. 7, T. 32 S., R. 24 E., which was brought in under control early in

July with an initial capacity estimated at 3,000 barrels of oil a day Before the end of the month, however, this yield had settled to about 400 barrels a day.

Sunset.—Increased activity in drilling that resulted in the completion of 64 oil wells in the Sunset district, Kern County, in 1917, compared with 20 in 1916, was insufficient to prevent a decrease of 9 per cent in the yield of oil from that district. The output of oil from the Sunset district in 1917 was 6,680,581 barrels and the decrease charged to the field was 677,237 barrels. Only two wells with initial yields comparable with the average in 1913 and 1914 were completed during the year. Both of these were on Maricopa Flat and were in sec. 4, T. 11 N., R. 23 W. San Bernardino meridian. The first, No. 5 International of the Union Oil Co., was completed in April and credited with a yield of 3,500 barrels of 27° Baumé oil the first 24 hours after completion from a depth of 3,330 feet. The second, No. 4 of the Miocene Oil Co., was completed in July and was credited with an initial yield of 6,000 barrels of 28° Baumé oil a day from a depth of 3,430 feet.

Persistent efforts to shut off salt water in the famous well No. 1 of the Lakeview No. 2 Oil Co., also in sec. 4, T. 11 N., R. 23 W., which deluged Maricopa Flat with a flood of oil that remained uncontrolled from May 10 to October 25, 1914, were finally rewarded in 1917 and in October the well was restored to the status of a producer with a daily output of 150 barrels of clean oil.

Kern River.—The output of crude oil credited to the Kern River district in 1917—8,144,348 barrels—was less by 82,440 barrels, or only 1 per cent, than the output in 1916. Activity in drilling was decidedly less than in 1916, only 39 new oil wells being completed in 1917 against 102 in 1916. To the success of methods employed under the supervision of the California State Mining Bureau to combat the ruin of this field by salt water belongs much of the credit for the fact that the decrease in output was no greater than that recorded. On the so-called Kern River front, west of the main field, the Standard Oil Co. (California) completed its test No. 3, in sec. 27, T. 28 S., R. 27 E., in June as an oil well credited with an initial yield of 40 barrels a day, at a depth of 2,417 feet, after completing as failures its test No. 2 in the same section and its test No. 1 in sec. 15 of the same township in April. Other tests in the same locality remained uncompleted at the end of the year.

COASTAL DIVISION.

An increase from 35 to 52 in the number of oil wells completed in the coastal division accounts in considerable part for the increase from 5,459,473 barrels in 1916 to 5,910,238 barrels in 1917 in the output of petroleum credited to the oil fields of the coastal division of the California oil field.

Santa Clara County.—Although no new oil wells were completed in the Watsonville or Sargent Ranch district in 1917, cleaning and deepening of the old wells resulted in an increase of 116 per cent in the quantity of oil marketed from the field. The output in 1917 was 98,715 barrels, compared with 45,603 barrels in 1916.

San Luis Obispo County.—The output of oil from the Arroyo Grande district, which is marketed for fuel to the Pacific Coast Railway Co., increased moderately in 1917 as a consequence of the completion of 6 new oil wells in that field.

Santa Barbara County.—To the fair results obtained by the Union Oil Co. in deepening wells on the Newlove tract and to the excellent results of drilling in the newer fields at Casmalia and near Los Alamos belong the credit for the increase of 8 per cent in the output of petroleum credited to the Santa Maria district in 1917. This output, which amounted to 4,801,065 barrels, was 361,446 barrels greater than the output in 1916.

Principal activity in drilling in 1917 centered in the Casmalia section of the district and resulted in the completion, chiefly by the Doheny Pacific Oil Co. and the Associated Oil Co., as successor to the Casmalia Syndicate Co., of a score of producing wells in secs. 18 and 19, T. 9 N., R. 34 W. San Bernardino meridian, and secs. 24 and 25 of the adjoining township to the west. The wells drilled there ranged in depth from 1,600 to 1,900 feet and in initial output of low-gravity oil from 100 to 400 barrels a day.

Although drilling was carried on less aggressively on the Theresa Bell ranch northwest of Los Alamos, several oil wells of fair capacity were completed there in 1917 both by the Union Oil Co. and by the Pan American Petroleum Investment Co.

Late in December interest in a possible extension of the former limits of the Santa Maria district to the east was aroused by the discovery of appreciable quantities of oil at a depth of about 3,500 feet in a test drilled by the Standard Oil Co. (California) to a total depth of 4,020 feet in the northeast corner of the Shaw ranch, northeast of Los Alamos and southeast of Cat Canyon. The worth of this discovery had not been proved to the end of 1917.

Tests begun in 1916 by the Standard Oil Co. (California) on the Pezzoni and Tognazzini ranches between Casmalia and Guadalupe in the northwestern part of Santa Barbara County were completed, failures, in August, 1917, and abandoned at depths of 4,450 feet and 4,260 feet, respectively, in that month.

No new wells were drilled in 1917 in the old Summerland field, but the output of oil from this field increased from 42,223 barrels in 1916 to 47,036 barrels in 1917 as a consequence of cleaning and repairing the old wells.

Ventura County.—Despite a decrease from 21 to 19 in the number of oil wells completed in the several oil districts in Ventura County, the output of petroleum increased from 932,028 barrels in 1916 to 963,422 barrels in 1917, a gain of 3 per cent. The greater proportion of the wells completed in 1917 were in the Bardsdale district, south of Fillmore. In that locality the principal event of the year was the completion in November by the Montebello Oil Co., on its Shiells lease of a well (No. 113) rated at 100 barrels a day when completed of 35° Baumé oil, at a depth of 3,378 feet. Other wells on the same lease were being deepened at the end of the year. Two additional oil wells were completed in the new field opened in 1916 by the Santa Paula Oil Co., 5 miles southwest of the Bardsdale field.

In the high-gravity oil district 2 miles north of Ventura two oil wells were brought in during the year by the Shell Co. of California, on property adjoining that of the State Consolidated Oil Co., the discoverer of the field. These wells were No. 1 Hartmann, completed in May and rated as a producer of about 20 barrels of 54° Baumé oil a day from a depth of about 2,200 feet; and No. 1 Gosnell, completed late in October and rated as a daily producer of about 30 barrels of 30° Baumé oil from a depth of 2,977 feet. Well No. 2 of the State Consolidated Oil Co.—the discovery well of the field—flowed water and oil throughout 1917 and from its production 10 to 20 barrels of 52° Baumé oil a day were recovered. Wells No. 3 and No. 1 of that company located, respectively, 700 feet north and 600 feet south of No. 2 were uncompleted at the end of 1917.

Two wells were completed in 1917 by the Doheny Pacific Petroleum Co., in sec. 36, T. 3 N., R. 18 W. San Bernardino Meridian, in Simi Valley, one credited with an initial yield of oil at the rate of 100 barrels a day from a depth of 1,080 feet, the other a failure at 1,950 feet.

SOUTHERN DIVISION.

As a consequence of the success attending routine development in the Whittier-Fullerton district and of the opening of an important new oil field near Los Angeles, the output of oil from the southern division, which includes the productive fields in Los Angeles and Orange counties, increased from 15,935,543 barrels in 1916 to 19,054,583 barrels in 1917, a gain of 20 per cent. Of 83 wells completed in 1917 in that division, 70 produced oil and 13 were failures, compared with 71 oil wells and 2 failures in 1916.

Whittier-Fullerton.—In the Whittier-Fullerton district, which includes the Whittier, Puente, Brea Canyon, Olinda, Fullerton, and Coyote Hills fields, the net result of routine development in 1917 was an increase of oil production from 14,069,701 barrels, the output in 1916, to 16,671,715 barrels, a gain of 18 per cent. Much of the credit for this increase belongs to the Murphy lease of the Standard Oil Co. (California) in the Coyote Hills, on which three wells with initial capacities in excess of 5,000 barrels a day each were completed during the year. Aside from the tapping of a prolific pocket of oil, which was exhausted in the course of a few weeks, at a depth of 2,100 feet in well No. 29 of the Brea Canyon Oil Co., in the Brea Canyon field where commercial production of oil is rarely found above a depth of 3,500 feet, activity in drilling in other sections of the Whittier-Fullerton district in 1917 resulted in no developments of especial significance.

Montebello.—The principal feature of oil-field development in California in 1917 was the opening of the Montebello field about 8 miles east of Los Angeles between that city and the old Whittier field. The discovery well (No. 1 Baldwin) drilled by the Standard Oil Co. (California) on the Merced ranch, near Montebello, was begun December 6, 1916, was completed late in February, 1917, at a depth of 2,395 feet, and was credited with an initial output of 350 barrels of 23° Baumé gravity oil a day. Following this discovery 6 additional oil wells, one of which—No. 3 Baldwin of the Standard Oil Co. (California)—was credited with an output of 7,000 barrels the first 24 hours after its completion, were completed before the end of 1917. Pipe-line connections with the refinery of the Standard Oil Co. (California) at El Segundo were provided and 829,428 barrels of oil were marketed from the field before the end of the year. The new field is located on a well-defined anticline along which officials of the California State Mining Bureau estimate[1] that about 2,000 acres will prove productive at reasonable drilling depths.

[1] California State Min. Bur. Weekly Press Bull. 104, November, 1917.

Los Angeles-Salt Lake.—The enhanced value of crude oil resulted in especial efforts to maintain the output of the old wells in the Los Angeles City field and in the old Salt Lake field in the western suburbs of that city. Despite those efforts, which included the drilling of 3 new oil wells in the Salt Lake field, the output of oil from the city field—261,348 barrels—was 13 per cent less than in 1916, and the output of the Salt Lake field—1,170,213 barrels—was 20 per cent below the output in 1916.

Newhall-Towsley Canyon.—In the northwestern part of Los Angeles County a few wells of small capacity were completed in the old Newhall field and in the Towsley Canyon field between Newhall and the eastern boundary of Ventura County.

MISCELLANEOUS WILDCAT TESTS.

Alameda County.—Near Livermore, Alameda County, in sec. 15, T. 3 S., R. 3 E. Mount Diablo meridian, a test drilled by the Atlantic & Western Oil Co., on the Hamilton ranch, had attained a depth of 2,800 feet before the end of 1917.

Kern County.—Copious flows of water encountered in October at a depth of 1,955 feet prevented further drilling during 1917 in a test well drilled by the Hale-McLeod Oil Co., near McFarland, in sec. 11, T. 26 S., R. 26 E.

In the eastern part of Kern County a wildcat test drilled by the Ricardo Oil Co. (Wm. Basusto), in sec. 27, T. 29 S., R. 37 E. Mount Diablo meridian, near Ricardo, was finally abandoned in April, 1917, at a depth of about 4,200 feet.

Monterey County.—In the Pleyto district, about 6 miles southwest of Bradley, unsuccessful tests, both in sec. 36, T. 24 S., R. 10 E. Mount Diablo meridian, were completed in 1917 by the Pleyto Oil Co. and by the Associated Oil Co., the well of the latter company attaining a maximum depth of 2,035 feet.

Santa Barbara County.—In the extreme northeast corner of Santa Barbara County encouraging showings of 36° Baumé gravity oil were reported at a depth of 1,770 feet in a test begun several years ago by the Webfoot Oil Co., which was cleaned and deepened in 1917 by the True Oil Co.

Los Angeles County.—Following the discovery by the Placerita Oil Co. of natural gas in considerable volume, together with an uncontrollable flow of water, in a well drilled near Chatsworth Park in 1915, a second well, drilled for the most part in 1916, was finally completed in 1917, a failure, at a depth of about 3,000 feet.

On the Dominguez ranch, south of Los Angeles, unsuccessful wildcat tests were completed in 1917 by the General Petroleum Corporation and by the Standard Oil Co. (California) at depths of about 1,600 feet and 5,005 feet, respectively. Near Long Beach a test on the Bixby ranch begun in 1916 by the Union Oil Co. and drilled to a depth of about 3,300 feet in 1917, remained uncompleted at the end of 1917.

On the flat north of the Coyote Hills a depth of 5,235 feet was attained before the end of 1917 in the wildcat test of the Tri-State Oil Co., near La Habra.

Near Newport Beach a wildcat test, drilled by W. S. Collins, in which traces of oil were reported to have been found at a depth of about 2,500 feet, was abandoned in June, 1917, at a total depth of about 2,900 feet.

Near the eastern end of La Habra Valley a wildcat test near Yorba Linda, drilled to a depth of about 3,200 feet by the Olinda Land Co., was abandoned, a failure, in November, 1917.

Tests started in 1916 by the Golden Seal Petroleum Co. and the Copa de Oro Petroleum Co. on the Fundenburg ranch, on the north flank of the Puente Hills, attained depths of 1,900 feet and 3,640 feet, respectively, before the end of 1917, but neither test was completed.

In the suburbs of Los Angeles a wildcat test near the base of Mount Washington, begun by I. H. Preston and acquired in October by E. E. Henderson, was drilled to a depth of 1,750 feet in 1917.

San Diego County.—Copious flows of water, control of which was not achieved in 1917, prevented the completion of either the well of the Balboa Oil Co., in Mission Valley north of San Diego, or the well of the Otay Oil Co., in Otay Valley, 10 miles southwest of San Diego.

PETROLEUM MARKETED.

Petroleum marketed in California, 1876–1917.

Year.	Quantity (barrels).	Percentage of total production.	Increase or decrease.		Value.	Yearly average price per barrel.
			Barrels.	Per cent.		
1876	12,000	0.13			$30,000	$2.500
1877	13,000	.10	+ 1,000	+ 8.33	32,500	2.500
1878	15,227	.10	+ 2,227	+ 17.13	35,174	2.309
1879	19,858	.10	+ 4,631	+ 30.41	45,872	2.310
1880	40,552	.15	+ 20,694	+104.21	93,675	2.309
1881	99,862	.36	+ 59,310	+146.26	230,727	2.310
1882	128,636	.42	+ 28,774	+ 28.81	297,149	2.309
1883	142,857	.61	+ 14,221	+ 11.06	330,000	2.310
1884	262,000	1.08	+ 119,143	+ 83.40	605,220	2.310
1885	325,000	1.49	+ 63,000	+ 24.46	750,750	2.310
1886	377,145	1.34	+ 52,145	+ 16.05	870,205	2.307
1887	678,572	2.39	+ 301,427	+ 79.92	1,567,501	2.310
1888	690,333	2.50	+ 11,761	+ 1.73	1,390,666	2.014
1889	303,220	.86	− 387,113	− 56.08	356,048	1.174
1890	307,360	.67	+ 4,140	+ 1.37	384,200	1.251
1891	323,600	.59	+ 16,240	+ 5.28	401,264	1.240
1892	385,049	.76	+ 61,449	+ 18.99	561,333	1.458
1893	470,179	.97	+ 85,130	+ 22.11	608,092	1.293
1894	705,969	1.43	+ 235,790	+ 50.15	823,423	1.166
1895	1,208,482	2.28	+ 502,513	+ 71.18	849,082	.703
1896	1,252,777	2.05	+ 44,295	+ 3.67	1,240,990	.991
1897	1,903,411	3.15	+ 650,634	+ 51.93	1,713,102	.900
1898	2,257,207	4.08	+ 353,796	+ 18.59	1,917,596	.850
1899	2,642,095	4.63	+ 384,888	+ 15.67	2,508,751	.950
1900	4,324,484	6.80	+ 1,682,389	+ 63.67	4,076,975	.943
1901	8,786,330	12.66	+ 4,461,846	+103.17	4,974,540	.566
1902	13,984,268	15.75	+ 5,197,938	+ 59.16	4,873,617	.348
1903	24,382,472	24.27	+10,398,204	+ 74.36	7,399,349	.303
1904	29,649,434	25.33	+ 5,266,962	+ 21.60	8,265,434	.279
1905	33,427,473	24.81	+ 3,778,039	+ 12.74	8,201,846	.245
1906	33,098,598	26.17	− 328,875	− .98	9,553,430	.289
1907	39,748,375	23.93	+ 6,649,777	+ 20.09	14,699,956	.370
1908	44,854,737	25.13	+ 5,106,362	+ 12.87	23,433,502	.523
1909	55,471,601	30.29	+10,616,864	+ 23.67	30,756,713	.554
1910	73,010,560	34.84	+17,538,959	+ 31.62	35,749,473	.490
1911	81,134,391	36.80	+ 8,123,831	+ 11.13	38,719,080	.477
1912	[a] 87,272,593	39.15	+ 6,138,202	+ 7.57	39,624,501	.454
1913	97,788,525	39.356	+10,515,932	+ 12.05	45,709,400	.467
1914	99,775,327	37.54	+ 1,986,802	+ 2.03	48,066,096	.482
1915	86,591,535	30.81	−13,183,792	− 13.21	36,558,439	.422
1916	90,951,936	30.24	+ 4,360,401	+ 5.04	53,702,733	.590
1917	93,877,549	27.996	+ 2,925,613	+ 3.22	86,161,764	.918
	1,012,694,579	23.81			518,170,168	.512

[a] Includes small quantity from Alaska.

Petroleum marketed in California in 1916 and 1917.

District and county.	1916			1917		
	Quantity (barrels).	Value.	Price per barrel.	Quantity (barrels).	Value.	Price per barrel.
Coastal and southern:						
Los Angeles County:						
Los Angeles city	299,781	$180,386	$0.602	261,348	$227,572	$0.871
Montebello	....	....	....	829,428	860,258	1.037
Newhall	108,590	89,947	.828	121,879	132,557	1.088
Salt Lake	1,457,471	867,319	.596	1,170,213	1,177,446	1.066
Coyote Hills						
Puente	1,973,882	1,336,713	.677	2,156,655	2,066,484	.958
Whittier						
Orange County:						
Coyote Hills	12,095,819	7,721,779	.638	14,515,060	14,021,289	.966
Fullerton						
Ventura County:						
Santa Paula	932,028	705,543	.757	963,422	1,044,904	1.084
Santa Barbara County:						
Lompoc						
Los Alamos	4,439,619	2,321,186	.523	4,801,065	4,193,557	.873
Santa Maria						
Summerland	42,223	29,267	.693	47,036	42,673	.909
Monterey County						
San Luis Obispo County	45,603	25,792	.566	98,715	89,140	.903
Santa Clara County						
San Joaquin Valley:						
Fresno County:						
Coalinga	14,231,251	8,460,623	.595	15,984,766	14,211,319	.889
Kern County:						
Kern River	8,226,788	4,528,711	.550	8,144,348	6,998,867	.859
Lost Hills	3,433,034	1,829,710	.533	4,249,039	4,044,013	.951
McKittrick [a]	4,467,668	2,692,120	.603	5,024,320	3,691,904	.734
Midway	31,840,361	18,570,505	.583	28,829,674	27,095,565	.939
Sunset	7,357,818	4,242,432	.577	6,680,581	6,264,216	.937
	55,325,669	31,863,478	.576	52,927,962	48,094,565	.908
Grand total	90,951,936	53,702,733	.590	93,877,549	86,161,764	.918

[a] Includes Belridge.

Petroleum marketed in California, 1908–1917, by counties, in barrels.

Year.	Fresno.	Kern.	Los Angeles.	Orange.	Santa Barbara.	Ventura.	San Mateo.	Santa Clara.	Total.
1908	10,386,168	18,132,893	4,692,495	3,358,714	7,816,682	379,044	[a] 88,741		44,854,737
1909	14,795,459	23,831,768	16,774,195				[a] 70,179		55,471,601
1910	18,387,750	37,896,727	16,665,678				[b] 60,405		73,010,560
1911	18,483,751	45,921,712	16,708,466				[b] 20,462		81,134,391
1912	19,911,820	50,245,255	[c] 17,095,395				[b] 20,123		87,272,593
1913	19,302,654	58,278,966	20,164,689				[b] 42,216		97,788,525
1914	15,692,733	62,429,243	3,150,892	13,260,226	4,363,797	857,685	[d] 20,751		99,775,327
1915	12,851,034	53,886,181	2,732,250	11,885,150	4,290,944	908,359	[d] 37,617		86,591,535
1916	14,231,251	55,325,669	3,839,724	12,095,819	4,481,842	932,028	[b] 45,603		90,951,936
1917	15,984,766	52,927,962	4,539,523	14,515,060	4,848,101	963,422	[b] 98,715		93,877,549

[a] Includes oil produced in San Luis Obispo County.
[b] Production of Santa Clara and San Luis Obispo counties.
[c] Includes small quantity from Alaska.
[d] Includes Monterey County.

PRICES.

Prices per barrel of California oil in 1961 and 1917, as posted by the Standard Oil Co. (California).

[Grades of oil stated in degrees Baumé.]

San Joaquin Valley.

Date.	14°–17.9°	18°–18.9°		25°–25.9°		37°–37.9°	
1916.							
Jan. 1	$0.43	$0.44	For each increase of gravity of 1 full degree above 18.0° gravity, 1 cent per barrel additional.				
Feb. 2	.48	.49					
Feb. 16	.53	.54					
Apr. 1	.58	.59	For each increase in gravity of 1 full degree above 18.0° gravity up to and inclusive of 24.9° gravity, 1 cent per barrel additional.	$0.67	For each increase in gravity of 1 full degree above 25.0° gravity, 2 cents per barrel additional.		
July 7	.63	.64		.72			
Sept. 20	.68	.69		.77	For each increase in gravity of 1 full degree above 25.0° gravity up to and inclusive of 36.9° gravity, 2 cents per barrel additional.	$1.02	For each increase in gravity of 1 full degree above 37.0° gravity, 3 cents per barrel additional.
Nov. 21	.73	.74		.82		1.07	
1917.							
May 11	.78	.79		.87		1.12	
June 7	.88	.89		.97		1.22	
June 28	.98	.99		1.07		1.32	

Ventura County.

Date.	25°–25.9°		37°–37.9°	
1916.				
Jan. 1	$0.67	For each increase in gravity of 1 full degree above 25.0° gravity, 1 cent per barrel additional.		
Feb. 2	.67			
Feb. 16	.67			
Apr. 1	.67	For each increase in gravity of 1 full degree above 25.0° gravity, 2 cents per barrel additional.		
July 7	.72			
Sept. 20	.77	For each increase in gravity of 1 full degree above 25.0° gravity up to and inclusive of 36.9° gravity, 2 cents per barrel additional.	$1.02	For each increase in gravity of 1 full degree above 37.0° gravity, 3 cents per barrel additional.
Nov. 21	.82		1.07	
1917.				
May 11	.87		1.12	
June 7	.97		1.22	
June 28	1.07		1.32	

Whittier-Fullerton-Santa Maria district.[a]

14°–17.9°	18°–18.9°		25°–25.9°		37°–37.9°		Date.
							1916.
$0.48	$0.49	For each increase in gravity of 1 full degree above 18.0° gravity, 1 cent per barrel additional.					Jan. 1
.48	.49						Feb. 2
.53	.54						Feb. 16
.58	.59	For each increase in gravity of 1 full degree above 18.0° gravity up to and inclusive of 24.9° gravity, 1 cent per barrel additional.	$0.67	For each increase in gravity of 1 full degree above 25.0° gravity, 2 cents per barrel additional.			Apr. 1
.63	.64		.72				July 7
.68	.69		.77	For each increase in gravity of 1 full degree above 25.0° gravity up to and inclusive of 36.9° gravity, 2 cents per barrel additional.	$1.02	For each increase in gravity of 1 full degree above 37.0° gravity, 3 cents per barrel additional.	Sept. 20
.73	.74		.82		1.07		Nov. 21
							1917.
.78	.79		.87		1.12		May 11
.88	.89		.97		1.22		June 7
.98	.99		1.07		1.32		June 28

[a] Santa Maria was classed with Whittier-Fullerton, Sept. 20, 1916.

Petroleum marketed in California in 1916 and 1917, with increase or decrease.

District and county.	Quantity (barrels).		Increase or decrease.	
	1916	1917	Barrels.	Per cent.
Coastal and southern:				
Los Angeles County:				
Los Angeles City	299,781	261,348	− 38,433	− 12.81
Montebello		829,428	+ 829,428	
Newhall	108,590	121,879	+ 13,289	+ 12.24
Salt Lake	1,457,471	1,170,213	− 287,258	− 19.71
Coyote Hills, Puente, Whittier	1,973,882	2,156,655	+ 182,773	+ 9.26
Orange County:				
Coyote Hills, Fullerton	12,095,819	14,515,060	+2,419,241	+ 20.00
Ventura County:				
Santa Paula	932,028	963,422	+ 31,394	+ 3.37
Santa Barbara County:				
Lompoc, Los Alamos, Santa Maria	4,439,619	4,801,065	+ 361,446	+ 8.14
Summerland	42,223	47,036	+ 4,813	+ 11.40
San Luis Obispo County, Santa Clara County	45,603	98,715	+ 53,112	+116.47
San Joaquin Valley:				
Fresno County:				
Coalinga	14,231,251	15,984,766	+1,753,515	+ 12.32
Kern County:				
Kern River	8,226,788	8,144,348	− 82,440	− 1.00
Lost Hills	3,433,034	4,249,039	+ 816,005	+ 23.77
McKittrick [a]	4,467,668	5,024,320	+ 556,652	+ 12.46
Midway	31,840,361	28,829,674	−3,010,687	− 9.48
Sunset	7,357,818	6,680,581	− 677,237	− 9.20
	55,325,669	52,927,962	−2,397,707	− 4.34
Grand total	90,951,936	93,877,549	+2,925,613	+ 3.22

[a] Includes Belridge.

Petroleum marketed, value, and average price per barrel in California, 1908–1917.

Year.	Coastal and southern.			San Joaquin Valley.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1908	16,335,676	$9,296,743	$0.569	28,519,061	$14,136,759	$0.4956	44,854,737	$23,433,502	$0.523
1909	16,844,374	9,737,616	.578	38,627,227	21,019,097	.544	55,471,601	30,756,713	.554
1910	16,726,083	10,532,080	.629	56,284,477	25,217,393	.448	73,010,560	35,749,473	.490
1911	16,728,928	10,607,280	.904	64,405,463	28,111,800	.436	81,134,391	38,719,080	.477
1912	[a]17,115,518	[a]10,454,186	.615	70,157,075	29,170,315	.416	87,272,593	39,624,501	.454
1913	20,206,905	11,293,794	.557	77,581,620	34,435,606	.444	97,788,525	45,709,400	.467
1914	31,653,351	13,047,568	.603	78,121,976	35,018,528	.448	99,775,327	48,066,096	.482
1915	19,854,320	9,668,430	.486	66,737,215	26,890,009	.403	86,591,535	36,558,439	.422
1916	21,395,016	13,378,632	.625	69,556,920	40,324,101	.580	90,951,936	53,702,733	.590
1917	24,964,821	23,855,880	.956	68,912,728	62,305,884	.904	93,877,549	86,161,764	.918

[a] Includes small quantity from Alaska.

FIELD REPORT.

Field report for oil industry in California in 1916 and 1917.

County and district.	Wells.					Acreage.		
	Productive Jan. 1.	Completed. Oil.	Completed. Dry.	Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
1916.								
Fresno County	1,086	54	2	31	1,109	21,701	4,810	26,511
Kern County:								
Kern River	1,764	102	14	9	1,857	11,843	5,144	16,987
Lost Hills	169	101	1	1	269	9,138	2,205	11,343
McKittrick [a]	386	40	3	5	421	11,564	36,127	47,691
Midway	1,305	190	2	17	1,478	24,410	33,378	57,788
Sunset	406	20	1	6	420	13,749	1,645	15,394
Los Angeles County:								
Los Angeles City	378				378	51	21	72
Newhall-Puente	126	3		8	121	4,860	1,467	6,327
Salt Lake	296			16	280	975	779	1,754
Coyote Hills, Whittier	144	17	1	1	160	2,648	1,377	4,025
Orange County	418	51	1	9	460	14,257	17,098	31,355
San Luis Obispo County	5				5	120	1,280	1,400
Santa Clara County	6	1	2		7	200	6,000	6,200
Santa Barbara County:								
Lompoc-Santa Maria [b]	301	13		6	308	26,116	30,289	56,405
Summerland	135			8	127	10	4	14
Ventura County	389	21	4	26	384	12,323	20,952	33,275
Miscellaneous			1			120	910	1,030
	7,314	613	32	143	7,784	154,085	163,486	317,571
1917.								
Fresno County	1,109	104	4	27	1,186	20,465	23,571	44,036
Kern County:								
Kern River	1,857	39	2	3	1,893	11,688	5,304	16,992
Lost Hills	269	72		3	338	10,568	2,181	12,749
McKittrick [a]	421	75	3	21	475	41,891	6,097	47,988
Midway	1,478	209	19	11	1,676	27,830	29,073	56,903
Sunset	420	64	2	12	472	3,595	1,900	5,495
Los Angeles County:								
Los Angeles City	378		1	2	376	29	21	50
Montebello		7			7	34	1,554	1,588
Marshall-Puente	121	7	2		128	4,968	396	5,364
Salt Lake	280	3			283	927	779	1,706
Coyote Hills, Whittier	160	13	2	2	171	2,688	1,367	4,055
Orange County	460	40	8	14	486	13,882	8,728	22,610
San Luis Obispo County	5	6			11		1,706	1,706
Santa Clara Co	7				7	200	6,000	6,200
Santa Barbara Co.:								
Lompoc-Santa Maria [b]	308	27	2	5	330	40,882	42,864	83,746
Summerland	127			3	124	10	1	11
Ventura County	384	19	3	4	399	12,847	24,210	37,057
Miscellaneous		1		1			600	600
	7,784	686	48	108	8,362	192,504	156,352	348,856

[a] Includes Belridge. [b] Includes Los Alamos.

MISCELLANEOUS STATES.

GENERAL STATEMENT.

Outside the recognized oil fields of the United States small quantities of petroleum were produced in 1917 in the State of Michigan and in the Territory of Alaska, the combined output from those two sources being 10,300 barrels, compared with 7,705 barrels from Michigan, Missouri, and Alaska in 1916.

The output from Michigan though small was 160 per cent greater than in 1916. It consisted as in other years of natural lubricating oil from a few shallow wells near Port Huron, St. Clair County.

The output from Alaska was 60 per cent greater than in 1916 and came as in other recent years from seven wells operated by the St. Elias Oil Co. in the Katalla district.

So far as can be ascertained petroleum was not produced commercially in Missouri in 1917.

PETROLEUM MARKETED.

Petroleum marketed in miscellaneous States, 1889–1917.

Year.	Quantity (barrels).	Percentage of total production.	Increase or decrease.		Value.	Average yearly price per barrel.
			Barrels.	Per cent.		
1889	[a] 20				$40	$2.000
1890	[a] 278		+ 258	+1,290.00	556	2.000
1891	[a] 25		− 253	− 91.01	84	3.360
1892	[a] 10		− 15	− 60.00	40	4.000
1893	[a] 50		+ 40	+ 400.00	154	3.080
1894	[a] 8		− 42	− 84.00	40	5.000
1895	[a] 10		+ 2	+ 25.00	50	5.000
1896	[a] 43		+ 33	+ 330.00	185	4.300
1897	[a] 19		− 24	− 55.81	174	9.158
1898	[a] 10		− 9	− 47.37	105	10.500
1899	[a] 132		+ 122	+1,220.00	205	1.553
1900	[b] 1,602		+ 1,470	+1,113.64	1,177	.735
1901	[b] 2,335		+ 733	+ 45.76	2,600	1.114
1902	[b] 757		− 1,578	− 67.58	1,066	1.408
1903	[b] 3,000		+ 2,243	+ 296.30	4,650	1.550
1904	[b] 2,572		− 428	− 14.27	4,769	1.854
1905	[b] 3,100		+ 528	+ 20.53	3,320	1.071
1906	[b] 3,500		+ 400	+ 12.90	4,890	1.397
1907	[b] 4,000		+ 500	+ 14.28	6,500	1.625
1908	[b] 15,246		+11,246	+ 281.15	22,345	1.466
1909	[b] 5,750		− 9,496	− 62.28	7,830	1.362
1910	[b] 3,615		− 2,135	− 37.13	4,794	1.326
1911	[b] 7,995		+ 4,380	+ 121.16	7,995	1.000
1912	([c])					
1913	[d] 10,843	0.004	+10,843		19,263	1.777
1914	[e] 7,792		− 3,051	− 28.14	14,291	1.834
1915	[e] 14,265	.005	+ 6,473	+ 83.07	24,295	1.703
1916	[e] 7,705	.003	− 6,560	− 45.99	14,410	1.870
1917	[f] 10,300	.003	+ 2,595	+ 33.68	20,600	2.000
	104,982	.002			166,428	1.585

[a] Missouri.
[b] Michigan and Missouri.
[c] Michigan included in Lima, Ohio; no production for Missouri.
[d] Alaska, Michigan, Missouri, and New Mexico.
[e] Alaska, Michigan, and Missouri.
[f] Alaska and Michigan.

DEVELOPMENT.

Alabama.—The quest for petroleum in Alabama, though prosecuted more vigorously in 1917 than in other recent years, resulted in no discoveries of consequence. In northern Alabama a gas field of promise was opened late in 1917 on the Aldrich dome, about 7 miles southeast of Birmingham. Two wells were completed before the end of the year and were credited with a combined daily capacity of 1,500,000 cubic feet of gas from a sand reached at the shallow depth of 230 feet. The gas is reported to be of good quality, with a fuel value of about 1,000 British thermal units per cubic foot.

In southern Alabama five or six wildcat tests were made in Mobile County in 1917, one of which, drilled by the Alabama Southern Oil Co. near Wilmer, was reported in August to have struck gas in considerable volume at a depth of about 3,000 feet.

Arizona.—Considerable interest was taken in 1917 in the possibilities of the occurrence of petroleum in Big Chino Valley, Yavapai County, Ariz., and plans were made by the Arizona Oil & Refining Co. for thorough tests in T. 18 N., Rs. 2 and 3 W., in 1918.

Arkansas.—Unsuccessful wildcat tests in quest of petroleum were completed in Arkansas in 1917, in Benton, Boone, Franklin, Howard, Independence, Jefferson, Logan, Madison, Polk, and Sebastian counties. At the end of the year unfinished tests were being drilled in Ashley, Drew, Hot Springs, Howard, Jefferson, Polk, Scott, and Sevier counties.

Florida.—Interest in the possibilities of petroleum in Florida resulted in the starting of a test well by Harple and others on the Moree farm, near Melbourne, Brevard County, in 1917.

Mississippi.—In Warren County, Miss., a deep test drilled by the Mississippi Oil, Gas & Investment Co. on the Mildred farm, near Vicksburg, was abandoned in 1917 at a depth of about 3,260 feet, a failure as far as oil and gas are concerned. Near Jackson, Hinds County, tests yielding similarly unencouraging results were abandoned on the Swearingen farm at a depth of 3,050 feet by the Arkansas Natural Gas Co., and on the Barber farm at a depth of 3,000 feet by the Atlas Oil Co. Near Pascagoula, Jackson County, in the extreme southeast corner of the State, a deep test was begun by the Atlas Oil Co. in April on the Woodman farm, in sec. 15, T. 6 S., R 7 W., St. Stephens base and meridian.

Nevada.—A wildcat test alleged to be backed by S. E. Yount, of Los Angeles, Cal., and others, at Moapa, Clark County, Nev., was reported to have been shut down in September at a depth of about 2,000 feet because of financial difficulties.

New Mexico.—The quest for petroleum in the Pecos valley resulted in the completion in May, 1917, by the Toltec Oil Co. of an unsuccessful test 3,120 feet deep, in sec. 31 T. 8 S., R. 25 E., about 14 miles northeast of Roswell, in Chaves County; a second test begun by the same company about 4 miles southwest of the failure had attained a reported depth of 1,865 feet before the end of 1917. A test by the same company, 7 miles south of Lamy, Santa Fe County, was reported drilling below 1,900 feet at the end of 1917. In Otero County, several miles northwest of Dog Canyon and several miles southwest of Alamogordo, a wildcat test was begun in July by the Twin Buttes Oil & Gas Co.

IMPORTS.[1]

Despite the fact that the United States is the world's principal producer and distributor of petroleum and petroleum products, its import trade in those commodities is steadily increasing. This is especially true with regard to grades of oil desired for use as fuel, including both crude petroleum and "topped crude," available from Mexico and Trinidad. Demand for fuel oil along the Atlantic

[1] Statistics of imports and exports were compiled by J. A. Dorsey, of the United States Geological Survey, from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

and Gulf seaboards of the United States resulted in an increase of about 10,000,000 barrels, or 50 per cent, in the quantity of crude petroleum imported for consumption in the United States in 1917, compared with 1916, and an increase of some 32,000,000 gallons, or 218 per cent, in the quantity of "other products" consisting for the most part either of "topped crude" or of "tops," in the same period.

In the matter of motor fuels, available statistics show an increase of nearly 8,000,000 gallons, or 288 per cent, in the quantity of gasoline, naphtha, and benzine, imported for consumption in the United States in 1917, compared with 1916. Although Canada profited slightly by this increase, Peru was the principal beneficiary, its deliveries of these products at United States ports increasing from 2,703,000 gallons in 1916 to 10,425,000 gallons in 1917.

Imports of paraffin wax increased slightly in 1917 compared with 1916, whereas imports of material classed as ozokerite and ceresine decreased abruptly from about 3,000,000 pounds in 1916 to 899,000 pounds in 1917.

The essential monopoly by domestic refiners of the market for paraffin oil in the United States is indicated by the steady decrease in importation of that commodity since the beginning of the war. The quantity imported in 1917 was 93 barrels, compared with 902 barrels in 1916 and with 3,676 barrels in 1913, the last normal year before the war.

The total declared value of petroleum and petroleum derivatives imported into the United States in 1917 was $21,334,381, compared with $14,598,329 in 1916.

Petroleum, paraffin oil, and ozokerite and paraffin wax imported for consumption in the United States, 1913–1917.

Year.	Petroleum.		Paraffin.		Ozokerite and paraffin wax.		Total value.
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (pounds).	Value.	
1913	17,809,058	$12,947,280	3,676	$49,458	16,051,322	$932,894	$13,929,632
1914	17,247,483	11,465,466	2,481	36,687	15,516,242	824,234	12,326,387
1915	18,140,110	10,389,012	1,707	85,121	10,259,445	553,397	11,027,530
1916	20,570,075	12,602,811	902	75,925	12,266,191	706,874	13,385,610
1917	30,162,583	16,400,017	93	3,514	10,698,099	729,210	17,132,741

Gross imports of petroleum and petroleum products into the United States in 1916 and 1917.

Kind and source.	1916		1917	
	Quantity.	Value.	Quantity.	Value.
Crude petroleum:	*Gallons.*		*Gallons.*	
Canada	201,615	$17,866	1,627,124	$152,493
Mexico	845,277,611	11,775,377	1,257,207,692	16,137,130
Cuba	1,148,280	15,037	4,804,060	57,454
Trinidad and Tobago	18,122,053	323,518	2,349,352	41,952
Other British West Indies			840,000	10,967
Dominican Republic			100	6
Peru	8,718,774	442,468		
England			130	10
China			8	5
	873,468,333	12,574,266	1,266,828,466	16,400,017

Gross imports of petroleum and petroleum products into the United States in 1916 and 1917—Continued.

Kind and source.	1916		1917	
	Quantity.	Value.	Quantity.	Value.
Benzine, gasoline, and naphtha:	*Gallons.*		*Gallons.*	
Canada	370	$113	69,108	$7,307
Mexico	100	20	84	25
Honduras			1	2
Cuba	350	93		
Peru	2,702,555	185,060	10,425,281	1,403,946
England			10	6
France			135	167
	2,703,375	185,286	10,494,619	1,411,453
Mineral wax (ozokerite and ceresine):	*Pounds.*		*Pounds.*	
Canada	238,997	17,323	54,682	4,398
Dominican Republic	160	40		
Brazil	1,760	344		
England	1,504,372	114,094	247,582	36,014
Italy	625	144		
Japan	22,400	2,133	170,001	19,880
British India	1,279,520	66,299	366,660	25,290
Straits Settlements			60,480	4,928
	3,047,834	200,377	899,405	90,510
Paraffin wax:				
Canada	1,368,783	61,685	1,995,888	135,893
England	4,995,916	282,476	251,479	22,843
Scotland	80,880	4,231		
China	740,723	36,691	145	11
British India	454,720	22,017	2,535,666	182,212
Japan	419,123	45,756	62,720	4,411
Dutch East Indies	1,009,630	46,616	4,862,796	293,330
Straits Settlements	188,340	11,217		
	9,258,115	510,689	9,708,694	638,700
All other:	*Gallons.*		*Gallons.*	
Canada	1,886,618	171,085	3,168,579	314,911
Mexico	10,605,045	733,699	43,643,195	2,472,035
Trinidad and Tobago			150	10
Argentina			2,450	2,071
Peru	2,147,984	146,514		
England	37,998	75,932	20,312	4,598
France			29	58
Hongkong			5	2
Japan	4,497	481	10	16
	14,682,142	1,127,711	46,834,730	2,793,701

EXPORTS.

TERRITORIAL SHIPMENTS.

The continued expansion of the demand for petroleum and its products from the United States in Alaska, Hawaii, and Porto Rico and the constriction of the similar demand in the Philippine Islands are indicated in the following summary:

Petroleum products shipped to Alaska from other parts of the United States, 1908–1917.

Year.	Oil used for fuel, including crude, gas oil, and residuum.		Gasoline, including all lighter products of distillation.		Illuminating.		Lubricating.	
	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.
1908	11,891,375	$176,483	939,424	$147,104	566,598	$102,567	94,542	$36,423
1909	14,119,102	340,225	746,930	118,810	531,727	98,786	85,687	35,882
1910	19,143,091	506,200	788,154	136,569	626,972	95,483	104,512	38,625
1911	20,878,843	485,279	1,238,865	167,915	423,750	57,896	100,141	34,048
1912	15,523,555	309,804	2,736,739	344,739	672,176	100,722	154,565	60,949
1913	15,682,412	453,756	1,735,658	272,661	661,656	106,603	150,918	61,966
1914	18,601,384	404,349	2,878,723	373,607	731,146	103,779	191,878	74,535
1915	16,910,012	476,564	2,413,962	243,712	513,075	82,105	271,981	101,988
1916	23,555,811	657,976	2,844,801	378,267	732,969	108,174	373,046	132,902
1917	23,971,114	1,014,100	3,256,870	501,867	750,238	106,619	465,693	171,638

Petroleum products shipped to Hawaii, the Philippines, and Porto Rico, 1908–1917.

Year.	Oil used for fuel, including crude, gas oil, and residuum.		Gasoline, including all lighter products of distillation.		Illuminating.		Lubricating.	
	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.
HAWAII.								
1908	47,719,900	$802,325	648,310	$91,851	1,143,591	$179,507	358,262	$140,157
1909	43,764,041	871,485	804,169	127,076	1,401,381	232,340	367,831	121,282
1910	54,539,511	1,095,549	974,268	160,700	1,359,671	226,481	359,528	133,968
1911	47,250,018	949,409	1,329,589	203,052	1,587,873	220,505	466,826	138,927
1912	58,790,343	1,182,230	2,501,938	343,062	1,817,718	190,939	477,012	165,993
1913	60,066,083	1,154,188	2,058,091	315,333	1,807,288	210,997	456,477	145,455
1914	67,893,460	1,207,036	3,162,667	364,260	2,157,021	250,158	408,606	147,243
1915	72,795,931	1,256,003	3,546,351	379,134	1,966,448	227,212	569,032	193,821
1916	67,771,683	1,397,398	5,136,021	803,461	1,842,793	232,216	612,938	197,496
1917	69,196,370	1,999,120	6,942,835	1,160,008	2,563,754	314,197	905,700	303,267
PHILIPPINES.								
1908	4,594	322	140,550	21,775	9,234,263	957,284	257,800	61,571
1909	21,789	1,581	184,390	23,428	5,995,090	558,642	362,068	81,278
1910	13,703	1,122	318,070	42,058	10,643,804	862,496	432,867	95,213
1911	5,502	376	1,074,615	158,592	11,653,570	913,760	470,832	107,499
1912	106,872	5,358	1,326,040	216,810	12,634,519	1,094,596	487,607	121,999
1913	10,370	1,013	1,414,225	280,690	12,091,810	1,142,403	517,494	105,001
1914	11,408	564	1,197,774	206,754	12,906,403	1,219,404	971,977	189,279
1915	12,427	366	1,483,534	241,273	8,524,833	731,026	784,192	157,925
1916	14,819	528	3,226,026	631,541	8,539,700	809,014	635,329	148,443
1917	21,659	1,857	1,564,199	357,156	6,252,140	663,741	533,628	170,626
PORTO RICO.								
1908	25,437	2,118	285,188	45,479	1,623,477	189,021	264,012	65,776
1909	7,566	475	495,367	93,649	1,931,676	216,316	218,829	78,963
1910	8,739	499	874,814	135,290	1,973,369	222,108	238,935	91,356
1911	51,656	2,899	1,106,327	133,470	2,323,401	207,804	479,579	117,034
1912	29,204	1,857	1,470,105	223,325	2,168,105	212,043	471,596	134,882
1913	21,108	1,439	1,580,772	303,012	2,381,187	246,137	507,412	120,007
1914	53,586	4,939	1,836,896	320,163	2,227,195	227,500	361,117	80,247
1915	65,447	3,337	2,401,695	449,044	2,426,133	219,148	391,245	88,081
1916	182,722	7,428	2,811,843	727,466	2,168,203	207,976	520,092	119,121
1917	239,199	17,347	3,154,196	768,862	2,769,066	323,226	608,214	202,368

FOREIGN SHIPMENTS.

The export trade of the United States in petroleum and its liquid products in the calendar year 1917 shows gain of 1.6 per cent in quantity and of 25 per cent in declared value over that in 1916 and establishes a new record for annual exports of mineral oils. The principal gain both in quantity and in value, compared with 1916, was in the item gasoline and naptha, though moderate increase was credited to the items crude, lubricating, and paraffin, gas oil and fuel oil, and residuum. Exports of illuminating oil decreased markedly both in quantity and in declared value compared with 1916.

Gains in quantity in 1917 over 1916 were 0.05 per cent on crude petroleum, 17 per cent on gasoline and naptha, 7.5 per cent on lubricating and paraffin oils, and 17 per cent on gas oil and fuel oil, and residuum, the aggregate being a little more than enough to offset the loss of 23 per cent on illuminating oils.

Corresponding gains in declared value amounted to 9 per cent on crude petroleum, 36 per cent on gasoline and naptha, 34 per cent on lubricating, and 68 per cent on gas oil and fuel oil, and residuum, whereas the corresponding loss on illuminating oils was 12 per cent.

Mineral oils exported from the United States in 1916 and 1917, by months.

Month.	1916		1917	
	Quantity (gallons).	Value.	Quantity (gallons).	Value.
January	173,131,096	$11,712,621	278,996,519	$20,701,353
February	179,829,436	12,004,278	158,491,237	13,114,334
March	220,197,853	16,272,472	210,110,702	16,739,617
April	157,461,216	12,542,136	200,261,380	19,481,880
May	231,344,348	18,194,760	213,449,444	22,189,419
June	223,236,606	19,594,723	264,737,392	27,342,036
July	255,835,136	21,703,828	143,998,673	14,055,530
August	253,039,351	22,203,177	225,487,195	21,307,362
September	266,566,822	20,987,053	200,687,535	16,809,054
October	224,207,595	16,415,489	222,775,688	22,131,313
November	205,697,621	15,039,027	231,835,757	29,931,671
December	216,935,286	15,051,727	300,286,827	29,173,907
	2,607,482,366	201,721,291	2,651,118,349	252,977,476

Mineral oils exported from the United States in 1916 and 1917, by kinds and ports.

Kind and port.	1916		1917	
	Quantity.	Value.	Quantity.	Value.
CRUDE.	*Barrels.*		*Barrels.*	
New York	195,802	$776,791	111,644	$675,623
Galveston	1,182	4,096	12	51
Sabine	70,791	149,210	5,828	19,581
Other districts	3,828,127	6,099,826	3,980,640	6,973,057
	4,095,902	7,029,923	4,098,124	7,668,312
GASOLINE AND NAPHTHA.	*Gallons.*		*Gallons.*	
Baltimore	59,501	16,153	581,042	150,569
Boston and Charlestown	131,132	32,546	128,439	35,614
New York	125,315,453	19,719,362	179,420,961	42,328,577
Philadelphia	54,644,646	11,493,731	100,601,279	22,433,561
Galveston	1,089,166	250,401	1,409,116	253,644
Sabine	50,198,200	9,092,557	27,741,447	4,639,545
Other districts	124,432,185	28,056,131	105,996,560	23,292,734
	355,870,283	68,660,881	415,878,844	93,134,244
ILLUMINATING.				
Baltimore	341,469	37,780	4,042,761	344,296
Boston and Charlestown	209,822	22,761	219,056	26,831
New York	406,509,854	31,162,685	357,116,450	29,447,061
Philadelphia	144,219,860	8,454,999	83,782,461	5,643,580
Galveston	484,740	26,958	1,381,998	95,545
Sabine	86,871,220	5,623,230	71,543,928	4,891,239
Other districts	46,051,439	10,534,493	140,069,833	8,505,058
	854,688,404	55,862,906	658,156,487	48,953,610
LUBRICATING AND PARAFFIN.				
Baltimore	7,689,303	1,170,577	9,523,410	1,937,522
Boston and Charlestown	132,131	30,852	317,405	68,497
New York	165,824,102	28,684,442	180,136,494	38,563,065
Philadelphia	67,016,667	9,709,701	70,793,039	12,998,815
Galveston	181,195	19,004	329,033	61,864
Sabine	3,730,817	612,560	2,636,855	543,118
Other districts	16,231,724	2,800,235	16,701,427	3,391,983
	260,805,939	43,027,371	280,437,663	57,564,864
GAS OIL AND FUEL OIL.[a] [b]				
Baltimore	106,221	11,388	1,464,411	952,028
Boston and Charlestown	1,777	134	12,278,530	733,879
New York	63,314,799	2,654,209	121,194,441	7,555,069
Philadelphia	30,581,480	1,218,422	82,056,333	6,269,047
Galveston	....	....	9,270,239	279,062

[a] Figures for 1916 include residuum.
[b] Excludes fuel or bunker oil in vessels engaged in the foreign trade, which aggregated in 1916, 5,529,787 barrels, valued at $5,583,222, and in 1917, 5,908,319 barrels, valued at $7,391,985.

Mineral oils exported from the United States in 1916 and 1917, by kinds and ports— Continued.

Kind and destination.	1916		1917	
	Quantity.	Value.	Quantity	Value.
GAS OIL AND FUEL OIL—continued.	*Barrels.*		*Barrels.*	
Sabine	408,463,989	$12,819,543	552,670,300	$18,285,334
Other districts	461,621,571	10,436,514	344,538,793	11,474,863
	964,089,837	27,140,210	1,123,473,047	45,549,282
RESIDUUM.[a]				
New York	....	....	356,632	23,839
Galveston	....	....	300	25
Sabine	....	....	100	7
Other districts	....	....	694,081	83,293
	....	....	1,051,113	107,164
Grand total (gallons)	2,607,482,366	201,721,291	2,651,118,349	252,977,476

[a] Figures for 1916 included in gas oil and fuel oil.

Recapitulation by kinds.

	Gallons.		*Gallons.*	
Crude	172,027,903	$7,029,922	172,121,195	$7,668,312
Gasoline and naphtha	355,870,283	68,660,881	415,878,844	93,134,244
Illuminating	854,688,404	55,862,906	658,156,487	48,953,610
Lubricating and paraffin	260,805,939	43,027,371	280,437,663	57,564,864
Gas oil and fuel oil [a]	[b] 964,089,837	[b] 27,140,211	1,123,473,047	45,549,282
Residuum	(c)	(c)	1,051,113	107,164
	2,607,482,366	201,721,291	2,651,118,349	252,977,476

Recapitulation by ports.

	Gallons.		*Gallons.*	
Baltimore	8,196,494	$1,235,898	15,611,624	$3,384,415
Boston and Charlestown	474,862	86,293	12,943,430	864,821
New York	769,187,886	82,997,489	842,914,025	118,593,227
Philadelphia	296,462,653	30,876,853	337,233,112	47,345,005
Galveston	1,804,749	300,459	12,391,186	690,196
Sabine	552,237,433	28,297,100	654,837,390	28,378,824
Other districts	979,118,289	57,927,199	775,187,582	53,720,988
	2,607,482,366	201,721,291	2,651,118,349	252,977,476

[a] Excludes fuel or bunker oil in vessels engaged in the foreign trade, which aggregated in 1916, 5,529,787 barrels, valued at $5,583,222, and in 1917, 5,908,319 barrels, valued at $7,391,985.
[b] Includes residuum.
[c] Included in gas oil and fuel oil.

Mineral oils exported from the United States in 1916 and 1917, by kinds and destinations.

Kind and destination.	1916		1917	
	Quantity.	Value.	Quantity.	Value.
CRUDE.				
North America:	*Barrels.*		*Barrels.*	
Canada	2,966,659	$4,057,513	3,329,356	$5,117,148
Mexico	189,821	299,914	47,725	81,998
Panama	11	59	41,730	92,224
Cuba	312,803	1,171,031	262,631	1,087,635
South America:				
Chile	55,064	44,146	56,245	68,973
Europe:				
France	156,809	460,795	7,902	33,000
Spain	59,498	265,094	58,622	410,996
Other Europe	42,297	104,900	7,591	14,865
Other countries	312,940	626,471	286,321	761,473
	4,095,902	7,029,923	4,098,123	7,668,312

Mineral oils exported from the United States in 1916 and 1917, by kinds and destinations—Continued.

Kind and destination.	1916 Quantity.	1916 Value.	1917 Quantity.	1917 Value.
REFINED.				
Gasoline.				
North America:	*Gallons.*		*Gallons.*	
Canada	25,312,456	$4,090,262	27,647,086	$4,861,883
South America:				
Argentina	2,579,281	424,652	4,398,606	801,251
Brazil	7,470,287	1,612,283	6,990,302	1,750,144
Europe:				
France	44,405,796	9,627,990	56,066,313	12,309,772
Italy	8,241,455	1,413,985	30,686,430	7,078,676
Netherlands	153,290	29,700	1,106,642	237,787
United Kingdom	45,530,888	9,216,252	54,574,416	11,287,816
Other Europe	10,655,903	2,069,037	5,752,850	1,272,232
British Oceania	9,237,065	2,035,348	15,655,165	3,893,139
Other countries	14,341,841	3,095,448	21,933,681	5,556,947
	167,928,262	33,614,957	224,811,491	49,049,647
Naphtha.				
All countries	187,942,021	35,045,924	191,067,353	44,084,597
	355,870,283	68,660,881	415,878,844	93,134,244
Illuminating oil.				
North America:				
Canada	9,736,254	552,103	17,395,638	1,134,356
Cuba	1,448,875	144,768	1,082,739	159,974
West Indies	6,506,134	762,149	6,913,092	900,899
South America:				
Argentina	12,587,302	1,332,443	13,064,881	1,650,075
Brazil	30,756,971	2,786,581	30,817,597	3,235,151
Chile	6,465,611	679,753	6,757,639	823,876
Other South America	11,385,498	1,194,379	9,184,554	1,114,555
Europe:				
Denmark	32,439,735	1,739,941	8,818,250	473,404
France	92,112,121	5,702,579	73,948,069	4,382,741
Italy	37,522,438	2,028,153	31,137,116	1,875,858
Netherlands	55,816,443	2,739,848	17,796,759	966,189
Sweden	27,762,077	1,564,832	11,439,719	666,925
United Kingdom	151,903,144	8,496,091	171,313,137	11,219,437
Other Europe	59,049,392	4,057,068	36,686,214	1,802,875
Asia:				
China	85,689,334	5,671,757	68,949,092	4,478,846
British India	49,802,870	2,502,805	29,485,437	2,120,559
Hongkong	21,674,231	1,469,581	14,090,907	911,126
Japan	44,223,949	2,377,557	20,488,540	1,336,012
Oceania:				
Dutch East Indies	11,342,660	1,002,677	11,702,690	1,258,875
British Oceania	27,587,720	2,639,349	19,990,057	2,077,704
Philippine Islands	8,539,700	809,014	6,252,140	663,741
British Africa	17,657,838	1,716,466	7,146,088	860,863
Other countries	52,678,107	3,893,012	43,696,132	4,839,569
	854,688,404	55,862,906	658,156,487	48,953,610
Lubricating and paraffin oil.				
North America:				
Canada	5,560,526	959,314	7,745,713	1,713,032
Mexico	619,608	138,847	644,201	189,058
Cuba	2,857,169	973,915	3,352,880	1,146,344
South America:				
Argentina	6,086,546	1,364,619	5,770,002	1,667,441
Brazil	3,674,350	839,934	4,833,617	1,222,482
Chile	2,696,410	560,192	2,556,557	634,677
Europe:				
France	56,539,190	8,460,149	71,687,467	14,452,685
Italy	17,019,194	2,608,926	20,067,146	3,795,289
Netherlands	3,596,943	679,995	534,296	112,295
United Kingdom	95,951,712	14,866,299	111,647,001	22,347,881
Other Europe	18,837,245	3,301,834	9,117,264	1,835,210
Asia:				
Japan	3,358,197	639,156	4,264,920	758,807
Oceania:				
British East Indies	16,498,674	2,386,514	13,308,716	2,244,394
British Oceania	9,410,414	1,575,261	6,725,247	1,440,621

Mineral oils exported from the United States in 1916 and 1917, by kinds and destinations—Continued.

Kind and destination.	1916 Quantity.	1916 Value.	1917 Quantity.	1917 Value.
REFINED—continued.				
Lubricating and paraffin oil—Continued.	*Gallons.*		*Gallons.*	
British Africa	4,142,524	$923,712	4,360,474	$966,332
Other countries	13,957,237	2,748,704	13,822,262	3,038,316
	260,805,939	43,027,371	280,437,663	57,564,864
Gas oil and fuel oil.[a]				
All countries	957,602,259	26,990,552	1,123,473,047	45,549,282
Residuum, including tar.				
All countries	6,487,578	149,658	1,051,113	107,164
Total refined	2,435,454,463	194,691,368	2,478,997,154	245,309,164
Total crude and refined (gallons)	2,607,482,366	201,721,291	2,651,118,349	252,977,476

[a] Excludes fuel or bunker oil in vessels engaged in the foreign trade, which aggregated in 1916, 5,529,787 barrels, valued at $5,583,222 and in 1917, 5,908,319 barrels, valued at $7,391,985.

Petroleum exported from Texas in 1916 and 1917.

1916.

Customs district.	Crude, including all natural oils. Quantity.		Crude Value.	Gasoline and naphtha. Quantity.	Gasoline Value.	Illuminating. Quantity.	Illuminating Value.
	Barrels.	*Gallons.*		*Gallons.*		*Gallons.*	
Laredo	4,240	178,079	$4,060	34,863	$8,047	71,222	$9,875
Galveston	1,182	49,648	4,096	1,075,866	248,525	484,740	26,958
Sabine	70,791	2,973,207	149,210	50,198,200	9,092,557	86,871,220	5,623,230
El Paso	8,330	349,842	10,234	426,350	93,990	145,038	21,084
Eagle Pass	17	696	70	30,367	6,983	42,736	5,808
	84,560	3,551,472	167,670	51,765,646	9,450,102	87,614,956	5,686,955

Customs district.	Lubricating and heavy paraffin. Quantity.	Lubricating Value.	Gas oil, fuel oil, and residuum. Quantity.	Gas oil Value.	Total. Quantity.	Total Value.
	Gallons.		*Gallons.*		*Gallons.*	
Laredo	30,557	$7,850	339,598	$8,943	654,319	$38,775
Galveston	181,195	19,004			1,791,449	298,583
Sabine	3,730,817	612,560	408,463,989	12,819,543	552,237,433	28,297,100
El Paso	30,967	10,487	6,650	205	958,847	136,000
Eagle Pass	34,360	12,567			108,159	25,428
	4,007,896	662,468	408,810,237	12,828,691	555,750,207	28,795,886

1917.

Customs district.	Crude, including all natural oils. Quantity.		Crude Value.	Gasoline and naphtha. Quantity.	Gasoline Value.	Illuminating. Quantity.	Illuminating Value.
	Barrels.	*Gallons.*		*Gallons.*		*Gallons.*	
Laredo	19	810	$51	165,466	$48,747	36,038	$6,442
Galveston	12	500	51	1,409,116	253,644	1,381,998	95,545
Sabine	5,828	244,760	19,581	27,741,447	4,639,545	71,543,928	4,891,239
El Paso	4,500	188,996	7,576	98,806	26,868	91,195	15,356
Eagle Pass				22,046	5,325	28,906	3,475
	10,359	435,066	27,259	29,436,881	4,974,129	73,082,065	5,012,057

Petroleum exported from Texas in 1916 and 1917—Continued.

1917—Continued.

Customs district.	Lubricating and heavy paraffin.		Gas oil, fuel oil, and residuum.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
Laredo	[a] 82,496	[a] $25,056	33,093	$1,833	317,903	$82,129
Galveston	329,033	61,864	9,270,539	279,092	12,391,186	690,196
Sabine	2,636,855	543,118	552,670,406	18,285,341	654,837,396	28,378,824
El Paso	30,883	9,900	96,100	4,179	505,980	63,879
Eagle Pass	13,980	3,575			64,932	12,375
	3,093,247	643,513	562,070,138	18,570,445	668,117,397	29,227,403

[a] Includes 950 gallons of paraffin oil, valued at $165.

Crude petroleum exported from Pacific ports, including shipments to noncontiguous territories, 1915–1917.

Customs district.	1915		1916		1917	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.
From—						
Alaska	1,158	$1,158			6,492	$11,042
Southern California	105,590	60,747	176,005	$160,159	590,700	773,815
Washington	157,721	126,168	64,725	65,012	35,642	49,657
Oregon					29	132
San Francisco	1,975,153	1,440,481	1,903,595	1,630,050	1,680,702	2,004,182
	2,239,622	1,628,554	2,144,325	1,855,221	2,313,565	2,838,828
To—						
Alaska	332,623	268,474	446,097	397,327	482,218	635,480
Brazil						
Canada	154,364	109,374			85,293	104,063
Chile	30,000	18,250			56,000	67,200
China						
Guatemala						
Hawaii	1,636,652	1,174,234	1,610,112	1,383,433	1,686,784	2,027,508
Mexico	8,422	7,619			3,289	4,400
Panama	55,393	36,878				
Salvador	21,680	13,500				
Other	488	225	88,116	74,461	71	177
	2,239,622	1,628,554	2,144,325	1,855,221	2,313,565	2,838,828

Petroleum marketed in the United States and petroleum products exported, 1908–1917.

Year.	Quantity marketed.		Exports.			
			Mineral, crude (including all natural oils, without regard to gravity).		Mineral, refined or manufactured.	
					Naphtha, benzine, gasoline, etc.	
	Barrels of 42 gallons.	Gallons.	Quantity (gallons).	Value.	Quantity (gallons).	Value.
1908	178,527,355	7,498,148,910	149,190,017	$6,519,849	43,887,044	$4,542,551
1909	183,170,874	7,693,176,708	170,337,773	6,027,588	68,758,675	5,799,994
1910	209,557,248	8,801,404,416	180,111,166	5,404,253	100,695,382	8,407,102
1911	220,449,391	9,258,874,422	201,843,355	6,165,403	137,294,606	11,482,761
1912	222,935,044	9,363,271,848	188,711,420	6,770,484	186,000,094	20,459,378
1913	248,446,230	10,434,741,660	194,469,634	8,448,294	188,043,379	28,091,608
1914	265,762,535	11,162,026,470	124,735,553	4,958,838	209,692,655	25,288,414
1915	281,104,104	11,806,372,368	158,263,069	4,282,827	281,609,081	33,885,047
1916	300,767,158	12,632,220,636	172,027,903	7,029,923	355,870,283	68,660,881
1917	335,315,601	14,083,255,242	172,121,195	7,668,312	415,878,844	93,134,244

Petroleum marketed in the United States and petroleum products exported, 1908–1917—Continued.

Year.	Exports—Continued.							
	Mineral, refined or manufactured—Continued.				Residuum (tar, pitch, and all other from which the light bodies have been distilled).		Total exports.	
	Illuminating.		Lubricating (heavy paraffin, etc.).					
	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.
1908..	1,129,004,833	$75,988,256	147,769,024	$18,971,436	77,551,683	$2,793,363	1,547,402,601	$108,815,455
1909..	1,046,401,072	67,814,406	161,639,609	20,016,107	121,966,249	4,180,495	1,569,103,378	103,838,590
1910..	940,247,039	55,642,368	163,832,544	20,921,103	117,605,802	3,732,196	1,502,491,933	94,107,022
1911..	1,112,295,006	61,055,095	183,319,645	23,337,126	133,979,087	3,882,463	1,768,731,699	105,922,848
1912..	1,026,138,239	62,084,022	216,393,206	28,297,467	266,236,938	6,599,031	1,883,479,897	124,210,382
1913..	1,119,441,243	72,042,107	207,639,092	29,608,549	426,872,373	11,125,851	2,136,465,721	140,316,409
1914..	1,010,449,253	64,112,772	191,647,570	26,316,313	703,508,021	19,224,250	2,240,033,652	139,900,587
1915..	836,958,665	49,988,597	239,678,725	32,459,641	812,216,209	22,325,557	2,328,725,749	142,941,669
1916..	854,688,404	55,862,906	260,805,939	43,027,371	964,089,837	27,140,210	2,607,482,366	201,721,291
1917..	658,156,487	48,953,610	280,437,663	57,564,864	1,124,524,160	45,656,444	2,651,118,349	252,977,476

Mineral oils exported from the United States in 1917, by months.

Month.	Crude.		Gasoline and naphtha.		Illuminating.	
	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.
January	13,149,318	$424,940	38,065,244	$7,125,670	97,128,906	$5,662,262
February	17,215,981	633,133	21,908,056	4,278,845	45,507,551	3,214,530
March	16,378,585	596,573	24,606,324	5,396,916	59,898,456	4,011,801
April	14,653,999	724,862	35,705,019	7,511,812	63,168,581	4,581,054
May	6,577,536	384,375	46,334,757	10,439,777	49,784,675	3,680,381
June	22,044,732	1,257,825	53,305,921	11,903,366	67,381,426	4,986,188
July	6,291,853	413,952	22,076,243	4,801,724	28,446,670	2,561,655
August	12,192,207	408,280	30,593,418	7,275,604	45,936,349	3,817,066
September	10,827,854	464,615	20,050,699	4,643,432	33,185,053	2,783,031
October	21,170,505	903,182	31,240,762	7,121,444	45,753,571	3,259,623
November	7,419,253	370,557	56,996,017	13,990,530	58,541,832	4,689,325
December	24,199,372	1,086,018	34,996,384	8,645,124	63,423,417	5,706,694
	172,121,195	7,668,312	415,878,844	93,134,244	658,156,487	48,953,610

Month.	Lubricating and paraffin.		All other lubricating.		Paraffin oil.	
	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.
January	23,464,959	$4,237,260				
February	16,260,429	3,104,619				
March	21,248,195	3,831,882				
April	25,009,724	4,676,886				
May	24,912,737	4,695,885				
June	27,970,927	5,561,479				
July			16,771,816	$3,148,858	671,048	$149,735
August			22,057,100	4,638,055	1,189,949	220,073
September			20,128,315	4,034,947	301,050	61,508
October			26,403,180	6,094,608	1,123,587	239,244
November			23,192,305	6,187,853	1,978,716	306,202
December			26,740,897	6,160,235	1,012,729	215,535
	138,866,971	26,108,011	135,293,613	30,264,556	6,277,079	1,192,297

Total lubricating and paraffin oil (gallons), 280,437,663, $57,564,864.

Mineral oils exported from the United States in 1917, by months—Continued.

Month.	Gas oil and fuel oil.		Fuel oil.		Gas oil.	
	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.
January	107,150,343	$3,248,894				
February	57,573,107	1,878,835				
March	87,978,337	2,902,345				
April	61,679,952	1,984,501				
May	85,759,841	2,985,783				
June	93,850,658	3,623,048				
July			63,694,163	$2,693,659	5,957,403	$279,387
August			107,082,233	4,516,675	6,382,153	428,458
September			112,316,277	4,569,643	3,792,659	246,621
October			92,278,020	4,267,557	4,789,479	243,957
November			81,309,537	4,267,761	2,346,945	116,065
December			140,499,690	6,832,533	9,032,250	463,560
	493,992,238	16,623,406	597,179,920	27,147,828	32,300,889	1,778,048

Total gas oil and fuel oil (gallons), 1,123,473,047, $45,549,282.

Month.	Residuum.		Total.	
	Quantity (gallons).	Value.	Quantity (gallons).	Value.
January	37,749	$2,372	278,996,519	$20,701,353
February	26,113	4,372	158,491,237	13,114,334
March	805	100	210,110,702	16,739,617
April	44,105	2,765	200,261,380	19,481,880
May	79,898	3,218	213,449,444	22,189,419
June	183,728	10,130	264,737,392	27,342,036
July	89,477	6,560	143,998,673	14,055,530
August	53,786	3,151	225,487,195	21,307,362
September	85,628	5,257	200,687,535	16,809,054
October	16,584	1,698	222,775,688	22,131,313
November	51,152	3,378	231,835,757	29,931,671
December	382,088	64,208	300,286,827	29,173,907
	1,051,113	107,164	2,651,118,349	252,977,476

PRICES.

The following tables, compiled from weekly quotations in the Oil, Paint, and Drug Reporter (New York), show the fluctuations in export price of the principal kinds of illuminating oil and of gasoline entering the foreign trade and, for comparison, the wholesale price of the same products to domestic jobbers in New York. The quotations on illuminating oil are for 150° F. fire test, water-white kerosene, and on gasoline for 68° to 72° Baumé auto naphtha. Quotations on standard white kerosene ranged 1 cent lower in price than quotations on the water-white grade.

Prices of illuminating oil at New York, 1916 and 1917.

Export price (cents per gallon).				Jobbing price (cents per gallon).		
Date.	Bulk.	Cases.	Barrels.	Date.	Tank wagon.	Barrels.
1916.				**1916.**		
Jan. 1	6.00	11.75	9.65	Jan. 1	9.00	13.00
Jan. 4		12.00		Mar. 6		12.00
Jan. 15	6.25	12.25	9.90			
Mar. 31			9.95			
June 1		12.50				
Aug. 4			10.10			
Aug. 11	6.10	12.35	9.95			
Aug. 14	6.00	12.25	9.85			
Sept. 5	5.75	12.00	9.60			
Sept. 12	5.50	11.75	9.35			
Dec. 6			9.65			
Dec. 22		12.75				
1917.				**1917.**		
Jan. 10	5.75	13.00	9.90	Aug. 6		13.00
Jan. 12	6.00	13.25	10.15	Nov. 10		14.00
Feb. 6			10.75	Dec. 8		15.00
Mar. 7	6.25	13.50	11.00	Dec. 19		16.00
Mar. 12	6.50	13.75	11.25			
July 9			11.35			
July 19		14.25				
Aug. 1		15.25				
Aug. 6		15.75				
Sept. 30		16.50				
Oct. 17			11.45			
Nov. 3			12.15			
Nov. 26	7.50	17.50	13.15			
Dec. 14			13.50			

Prices of gasoline at New York, 1916 and 1917.

Export price (cents per gallon).			Jobbing price (cents per gallon).		
Date.	10-gallon drum (less than 100 cases).	Cans and cases (less than 100).	Date.	Wooden barrels.	Auto naphtha, to garages only (steel barrels).
1916.			**1916.**		
Jan. 1	34.00	29.00	Jan. 1	29.00–30.00	21.00
Jan. 14	36.00	31.00	Jan. 5	30.00–31.00	22.00
Feb. 5	37.00	32.00	Feb. 7		23.00
Feb. 25	38.00	33.00	Mar. 2	31.00–32.00	24.00
June 1	38.00	33.25	Aug. 7		23.00
Aug. 11	37.00	32.25	Sept. 7		22.00
Dec. 23	38.00	33.25			
1917.			**1917.**		
Jan. 10	39.00	34.25	Feb. 3	32.00–33.00	23.00
May 24	41.00	36.25	Mar. 1	33.00–34.00	24.00
July 19	41.50	36.75	Aug. 11	34.00–35.00	
Aug. 1		37.75			
Aug. 6		38.25			
Aug. 21	43.75				
Sept. 20		39.00			
Nov. 26	51.25				

FUEL OIL.

GENERAL STATEMENT.

The year 1917 was one of marked expansion in the utilization of fuel oil in the United States despite an equally marked advance in its cost to the consumer. Several factors, not unrelated to the active participation by the United States in the world war, combined in 1917 to create a demand for fuel oil that was unprecedented and that aroused no small degree of concern in the adequacy of available supplies to satisfy immediate and prospective needs. Of those factors, increased requirements of fuel by our allies, by the United States Navy, by scores of new munition plants, shipyards, and essential industries in the United States, and by railroads depending wholly or in part on liquid fuel were the most potent, although the increasing inability of many industries to obtain adequate supplies of coal proved a factor of growing importance at the end of the year. To the foresight of a number of the eastern marketers in accumulating unusually large stocks of fuel oil in the summer and fall of 1917 may be credited the fact that no serious shortage of fuel oil actually occurred in the eastern industrial district in the winter of 1917–18, other than local shortage here and there due to a lack of tank cars or to deficiencies in transportation.

The fuel oil utilized in the United States consists in greater part of topped or semirefined petroleum of asphaltic or semiasphaltic base, though limited quantities of low-grade crude petroleum of asphaltic base and of the refining residuals of petroleum of paraffin base are also used. Because of the development of successful methods of refining by which ever-increasing proportions of the lower-grade products of petroleum distillation are converted into gasoline and motor fuel, the tendency in recent years has been decidedly away from the use of petroleum in the crude state as fuel, and to-day only the grades of crude oil averaging in gravity below 20° Baumé are considered as being available for use as fuel, without some form of refining. Outside California, where some 35 to 40 per cent of the annual output of crude oil is of a gravity below 20° Baumé, the requirements of fuel oil in the United States are satisfied, except locally, by the product of the topping plants and petroleum refineries and by imports of low-gravity crude oil or of topped crude from Mexico.

That the market for fuel oil in the eastern part of the United States will expand enormously after the war is certain, for with the release from foreign service of the rapidly increasing fleet of ocean tankers, facilities will be available for the transport from Mexico of sufficient quantities of petroleum fuel to supply any market that may be developed for it.

PRICES.

Prices of fuel oil ranged appreciably higher in 1917 than in 1916, reflecting not only the growing demand for that commodity but also the steady advance in prices of crude oil at the well. The market was unusually firm throughout the year in all parts of the country, though some weakness developed near the end of 1917 from rumors of proposed Government control of the petroleum industry, with fixation of prices.

The following tabulation of monthly prices per barrel for semi-refined fuel oil at various marketing centers throughout the United States has been compiled mainly from the files of the Oil Trade Journal (New York).

Monthly prices of semirefined fuel oil in 1916 and 1917.

1916.

Month.	Houston, Tex.	Tulsa, Okla.	San Francisco, Cal.	Seattle, Wash.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*
January	$1.05	$1.00-$1.05	$0.80	$1.00
February	1.05	1.05- 1.10	.80	1.00
March	1.10	1.10- 1.20	.80	1.00
April	$1.00- 1.05	.85- .95	.80	1.00
May	.85- .90	.60- .80	.80	1.00
June	.80- .85	.60- .80	.80	1.00
July	.75- .80	.55- .75	$0.80- 1.00	$1.00- 1.20
August	.75- .80	.55- .75	1.00	1.20
September	.75- .80	.55- .75	1.00- 1.05	1.20- 1.25
October	.80- .90	.60- .80	1.05	1.25
November	.95- 1.00	1.00- 1.25	1.05- 1.10	1.25
December	.95- 1.00	1.00- 1.25	1.10- 1.15	1.25- 1.30

1917.

Month.	Northern Texas.	Northern Louisiana.	Oklahoma.	Southern Texas.	Southern Louisiana.	San Francisco.	Pennsylvania points.	Chicago.	New York.
	Barrels.	*Bbls.*	*Barrels.*	*Barrels.*	*Bbls.*	*Bbls.*	*Gallons.*	*Gallons.*	*Gallons.*
January	$1.00	$1.00	$1.00-$2.00	$1.15-$1.20	$1.15	$1.10	$0.04½-$0.05½	....	....
February	1.20	1.00	1.00- 2.00	1.25- 1.30	1.30	1.20	.05½- .06½	....	....
March	1.20	1.20	1.00- 2.00	1.25- 1.30	1.30	1.20	.05½- .06½	....	....
April	1.20	1.20	1.00- 2.00	1.25- 1.30	1.30	1.20	.05½- .06½	....	....
May	1.25	1.20	1.00- 2.00	1.25- 1.30	1.30	1.25	.07 - .07½	....	....
June	1.30	1.20	1.25- 1.50	1.30	1.30	1.36½	.07	$0.04-$0.05	$0.10-$0.10½
July	$1.50- 1.60	1.25	1.25- 1.50	1.50- 1.60	1.60	1.45	.07	.04- .05	.10½
August	1.50- 1.60	1.40	1.25- 1.50	1.50- 1.60	1.60	1.45	.07 - .08	.04- .05	.10½
September	1.50- 1.60	1.40	1.25- 1.50	1.50- 1.60	1.60	1.45	.08 - .08½	.04- .05	.10½
October	1.50- 1.60	1.50	1.60- 2.00	1.50- 1.60	1.60	1.45	.07¼- .08¼	.07- .08	.10½- .11
November	1.50- 1.60	1.50	1.25- 2.25	1.50- 1.60	1.60	1.45	.08 - .08½	.07- .08	.11
December	1.65- 1.95	1.50	1.25- 2.25	1.65- 1.95	1.60	1.45	.09¼- .09½	.08- .09	.11 - .13

CONSUMPTION.

Complete statistics of the consumption of fuel oil in the United States are not available. Data compiled from the reports of pipe-line companies show that 46,681,430 barrels of crude petroleum were delivered for use as fuel direct from the sources of domestic production in 1917. Reports of oil producers show that 4,857,000 barrels of crude oil were consumed, mainly in drilling and pumping operations, in the oil fields of the country. Data compiled by the Bureau of Mines show that no less than 149,725,000 barrels of fuel oil and gas oil were produced and sold by refiners of crude petroleum in the United States in 1917, and that refinery stocks of these products were reduced to the extent of a further 3,397,000 barrels during that year.

The records of the Bureau of Foreign and Domestic Commerce show that 30,138,773 barrels of petroleum, the greater part of which was for fuel, was imported, chiefly from Mexico, in 1917; and that 30,872,508 barrels of crude oil, gas oil, fuel oil, and residuum were exported from the United States in the same period. From these data, such as they are, the consumption of fuel oil, including gas oil, in the United States in 1917, would appear to have amounted to about 204,000,000 barrels, a quantity equivalent to 61 per cent of the marketed production of petroleum in the entire country in that year.

RAILROADS.

The immense increase in railroad traffic due to the active participation of the United States in the war increased to some extent the quantity of petroleum and petroleum distillates consumed as locomotive fuel in 1917, though the increase in that yeai was only about one-half the rate of increase in 1916, because of mounting costs and growing scarcity of liquid fuel. Reports submitted by all railroad companies that operated oil-burning locomotives in the United States show that the quantity of fuel oil consumed by them in 1917 was 45,700,576 barrels, a gain of 3,574,159 barrels, or 8.5 per cent, over 1916 and a larger consumption than in any other year.

Fuel oil consumed by the railroads of the United States, 1908–1917.

Year.	Fuel oil consumed.	Length of line operated by the use of fuel oil.[a]	Total mileage made by oil-burning engines.	Average number of miles per barrel of oil consumed.
	Barrels.	*Miles.*	*Miles.*	*Miles.*
1908	16,870,882	15,474	64,279,509	3.81
1909	19,905,335	17,676	72,918,118	3.66
1910	23,817,346	22,709	89,107,883	3.74
1911	29,748,845	30,039	109,680,976	3.69
1912	33,605,598	28,451	121,393,228	3.61
1913	33,004,815	29,145	118,672,162	3.60
1914	31,093,266	29,595	118,737,469	3.82
1915	36,648,466	30,776	124,255,525	3.39
1916	42,126,417	31,980	140,434,566	3.33
1917	45,700,576	32,380	146,957,268	3.22

[a] Some of these lines also used coal.

The following railroad companies used fuel oil on their lines in 1917:

Arizona:
- Atchison, Topeka & Santa Fe Railway System.
- Southern Pacific Co.

Arkansas:
- Kansas City Southern Railway Co.

California:
- Atchison, Topeka & Santa Fe Railway System.
- Los Angeles & Salt Lake Railroad.
- Northwestern Pacific Railroad Co.
- San Diego & Arizona Railway Co.
- San Diego & Southeastern Railway Co.
- Southern Pacific Co.
- Tonopah & Tidewater Railroad Co.
- Western Pacific Railroad Co.

Florida:
- Florida East Coast Railway Co.

Georgia:
- Central of Georgia Railway Co. (on Tybee district).

Idaho:
- Chicago, Milwaukee & St. Paul Railway Co.
- Great Northern Railway Co.
- Oregon Short Line Railroad Co.
- Oregon-Washington Railroad & Navigation Co.
- Washington, Idaho & Montana Railway Co.

Kansas:
- Atchison, Topeka & Santa Fe Railway System.
- Kansas City Southern Railway Co.

Louisiana:
- Atchison, Topeka & Santa Fe Railway System.
- Houston & Shreveport Railroad Co.
- Kansas City Southern Railway Co.
- Louisiana Railway & Navigation Co.
- Louisiana Western Railroad Co.
- Morgan's Louisiana & Texas Railroad & Steamship Co.
- New Orleans, Texas & Mexico Railway.

Missouri:
- Kansas City Southern Railway Co.

Montana:
- Chicago, Burlington & Quincy Railroad Co.
- Chicago, Milwaukee & St. Paul Railway Co.
- Great Northern Railway Co.
- Oregon Short Line Railroad Co.

Nebraska:
- Chicago & Northwestern Railway Co.

Nevada:
- Atchison, Topeka & Santa Fe Railway System.
- Bullfrog Goldfield Railroad Co.
- Las Vegas & Tonopah Railroad Co.
- Los Angeles & Salt Lake Railroad.
- Southern Pacific Co.
- Tonopah & Goldfield Railroad Co.
- Tonopah & Tidewater Railroad Co.
- Western Pacific Railroad Co.

New Mexico:
- Atchison, Topeka & Santa Fe Railway System.
- El Paso Southwestern System.
- Southern Pacific Co.

New York:
- Delaware & Hudson Co. (in the Adirondacks).
- New York Central Railroad Co. (in the Adirondacks, including Old Forge and the Fulton Chain).

Oklahoma:
- Atchison, Topeka & Santa Fe Railway System.
- Kansas City Southern Railway Co.

Oregon:
- Great Northern Railway Co.
- Northern Pacific Railway Co.
- Oregon Trunk Railway.
- Oregon-Washington Railroad & Navigation Co.
- Southern Pacific Co.
- Spokane, Portland & Seattle Railway Co.

South Dakota:
- Chicago, Burlington & Quincy Railroad Co.
- Chicago & Northwestern Railway Co.

Texas:
- Atchison, Topeka & Santa Fe Railway System.
- Beaumont, Sour Lake & Western Railway.
- Fort Worth & Denver City Railway Co.
- Galveston, Harrisburg & San Antonio Railway Co.
- Galveston, Houston & Henderson Railroad Co.
- Houston, East & West Texas Railway Co.
- Houston & Texas Central Railroad Co.
- International & Great Northern Railway Co.
- Orange & Northwestern Railroad.
- St. Louis, Brownsville & Mexico Railway.
- San Antonio & Aransas Pass Railway Co.
- Texarkana & Fort Smith Railway Co.
- Texas & New Orleans Railroad Co.
- Texas & Pacific Railway.
- Trinity & Brazos Valley Railway Co.

Utah:
- Los Angeles & Salt Lake Railroad Co.
- Southern Pacific Co.

Washington:
- Bellingham & Northern Railway Co.
- Chicago, Milwaukee & St. Paul Railway Co.
- Great Northern Railway Co.
- Northern Pacific Railway Co.
- Oregon Trunk Railway.
- Oregon-Washington Railroad & Navigation Co.
- Spokane, Portland & Seattle Railway Co.
- Washington, Idaho & Montana Railway Co.

Wyoming:
- Chicago, Burlington & Quincy Railroad Co.
- Chicago & Northwestern Railway Co.

UNITED STATES NAVY.

The consumption of fuel oil by the United States Navy in the fiscal year ending June 30, 1917, was 2,079,580 barrels,[1] an increase of 1,237,148 barrels, or 147 per cent, over the consumption in 1916.

On account of the war, the increase in the number of oil-burning destroyers and the acceleration of the building program revised estimates[1] of the fuel needs of the Navy placed the requirements for the fiscal year ending June 30, 1918, at 5,000,000 barrels, if at war; for the fiscal year ending June 30, 1919, at 8,635,000 barrels, if at war; and for the fiscal year ending June 30, 1920, at 16,635,000 barrels.

The status as of March, 1918, of the United States Navy (exclusive of oil-burning auxiliaries requisitioned for naval use during the war), so far as it includes vessels utilizing oil fuel exclusively, is shown in the following table:[1]

Oil-burning naval vessels.

	In commission.	Building prior to 1917 program.	1917 program.
Battleships	5	4	10
Battle cruisers			6
Scout cruisers			10
Torpedo-boat destroyers	49	2	50
Fleet submarines		3	9
Coast submarines	56	16	58
Fuel ships	4		3
Repair ships			1
Transports	1		1
Hospital ships			1
Destroyer tenders	1		2
Submarine tenders	2		1
Ammunition ships			2
Supply ships	1		
	119	25	154

FIELD USE.

The use of crude petroleum as a fuel for drilling and pumping wells is restricted for the most part to fields that produce oils of relatively low grade or to areas where other fuels are not available

[1] Testimony of Commander N. H. Wright before Committee on Public Lands, House of Representatives, Mar. 2, 1918.

at prices that would effect an economy in their adoption. Wherever natural gas or cheap electric power are available, they are used in preference to petroleum for oil-field operations.

The statistics presented in the following table are compiled from the reports of oil-producing companies and show that approximately 1.4 per cent of the total output of petroleum in the United States in 1917 was reinvested in the development of the properties that produced the other 98.6 per cent of the output.

Crude petroleum used as field fuel in 1916 and 1917, in barrels.

Field.	1916	1917
Illinois	7,645	3,287
Mid-Continent	71,825	462,136
Gulf	470,362	1,577,159
Rocky Mountain	11,760	16,551
California	2,778,659	2,798,225
	3,340,251	4,857,358

WORLD'S PRODUCTION OF PETROLEUM.

World's production of crude petroleum in 1917 and since 1857, by countries.

Country.	Production, 1917.			Total production, 1857-1917.		
	Barrels of 42 gallons.	Metric tons.	Per cent of total.	Barrels of 42 gallons.	Metric tons.	Per cent of total.
United States	a 335,315,601	44,708,747	66.17	4,252,644,003	567,019,201	60.78
Russia	b 69,000,000	9,418,509	13.62	1,832,583,017	212,336,152	26.19
Mexico	55,292,770	8,252,652	10.91	222,082,472	33,166,241	3.18
Dutch East Indies	c 12,928,955	1,778,495	2.55	175,103,267	23,628,200	2.50
India	8,078,843	1,077,179	1.59	98,162,365	13,088,315	1.40
Persia	6,856,063	952,231	1.35	14,056,063	d 1,952,231	.20
Galicia	5,965,447	d 829,629	1.18	148,459,653	20,646,663	2.12
Japan and Formosa	2,898,654	386,487	.57	36,065,454	4,808,727	.52
Rumania	2,681,870	b 373,000	.53	142,992,465	19,283,174	2.04
Peru	2,533,417	337,789	.50	21,878,285	2,917,104	.31
Trinidad	1,599,455	222,456	.32	5,347,466	743,736	.08
Argentina	1,144,737	166,871	.23	2,974,778	424,564	.04
Egypt	1,008,750	134,500	.20	2,768,686	369,158	.04
Germany	995,764	b 140,000	.20	15,952,861	2,155,974	.23
Canada	205,332	27,378	.04	24,112,529	3,215,004	.35
Venezuela	127,743	17,742	.03	127,743	17,742	
Italy	50,334	b 7,000	.01	947,289	133,919	.02
Cuba	19,167	2,662		19,167	2,662	
Other countries	....	....	....	397,000	55,139	
	506,702,902	68,833,327	100.00	6,996,674,563	935,963,906	100.00

a Quantity marketed.
b Estimated.
c Includes British Borneo.
d Estimated in part.

World's production of crude petroleum since 1857,

Year.	Rumania.	United States.[a]	Italy.	Canada.	Russia.	Galicia.	Japan and Formosa.	Germany.
1857	1,977							
1858	3,560							
1859	4,349	2,000						
1860	8,542	500,000	36					
1861	17,279	2,113,609	29					
1862	23,198	3,056,690	29	11,775				
1863	27,943	2,611,309	58	82,814	40,816			
1864	33,013	2,116,109	72	90,000	64,686			
1865	39,017	2,497,700	2,265	110,000	66,542			
1866	42,534	3,597,700	992	175,000	83,052			
1867	50,838	3,347,300	791	190,000	119,917			
1868	55,369	3,646,117	367	200,000	88,327			
1869	58,533	4,215,000	144	220,000	202,308			
1870	83,765	5,260,745	86	250,000	204,618			
1871	90,030	5,205,234	273	269,397	165,129			
1872	91,251	6,293,194	331	308,100	184,391			
1873	104,036	9,893,786	467	365,052	474,379			
1874	103,177	10,926,945	604	168,807	583,751	149,837		
1875	108,569	8,787,514	813	220,000	697,364	158,522	4,566	
1876	111,314	9,132,669	2,891	312,000	1,320,528	164,157	7,708	
1877	108,569	13,350,363	2,934	312,000	1,800,720	169,792	9,560	
1878	109,300	15,396,868	4,329	312,000	2,400,960	175,420	17,884	
1879	110,007	19,914,146	2,891	575,000	2,761,104	214,800	23,457	
1880	114,321	26,286,123	2,035	350,000	3,001,200	229,120	25,497	9,310
1881	121,511	27,661,238	1,237	275,000	3,601,441	286,400	16,751	29,219
1882	136,610	30,349,897	1,316	275,000	4,537,815	330,076	15,549	58,025
1883	139,486	23,449,633	1,618	250,000	6,002,401	365,160	20,473	26,708
1884	210,667	24,218,438	2,855	250,000	10,804,577	408,120	27,923	46,161
1885	193,411	21,858,785	1,941	250,000	13,924,596	465,400	29,237	41,360
1886	168,606	28,064,841	1,575	584,061	18,006,407	305,884	37,916	73,864
1887	181,907	28,283,483	1,496	525,655	18,367,781	343,832	28,645	74,284
1888	218,576	27,612,025	1,251	695,203	23,048,787	466,537	37,436	84,782
1889	297,666	35,163,513	1,273	704,690	24,609,407	515,268	52,811	68,217
1890	383,227	45,823,572	2,998	795,030	28,691,218	659,012	51,420	108,296
1891	488,201	54,292,655	8,305	755,298	34,573,181	630,730	52,917	108,929
1892	593,175	50,514,657	18,321	779,753	35,774,504	646,220	68,901	101,404
1893	535,655	48,431,066	19,069	798,406	40,456,519	692,669	106,384	99,390
1894	507,255	49,344,516	20,552	829,104	36,375,428	949,146	171,744	122,564
1895	575,200	52,892,276	25,843	726,138	46,140,174	1,452,999	141,310	121,277
1896	543,348	60,960,361	18,149	726,822	47,220,633	2,443,080	197,082	145,061
1897	570,886	60,475,516	13,892	709,857	54,399,568	2,226,368	218,559	165,745
1898	776,238	55,364,233	14,489	758,391	61,609,357	2,376,108	265,389	183,427
1899	1,425,777	57,070,850	16,121	808,570	65,954,968	2,313,047	536,079	192,232
1900	1,628,535	63,620,529	12,102	913,498	75,779,417	2,346,505	866,814	358,297
1901	1,678,320	69,389,194	16,150	756,679	85,168,556	3,251,544	1,110,790	313,630
1902	2,059,935	88,766,916	18,933	530,624	80,540,044	4,142,159	1,193,038	353,674
1903	2,763,117	100,461,337	17,876	486,637	75,591,256	5,234,475	1,209,371	445,818
1904	3,599,026	117,080,960	25,476	552,575	78,536,655	5,947,383	1,419,473	637,431
1905	4,420,987	134,717,580	44,027	634,095	54,960,270	5,765,317	1,472,804	560,963
1906	6,378,184	126,493,936	53,577	569,753	58,897,311	5,467,967	1,710,768	578,610
1907	8,118,207	166,095,335	59,875	788,872	61,850,734	8,455,841	2,001,838	756,631
1908	8,252,157	178,527,355	50,966	527,987	62,186,447	12,612,295	2,070,145	1,009,278
1909	9,327,278	183,170,874	42,388	420,755	65,970,350	14,932,799	1,889,563	1,018,837
1910	9,723,806	209,557,248	50,830	315,895	70,336,574	12,673,688	1,930,661	1,032,522
1911	11,107,450	220,449,391	74,709	291,096	66,183,691	10,519,270	1,658,903	1,017,045
1912	12,976,232	222,935,044	53,778	243,336	68,019,208	8,535,174	1,671,405	1,031,050
1913	13,554,768	248,446,230	47,198	228,080	62,834,356	7,818,130	1,942,009	[b] 995,764
1914	12,826,579	265,762,535	39,849	214,805	67,020,522	[b] 5,033,350	2,738,378	[b] 995,764
1915	12,029,913	281,104,104	43,898	215,464	68,548,062	4,158,899	3,118,464	[b] 995,764
1916	[d] 10,298,208	300,767,158	50,585	198,123	[d] 72,801,110	6,461,706	2,997,178	[b] 995,764
1917	[b] 2,681,870	335,315,601	[b] 50,334	205,332	[b] 69,000,000	[d] 5,965,447	2,898,654	[b] 995,764
	142,992,465	4,252,644,003	947,289	24,112,529	1,832,583,017	148,459,653	36,065,454	15,952,861

[a] Quantity marketed. [b] Estimated. [c] Includes British Borneo.

by years and countries, in barrels of 42 gallons.

India.	Dutch East Indies.	Peru.	Mexico.	Argentina.	Trinidad.	Egypt.	Other countries.	Total.	Year.
...	...	...	...	...	...	...	...	1,977	1857
...	...	...	...	...	...	...	...	3,560	1858
...	...	...	...	...	...	...	...	6,349	1859
...	...	...	...	...	...	...	...	508,578	1860
...	...	...	...	...	...	...	...	2,130,917	1861
...	...	...	...	...	...	...	...	3,091,692	1862
...	...	...	...	...	...	...	...	2,762,940	1863
...	...	...	...	...	...	...	...	2,303,780	1864
...	...	...	...	...	...	...	...	2,715,524	1865
...	...	...	...	...	...	...	...	3,899,278	1866
...	...	...	...	...	...	...	...	3,708,846	1867
...	...	...	...	...	...	...	...	3,990,180	1868
...	...	...	...	...	...	...	...	4,695,985	1869
...	...	...	...	...	...	...	...	5,799,214	1870
...	...	...	...	...	...	...	...	5,730,063	1871
...	...	...	...	...	...	...	...	6,877,267	1872
...	...	...	...	...	...	...	...	10,837,720	1873
...	...	...	...	...	...	...	...	11,933,121	1874
...	...	...	...	...	...	...	...	9,977,348	1875
...	...	...	...	...	...	...	...	11,051,267	1876
...	...	...	...	...	...	...	...	15,753,938	1877
...	...	...	...	...	...	...	...	18,416,761	1878
...	...	...	...	...	...	...	...	23,601,405	1879
...	...	...	...	...	...	...	...	30,017,606	1880
...	...	...	...	...	...	...	...	31,992,797	1881
...	...	...	...	...	...	...	...	35,704,288	1882
...	...	...	...	...	...	...	...	30,255,479	1883
...	...	...	...	...	...	...	...	35,968,741	1884
...	...	...	...	...	...	...	...	36,764,730	1885
...	...	...	...	...	...	...	...	47,243,154	1886
...	...	...	...	...	...	...	...	47,807,083	1887
...	...	...	...	...	...	...	...	52,164,597	1888
94,250	...	...	...	...	...	...	...	61,507,095	1889
118,065	...	...	...	...	...	...	...	76,632,838	1890
190,131	...	...	...	...	...	...	...	91,100,347	1891
242,284	...	...	...	...	...	...	...	88,739,219	1892
298,969	600,000	...	...	...	...	...	...	92,038,127	1893
327,218	688,170	...	...	...	...	...	...	89,335,697	1894
371,536	1,215,757	...	...	...	...	...	...	103,662,510	1895
429,979	1,427,132	47,536	...	...	...	...	...	114,159,183	1896
545,704	2,551,649	70,831	...	...	...	...	...	121,948,575	1897
542,110	2,964,035	70,905	...	...	...	...	...	124,924,682	1898
940,971	1,795,961	89,166	...	...	...	...	...	131,143,742	1899
1,078,264	2,253,355	274,800	...	...	...	...	...	149,132,116	1900
1,430,716	4,013,710	274,800	10,345	...	...	...	[b] 20,000	167,434,434	1901
1,617,363	2,430,465	286,725	40,200	...	...	...	[b] 26,000	182,006,076	1902
2,510,259	5,770,056	278,092	75,375	...	...	...	[b] 36,000	194,879,669	1903
3,385,468	6,508,485	345,834	125,625	...	...	...	[b] 40,000	218,204,391	1904
4,137,098	7,849,896	447,880	251,250	...	...	...	[b] 30,000	215,292,167	1905
4,015,803	8,180,657	536,294	502,500	...	...	...	[b] 30,000	213,415,360	1906
4,344,162	9,982,597	756,226	1,005,000	101	...	...	[b] 30,000	264,245,419	1907
5,047,038	10,283,357	1,011,180	3,932,900	11,472	169	...	[b] 30,000	285,552,746	1908
6,676,517	11,041,852	1,316,118	2,713,500	18,431	57,143	...	[b] 20,000	298,616,405	1909
6,137,990	11,030,620	1,330,105	3,634,080	20,753	142,857	...	[b] 20,000	327,937,629	1910
6,451,203	12,172,949	1,368,274	12,552,798	13,119	285,307	9,150	[b] 20,000	344,174,355	1911
7,116,672	10,845,624	1,751,143	16,558,215	47,007	436,805	205,905	[b] 20,000	352,446,598	1912
7,930,149	11,172,294	2,133,261	25,696,291	130,618	503,616	94,635	[b] 20,000	383,547,399	1913
7,409,792	[c] 11,834,802	1,917,802	26,235,403	275,500	643,533	777,038	[b] 20,000	403,745,342	1914
8,202,674	[c] 12,386,800	2,487,251	32,910,508	516,120	[b] 750,000	262,208	[b] 10,000	427,740,129	1915
8,491,137	[c] 13,174,399	2,550,645	40,545,712	796,920	928,581	411,000	[b] 25,000	461,493,226	1916
8,078,843	[c] 12,928,955	2,533,417	55,292,770	1,144,737	1,599,455	1,008,750	[e] 7,004,973	506,702,902	1917
98,162,365	175,103,267	21,878,285	222,082,472	2,974,778	5,347,466	2,768,686	14,599,973	6,996,674,563	

[d] Estimated in part.
[e] Includes 19,167 barrels produced in Cuba, 127,743 barrels in Venezuela, and 6,856,063 barrels in Persia.

As nearly as can be ascertained the world's production of petroleum in 1917 exceeded the output in 1916 by more than 45,000,000 barrels, or about 9.8 per cent. It aggregated a little more than half a billion barrels and it constitutes a record for annual production of petroleum in the world.

Among the four countries that contributed more than 93 per cent of this record total there were no changes in rank compared with 1916, the order of importance remaining the United States, Russia, Mexico, and Dutch East Indies. Among the other countries Persia, with a very large new production, took sixth rank, Rumania receded from fifth to ninth, and India advanced to fifth. Peru, Trinidad, Germany, Canada, and Italy, which ranked ninth, tenth, eleventh, fourteenth, and fifteenth, respectively, in 1916, receded to tenth, eleventh, fourteenth, fifteenth, and seventeenth places, respectively, while Venezuela took sixteenth place. Galicia, Japan and Formosa, Argentina, and Egypt retained seventh, eighth, twelfth, and thirteenth places, respectively.

FOREIGN OIL FIELDS.

NORTH AMERICA.

CANADA.

GENERAL STATEMENT.

As a consequence of the stimulus to development work provided by advancing prices for crude oil and of the success that attended drilling in certain parts of Ontario, the production of petroleum in Canada increased moderately in 1917. The output was 205,332 barrels of 35 imperial gallons each and was greater by 7,113 barrels, or nearly 4 per cent, than the output in 1916.

The average price received for this oil at the wells was $2.33 a barrel, and the market value of the entire output was $478,937, a gain of 35 cents in average unit price and of $86,653, or 22 per cent, in total market value, compared with 1916. In addition to their receipts from the sale of this oil its producers received the usual Government bounty of 1.5 cents a gallon or 52.5 cents a barrel on the quantity marketed.

Price changes affecting Canada crude, the dominant grade of oil produced in Canada, followed closely the course of Lima grade in the United States. From the opening quotation of $1.98 a barrel reached in December, 1916, Canada crude advanced to $2.08 a barrel on January 2, 1917, to $2.18 a barrel on January 6, to $2.23 a barrel on January 28, to $2.28 a barrel on April 19, and attained its closing price of $2.48 a barrel on August 21, the total advance during the year amounting to 50 cents a barrel or 25 per cent on the quotation in effect at the beginning of 1917.

Credit for the gain in production in 1917 belongs almost wholly to the Mosa district opened in February, 1917, near Glencoe, Mosa Township, Middlesex County, Ontario, by the Ontario Petroleum Co., though slight assistance was rendered by the Thamesville pool, Kent County, Ontario, opened late in 1916 by the Vacuum Gas & Oil Co., by the Dutton pool, Elgin County, Ontario, and by the old Albert field near Moncton, Albert County, New Brunswick. The

Belle River field, in Essex County, Ontario, comprising a few shallow wells of small capacity drilled in 1913, was abandoned in 1917. In the other recognized oil districts of Ontario the output of oil decreased moderately in 1917.

Concerning the results of development work in the Calgary district, Alberta, the Canada correspondent of the Oil and Gas Journal writes:[1]

Although no official returns are made of the crude oil production in the Calgary field, the companies operating there in 1917 made returns to the inland revenue department showing the amount of gasoline and kerosene produced from Calgary oil. The production is handled by small local refineries, only the lighter oils being marketed.

The returns show that there were in 1917 some four producing properties. The main production came from the Southern Alberta Oil Co.'s No. 1 well on sec. 18–20–2. This well first produced in 1915, and has been a steady producer since September, 1916. It is an intermittent flowing well and has never been pumped, but at intervals flows from 40 to 50 barrels a day, the well being shut in at times owing to limited facilities for handling the oil.

The Calgary Petroleum Products Co.'s No. 1 (Dingman) well, sec. 6–20–2, is also rated a producer. This is the well that started the boom some four years ago. It has never developed much of an oil production but is a steady producer of high-grade oil in a very small way, and has a big gas flow. The company secures no oil from its No. 2, which is also a good gasser, however. The gas will be utilized in the casing-head gasoline plant now being constructed under an arrangement with California capitalists. The two wells have between 4,000,000 and 5,000,000 cubic feet per day, estimated to contain a half gallon of gasoline per 1,000 cubic feet. The plant will probably be in operation this spring.

The two other producing wells were one of the McKinney (now Midwest Oil Co.) wells, which produced on a small scale in January, February, and March [1917]; and the Prudential Oil Co.'s well, now owned by W. E. McLeod, of Calgary, which has been producing since July.

The internal revenue department's figures show that from February to December, inclusive, the Southern Alberta Oil Co. produced 6,284 barrels of gasoline and 283 barrels of kerosene. The McKinney wells produced 118 barrels of gasoline and 44 barrels of kerosene. W. E. McLeod produced 295 barrels of gasoline and 150 barrels of kerosene. The Dingman well produced 442 barrels of gasoline and 88 barrels of kerosene between March and December. This makes a total production for the Calgary area of 7,139 barrels of gasoline, and 564 barrels of kerosene. The oil has a very high proportion of gasoline and a very slight residue of paraffin and heavy oils, so that this production of 7,703 barrels of the two products may be taken as pretty fairly representing at least 75 per cent of the crude.

Two new producing wells were added to the list in the last days of 1917. The Alberta Petroleum Consolidated No. 2 was cleaned out last year, and since December 4 has been pumping 50 barrels a day with no signs of diminution. This production is being sold to the Canada Southern Refining plant on the ground at $2.25 to $2.50 a barrel. No. 1 well of this company, on sec. 1–20–3, which has been shut down at 2,150 feet, will resume drilling this spring.

The Alberta Southern Oil Co. No. 1, sec. 13–20–3, finished at 3,500 feet and is now pumping with a fair production reported at 30 barrels a day, but perhaps a little less. This company has No. 2 derrick up on sec. 13–20–8, and will start drilling in the spring.

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[1] Canadian field: Oil and Gas Jour., vol. 16, No. 37, p. 28, 1918.

PRODUCTION.

Petroleum produced in Canada, 1908–1917.

[Reported by Canada Department of Mines.]

Year.	Quantity (barrels).[a]	Value.	Average price per barrel.
1908	527,987	$747,102	$1.415
1909	420,755	559,604	1.330
1910	315,895	388,550	1.230
1911	291,096	357,073	1.227
1912	243,336	345,050	1.418
1913	228,080	406,439	1.782
1914	[b] 214,805	343,124	1.590
1915	215,464	300,572	1.392
1916	198,123	392,284	1.979
1917	205,332	478,937	2.3325

[a] Barrels of 35 imperial gallons. The Canadian barrel of 35 imperial gallons is the practical equivalent of the United States barrel of 42 gallons, the difference being less than 0.03 per cent.
[b] Includes 387 barrels from Alberta.

Petroleum produced in Ontario and New Brunswick, 1913–1917, in barrels.

[Reported by supervisor of petroleum bounties at Petrolia, Ontario.]

District.	1913	1914	1915	1916	1917
Bothwell	34,349	33,961	33,395	33,856	29,682
Dutton	4,610	2,190	5,401	2,851	2,941
Lambton	155,747	154,186	161,368	142,208	135,523
Tilbury and Romney	26,824	18,530	12,742	16,296	10,041
Leamington; Onondaga (Brant County)	4,172	2,437	1,490	1,663	382
Belle River	464	1,191	46		
Mosa					20,998
Thamesville					6,420
Total Ontario	226,166	212,495	214,442	196,874	202,991
New Brunswick	2,111	1,725	1,020	1,345	2,341
Total Canada	228,277	214,220	215,462	198,219	205,332

PRICES.

Average monthly prices per barrel for crude oil at Petrolia, Ontario, 1913–1917.

Month.	1913	1914	1915	1916	1917	Month.	1913	1914	1915	1916	1917
January	$1.681	$1.89	$1.305	$1.846	$2.161	August	$1.790	$1.47	$1.305	$1.927	$2.157
February	1.738	1.89	1.305	1.969	2.230	September	1.790	1.45	1.440	1.830	2.480
March	1.761	1.89	1.305	2.072	2.230	October	1.790	1.41	1.480	1.933	2.480
April	1.780	1.80	1.305	2.130	2.255	November	1.831	1.36	1.605	1.930	2.480
May	1.790	1.00	1.305	2.130	2.280	December	1.856	1.36	1.700	1.945	2.480
June	1.790	1.58	1.305	2.130	2.280						
July	1.790	1.56	1.305	2.130	2.280	The year	1.782	1.59	1.395	1.979	2.33¼

MEXICO.

GENERAL STATEMENT.

An output of 55,292,770 barrels of crude petroleum in Mexico in 1917 was an increase of 14,747,058 barrels, or 36 per cent, over the production credited to that country in 1916. This output, which establishes a new record for the production of petroleum in Mexico, provides rather a measure of the improvement in facilities for ocean transport of petroleum than any gage of the potential capacity of the Mexican fields, as it is common knowledge that the domestic market for petroleum in Mexico is extremely limited.

According to De Golyer,[1] the output of petroleum in Mexico in 1917 was distributed among the various fields as follows:

	Barrels of 42 gallons.
Tampico-Tuxpam zone:	
Panuco River valley region:	
San Pedro field	1,955
Ebano-Chijol field	1,125,702
Topila field	815,954
Panuco field	14,955,940
Total region	16,899,551
Tuxpam region:	
Casiano-Tepetate field	8,153,692
Tanhuijo-San Marco field	3,093
Cerro Azul field	9,171,478
Potrero-Alazan field	16,893,717
Alamo field	4,112,899
Furbero field	34,689
Total region	38,369,663
Total zone	55,269,214
Tehuantepec-Tabasco zone	23,556
Total Mexico	55,292,770

In discussing the production of petroleum in Mexico in 1917 the following comments by Blardone[2] are of especial interest in indicating the enormous potentialities of oil production in Mexico:

It will be noted that the greatest volume of oil came from the southern fields, in which are located such capital wells as the Huasteca's Juan Casiano No. 7 and its Cerro Azul No. 4, Mexican Eagle Oil Co.'s Potrero del Llano No. 4, and the Alamo pool of the Penn-Mex Fuel Co. It will be of interest also to note that while, de jure, this immense production came from five wells most of it came, de facto, from only two wells—that is, Huasteca Petroleum Co.'s Juan Casiano No. 7 and the Potrero well of the Mexican Eagle Co., the two famous gushers drilled in 1910, both of which continue to produce without any change in physical characteristics, marking them as the world's most famous wells from the viewpoint of longevity, while in volume of production they also rank among the first in the history of gushers of first magnitude.

Concerning the total yield of petroleum by the two wells specifically mentioned by Blardone, statistics prepared by De Golyer[1] credit Potrero del Llano No. 4 with a gross production of 90,000,000 barrels and Juan Casiano No. 7 with a gross production of 70,000,000 barrels since their completion in 1910.

Activity in drilling in Mexico in 1917 resulted in the completion of 79 wells, 43 of which produced oil in commercial quantities, the remaining 36 being unsuccessful. At the end of 1917 there were 339 productive wells in Mexico credited with a total potential daily capacity of 1,337,213 barrels of oil. The following extracts from Blardone's annual review[3] record the principal developments in the Mexican oil fields and in the Mexican petroleum industry in 1917:

[1] De Golyer, E., The petroleum industry of Mexico: Evening Post Oil-Industry Supplement, New York, Aug. 31, 1918, p. 17.
[2] Blardone, George, Mexico's petroleum production in 1917: Oil and Gas Jour. (Tulsa, Okla.), vol. 16, No. 34, pp. 28, 32, 1918.
[3] Op. cit.

SOUTHERN FIELDS.

While Panuco continued to lead in the number of completions and in new production during the year, the interest of the major companies was centered in the southern fields which produce Mexico's light gravity gasoline producing crude. The year saw a well of some 60,000 barrels completed in the Tepetate-Chinampa sector, which has occupied the center of the stage in that district for some time. Another well of 10,000 barrels was also completed in the same sector, but this was followed by no less than four tests that failed to develop pay, although two developed salt water in the same sector, but they were more to the west than the two pay completions. Drilling goes merrily on, however, with more favorable indications for some of the drilling tests.

The surprise of the year was furnished by a well in the Molino district, which is a tract lying just north of the Tuxpam River, its southern boundary being that stream. A well estimated at 40,000 barrels was drilled in there in the last month of the year, the oil testing 11.9 Baume. The volume of the production was no great surprise in this land of big wells, but the gravity, in that district, was; and there is considerable speculation as to the why and the wherefore of it.

At Panuco.—Panuco had its usual run of wells ranging from a few hundred barrels to as much as 20,000 barrels, all drilled in its proven limits, to speak generally. The feature of the pool was the bringing in during the spring of the year of a 2,500-barrel well in the Isleta, the latter sector of the pool being east of the town, a distance of several kilometers as the bird flies, and on the north bank of the Panuco River. This well marked no mean extension from major production in the direction noted. In the early fall another well was drilled in offsetting the 2,500-barrel producer, and the result was a 40,000-barrel affair. In the opposite direction from this extension, say west of Panuco, and also on the north bank of the Panuco River, in the sector known as West Magaubes, a producer worth probably 1,000 barrels was drilled in during the closing months of the year also. This sector has heretofore been distinguished for failures (oil showings in plenty in tests previously drilled, but never in sufficient volume to make them commercial producers), and this little well was a surprise. It emphasized the maxim that every well in Mexico is a wildcat.

Topila and miscellaneous.—The Tamboyoche sector of the Topila field close to the Panuco River furnished the only agreeable sensations in the Topila pool. Two wells of some 13,000 barrels each were drilled in here during the year. An offset to both of them that was about as close to the second big producer as the law would permit was good for 500 barrels. Two other offsets a little nearer the river were comparative failures. One being good for about 100 barrels, and the second had a 30-barrel showing. Some of Topila's old producers had to be throttled down, too, during the year in order to permit the oil to "head up" under back pressure.

The miscellaneous column is a distinct disappointment. The ubiquitous wildcatter was bravely in evidence at the commencement of the year, putting down tests in three States, but the only score made was a very small well at Lomas y Llanos, which is more valuable as a contribution to contemporary history than as a commercial producer of worth. This locality, it will be recalled, is on the north bank of the Panuco about 9 miles north of Panuco.

Despite the efforts of two companies during the year, the State of Tamaulipas is still in the nonproducing column. At Soto la Marina three wells were abandoned as dry holes during the year, which makes a total of four holes abandoned for the same cause in that district. These tests were carefully drilled, the deepest one being 4,000 feet. All of them were drilled over 3,000 feet. Farther south, near the village of La Dama, at a place called Sabino Gordo, another test was drilled, but the hole was abandoned at 3,278 feet, a duster.

In Vera Cruz, in the Hacienda of Santa Anna, southeast of Panuco and approximately south of Topila, the drill was sent to 3,016 feet in a test, but the shale stratum was so thick that it failed to penetrate it, and the test was abandoned a duster. At La Canoa, north of the Panuco River, and say north of Panuco about 9 miles, a test was drilled approximately 2,950 feet, where it developed a show of salt water and was abandoned. South of Tampico, some 3 kilometers from the borders of the Pueblo Veijo lagoon in the Guasima y San Lorenzo tract, a test was drilled 3,280 feet, but the shale was not penetrated, and the test was abandoned, a duster. South by east from Topila, about 25 miles, at a place called Los Esterillos, a test was drilled 3,707 feet without getting to the limestone, and it, too, was abandoned. Farther south at La Encinal, about a kilometer from an arm of the Laguna de Tamiahua, and north of the

Cucharra River, the drill was sent 3,653 feet in a test that failed to develop anything but shale, hence its being declared a failure.

In the State of San Luis Potosi, in what is generally termed the Valles district, although the operations are about 20 miles south of the railway station of that name, the drill was sent over 4,000 feet in two tests, and both were abandoned as dry holes.

As the year closed the field operations included 33 tests drilling, or with crews on the several scenes of operations ready to drill; 18 derricks were up, while 53 unfinished tests were standing, some of them having had this status for three years.

General review.—The most important transfer of petroleum property during the year was the sale to the Standard of New Jersey of the Transcontinental Petroleum Co., and the Vera Cruz Mexican Oil Syndicate (Ltd.), two promotions by the late Ricardo Mestres. In securing this property, the Standard came into possession of valuable production at Panuco, and a fine ocean terminal and tank farm at Tampico, river transportation, et cetera.

The only important decree of government gazetted during the year affecting the exploitation of petroleum was that dated April 13, effective May 1, doing away with the old blanket production tax of 60 centavos the ton, Mexican gold, and substituting a tax based on the market value of petroleum, and its gravity. This tax is 10 per centum, Mexican gold, on such market value, the valuations being revised by the department of hacienda and public credit every two months. Southern fields light gravity oil pays a higher tax than does Panuco and other heavy oils; and the tax affects only export oils, whether crude, topped, or refined, all petroleum destined for domestic use escaping the levy. Bunker oil for foreign-bound steamers comes under the provisions of this export tax.

The year just passed saw considerable impetus given pipe-line construction in the southern fields—that is, from the Tepetate-Chinampa district east toward tidewater at Port Lobos and north toward Tampico. The Texas Co.'s line from Tepetate east to Port Lobos was virtually laid as the year ended. The Cortez Oil Corporation continues work on its line between the same termini. Both of these lines are 10-inch, with water lines, etc. Mexican Gulf Oil Co. is making fast progress on its 8-inch line from Tepetate to Tampico and will probably complete it in the next 60 days. Cia. Metropolitana de Oleoductos (Island Oil & Transport) is rushing work on its 10-inch line, another transport artery from Tepetate east to Port Lobos.

From Panuco to Tampico, the East Coast Oil Co. has completed the last link in its 8-inch line and is awaiting the arrival of pumps already in transit for its intermediate pump station at Tamboyoche, near Topila. The Corona Petroleum Co. secured a concession from the Government during the year for a pipe line from Panuco to its Tampico terminals, and the present year will probably see it completed. National Petroleum Corporation, a Doherty interest, has also secured a concession and is moving material on the ground for a line from Panuco to El Barco, a point on the Panuco River, say 22 miles (by river) above Tampico, it being its intention to save most of the river haul and entirely escape shoals in the upper river with this line, barging its production from El Barco down to ocean terminals at Tampico.

The latter half of the year, field operations were hampered by the lack of oil-field supplies.

PRODUCTION.

The following statistics are reported by the Petroleum Bureau, Department of Industry and Labor, Mexico City:

Petroleum produced in Mexico, 1901–1917.

	Barrels.		Barrels.
1901	10,345	1910	3,634,080
1902	40,200	1911	12,552,798
1903	75,375	1912	16,558,215
1904	125,625	1913	25,696,291
1905	251,250	1914	26,235,403
1906	502,500	1915	32,910,508
1907	1,005,000	1916	40,545,712
1908	3,932,900	1917	55,292,770
1909	2,713,500		

IMPORTS.

Petroleum and petroleum products imported into Mexico from the United States, years ending June 30, 1914, 1915, 1916, and 1917.

	1914		1915		1916		1917	
	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.
Crude	14,900,388	$532,780	5,707,481	$216,656	12,050,278	$422,523	2,705,957	$113,003
Naphtha	45,446	4,112	81,615	7,702	181,145	23,161	224,827	27,103
Gasoline	267,744	48,055	475,840	63,521	955,795	184,904	614,793	147,173
Illuminating	971,355	153,108	1,763,624	198,816	1,357,976	162,661	506,273	66,896
Lubricating	791,556	186,134	797,894	182,201	681,388	163,825	637,389	163,396
Gas oil and fuel oil	1,447,858	39,715	586,139	14,621	7,311,221	198,895	21,611,633	824,108
Residuum	27,384	2,495	8,179	409	38,820	2,263	8,678	787
	18,451,731	966,399	9,420,772	683,926	22,576,623	1,158,232	26,309,550	1,342,466

Mineral oils imported into Mexico from the United States, years ending June 30, 1908–1917.

Year.	Crude.		Refined, including residuum.		Total.	
	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.
1908	17,523,440	$901,115	1,839,803	$320,235	19,363,243	$1,221,350
1909	27,554,581	1,184,398	1,979,093	306,579	29,533,674	1,490,977
1910	41,202,786	1,428,632	2,333,558	357,258	43,536,344	1,785,890
1911	24,398,337	814,298	2,895,876	349,787	27,294,213	1,164,085
1912	22,752,588	884,320	1,659,566	259,234	24,412,154	1,143,554
1913	16,138,930	590,098	2,299,247	335,290	18,438,177	925,388
1914	14,900,388	532,780	3,551,343	433,619	18,451,731	966,399
1915	5,707,481	216,656	3,713,291	467,270	9,420,772	683,926
1916	12,050,278	422,523	10,526,345	735,709	22,576,623	1,158,232
1917	2,705,957	113,003	23,603,593	1,229,463	26,309,550	1,342,466

WEST INDIES.

TRINIDAD.

GENERAL STATEMENT.

The year 1917 was one of marked progress in the development of the petroleum resources of Trinidad. The quantity of oil produced in that year was 1,599,455 barrels, a gain of about 671,000 barrels, or 72 per cent, over the output in 1916. As the primary factor tending to restrict the production of petroleum in Trinidad is the inability of the producers to market their product, the gain in output in 1917 may be ascribed chiefly to the increase in ocean tonnage available for the transport of the Trinidad product to the oil markets of the world.

On the Forest Reserve properties of the Trinidad Leaseholds (Ltd.) increased activity in drilling resulted in 1917 in the completion of several new oil wells, one of which, No. 23, struck oil in July at a depth of 1,540 feet and yielded some 15,000 barrels of oil in the first 28 hours following its completion. It then became choked with sand and ceased flowing, but was brought back with decreased output near the end of July, and continued producing at a diminishing rate until it again became choked with sand and ceased flowing in September.

On October 13 production was again restored and 20,000 barrels of oil were produced in 20 hours. At the end of that period the flow again ceased because of sand and to the end of 1917 was not again restored. A topping plant having a daily capacity of 300 tons of crude oil, erected by the Trinidad Leaseholds (Ltd.), at La Carriere, began operations in May. Arrangements were made by the same company for acquiring in 1918 the properties of the Trinidad Oil & Transport Co., comprising about 1,000 acres in the Barrackpore district with a settled production of about 3,000 tons of oil a month, and also a topping plant having a capacity of 130 tons of oil a day, with 49 acres of ground at Point-à-Pierre.

Increased activity in drilling resulted in appreciable gains in production of oil by the United British Oil-fields of Trinidad (Ltd.), the Trinidad Lake Petroleum Co. (Ltd.), and the Trinidad Central Oil Fields (Ltd.), the other leading producers of crude petroleum on the island.

PRODUCTION.

Petroleum produced in Trinidad, 1908–1917.

	Barrels.		Barrels.
1908	169	1913	503,616
1909	57,143	1914	643,533
1910	142,857	1915	[a] 750,000
1911	285,307	1916	928,581
1912	436,805	1917	1,599,455

CUBA.

As a consequence of the results obtained in the quest for petroleum in Cuba in 1917, that country attained for the first time a place among the world's oil producers. The marketed production of crude oil in Cuba in 1917 was 19,167 barrels, compared with negligible quantities, of scientific rather than commercial importance, in previous years.

The revival of interest in the petroleum resources of Cuba resulted from the completion in March by the Cuban Petroleum Co. (United States capital) of its well No. 1 near Bacuranao, about 15 miles northeast of Habana. The well was completed at a depth of 865 feet and under the pump was credited with a daily capacity of about 25 barrels of oil testing 28° Baumé gravity. This well was drilled in the immediate vicinity of the Guanabaco property of the Union Oil Co. of Cuba (United States capital) on which three wells previously drilled had yielded encouraging showings of oil and one, No. 4 on the property, completed in August, 1916, had been producing oil at the rate of 12 to 15 barrels a day for several months. On that property well No. 5 completed and shot in June proved to be the record producer completed during the year, its output settling after the shot to about 80 barrels of oil a day. The reported depth of that well was 1,016 feet.

One additional oil well, completed by the Republic Oil Co. in the Bacuranao district in 1917, was credited with a settled capacity of 12 barrels a day from a depth of 917 feet.

The oil in the Bacuranao district is reported to be obtained from crevices in serpentine rock near its contact with sedimentary strata under conditions somewhat analogous to the occurrence of petroleum

[a] Estimated.

in the Thrall oil field in Texas. The oil is dark in color, ranges in gravity from 25° to 27° Baumé, and yields when refined about 12 per cent of gasoline, 22 per cent of refined oils, and 62 per cent of fuel oil.

Though numerous tests were begun in 1917 in parts of Habana other than the Bacuranao district, and in Matanzas, Pinar del Rio, and Santa Clara, the Bacuranao district remained at the end of 1917 the only source of the commercial production of oil in Cuba.

A list of the petroleum companies operating or organized to operate in Cuba, revised to June, 1918, includes the following:

Antillian Oil Corp.
Bacuranao Oil Co.
Bacuranao Petroleum Co.
Bacuranao Oil & Gas Co.
Bacuranao Mining & Petroleum Co.
Benedum, Trees & Crawford.
Candelaria Oil Co.
Cárdenas & Sabanilla.
Chretland-New Havana Oil Co.
Cía. Minera de Jaruco.
Cienfuegos Petroleum Co.
Cuban-American Petroleum Co.
Cuban International Petroleum Co.
Cuban Standard Petroleum Co.
Eugenia Oil Co.
Guanabacoa Oil Co.
Pinar del Rio Mining Co.
Republic Oil Co.
San Francisco de Paula.
Sinclair-Cuban Oil Corp.
Triunfo Oil Co.
Union Oil Co. of Cuba.
U. S. Petroleum Co.
Wells, Howard & Whitely.

CENTRAL AMERICA.

COSTA RICA.

Geologic exploration and wildcat drilling were continued in Costa Rica in 1917 by the Costa Rica Oil Co., a subsidiary of the Sinclair-Central American Oil Corporation of New York, which holds concessions covering prospective oil lands in the Provinces of Limon, Guanacaste, and Puntarenas.

NICARAGUA.

Investigation by United States interests of the petroleum possibilities of Nicaragua is indicated by the reported signing in 1917 by President Emiliano Chamovro of a contract granting Lincoln G. Valentine, of the United States, the right to prospect the republic for oil. Ratification of the contract by the Nicaraguan Congress was pending at the end of 1917.

HONDURAS.

American interests are reported[1] to have secured a concession to explore a portion of Honduras for petroleum and considerable preliminary work is said to have been done already under the terms of the concession.

PANAMA.

Preliminary geologic surveys and test drilling were begun in 1917 in the Province of Bocas del Toro, Panama, by the Sinclair-Panama Oil Corporation, a subsidiary of the Sinclair-Central American Oil Corporation, of New York, under the terms of a concession granted by the Government of Panama.

[1] Commerce Repts. Suppl. 31 b, Sept. 17, 1917.

SOUTH AMERICA.

COLOMBIA.

Development work has continued in 1917 by the Tropical Oil Co. on its concessions at Barranca Bermeja, in the valley of the Magdalena about 420 miles above the mouth of that river, and was begun by the Carib Syndicate on its concessions near Villamizar, on the west flank of the Andes adjacent to the Venezuelan properties of the Colon Development Co.

Several efforts have been made at various times to develop oil in Colombia in commercial quantities but with little success to the end of 1917. Wells have been drilled near Puerto, near Barranquilla, and in the valley of Sinu River, but none have discovered oil in commercial quantities. Vigorous development of the areas of promising oil territory in the interior of Colombia will take place after the war.

VENEZUELA.

Development work was continued with good success in 1917 on the concession of the Caribbean Petroleum Co. and the Colon Development Co., in the region adjacent to Maracaibo, and was actively begun by the Compañía Anónima Minerales Petrolíferos Riopauji on its small concession, 30 miles east of Lake Maracaibo.

According to Consul Emil Sauer: [1]

The petroleum refinery erected by the Caribbean Petroleum Co. at San Lorenzo, on the east side of Lake Maracaibo, some 70 miles from the city of Maracaibo, started operations on August 18. The refinery has a daily capacity of about 2,000 barrels (of 42 gallons each).

Kerosene costs in the retail market of Maracaibo 2.80 bolivars, or 54 cents, per gallon, and gasoline, 3.50 bolivars, or 67½ cents, per gallon. The price of both will very likely go down when the products from the new refinery are put on the market here. Reduction in the prices of gasoline may be expected to affect favorably the market here for motor boats and automobiles, especially motor boats. Lack of improved roads, however, will continue to discourage importation of automobiles.

The crude petroleum at San Lorenzo is said to yield only 9 or 10 per cent kerosene and gasoline in the ratio of about 2 to 1, respectively. It is expected that a market will be found locally for the large percentage of fuel oil. Some of the sugar refineries have already made arrangements to burn fuel oil.

A refinery is being erected also at Curaçao by the Curaçao Petroleum Co., which plant is expected to be completed by the end of this year. The crude petroleum for this refinery will come from the Lake Maracaibo region. Pipe lines have been laid from the wells to Lake Maracaibo, and from there crude oil is carried in barges to Curacao, a trip of several days for the slow tugs. Two such tank barges, with a capacity of 600 tons each, are operating at present, and eight additional barges, with a capacity of 1,000 to 1,200 tons each, with the necessary tugs, will be procured by the time the refinery at Curaçao begins operations.

British interest in the petroleum resources of Venezuela resulted in 1917 in the organization of the Bolivar Concessions (1917) (Ltd.), with a capital of £200,000, for the development of what is known as the Buchivacoa concession comprising from 6,000,000 to 7,000,000 acres of prospective oil land in the State of Falcon, adjoining the properties of the Venezuelan Oil Concessions (Ltd.).

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[1] Commerce Repts., Oct. 4, 1917.

That the Venezuelan Government intends to administer its fuel resources is indicated by a resolution of the Minister of Fomento, issued November 27, 1917, which, according to American Minister Preston McGoodwin,[1] provides as follows:

> The Provisional President of the Republic directs that in conformance with article 3 of the law of mines the petroleum and coal mines in the States of Trujillo, Merida, and Zulia which are not already leased and which belong to no private parties or companies shall be administered henceforth by the Federal Executive.

In another resolution, dated November 28, announcement was made of the appointment of an administrator of mines for the district comprising the States of Zulia, Merida, and Trujillo, which includes all the known petroleum fields of Venezuela. At the end of 1917 legislation was being drafted providing for a Federal tax on gross production of petroleum.

BRITISH GUIANA.

Seventeen licenses to explore for mineral oil, and two permits for drilling on lands previously held under exploration licenses in British Guiana were issued by the Colonial Government in 1916.

BOLIVIA.

The essential provisions made by the Bolivian Government for control and development of the petroleum resources of Bolivia as set forth in legislation, effective December 12, 1916, are reported by the Mining Journal (London[2]) as follows:

> The claim license for three years is reduced to 2 centavos per hectare. The state claims 10 per cent of the gross product of all petroleum claims. From the date of this law all fresh concessions of petroleum deposits are prohibited, with the exception of those owned by the state. Mineral oils met with in the working of mines already granted will be the property of the state, except where the ownership of the said oils is excepted by the law which grants concessionaires entitled to minerals underlying their claims. The sums raised by claim license are allocated to the extension of the Sucre-Santa Cruz Railway.

PERU.

GENERAL STATEMENT.

Although the quantity of petroleum produced in Peru in 1917 fell a little short of the output in 1916, it was greater than the output of crude oil in Peru in any other year. The quantity produced in 1917 was 337,789 metric tons, or 2,533,417 barrels of 42 United States gallons each, and was less by 2,297 tons—17,228 barrels—or 0.7 per cent, than the production in 1916.

The decrease in 1917 is chargeable entirely to the Negritos and Lagunitos fields, the combined output of which was 1,771,560 barrels, compared with 1,822,733 barrels in 1916, the decrease being 51,173 barrels, or about 3 per cent of the output in 1916. At the end of 1917 there were 695 producing wells in these two fields, which are controlled by the International Petroleum Co. (Ltd.), of Toronto, Canada.

In the Lobitos field, which lies about 12 miles north of Talara and is controlled by the Lobitos Oilfields (Ltd.), of London, 14 oil wells

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[1] Commerce Repts., Oct. 4, 1917.
[2] Oil concessions in Bolivia: Min. Jour. (London), May 5, 1917.

were completed in 1917, as a consequence of which the production of the field was increased from 654,060 barrels in 1916 to 686,595 barrels in 1917, a gain of 32,535 barrels, or 5 per cent. At the end of 1917 there were 150 producing wells in the Lobitos field, compared with 143 at the end of 1916.

The Peruvian holdings of the Lobitos Oilfields (Ltd.) were increased slightly in 1917 by the acquisition of adjoining tracts, and the scope of that company's operations was enlarged by the acquisition of a considerable area of prospective oil land in Ecuador.

In the Zorritos district, which lies a few miles south of Tumbez, development work in 1917 resulted in a small increase in production of petroleum. The output in 1917 was 75,262 barrels, compared with 73,852 barrels in 1916, a gain of about 2 per cent. The Zorritos field is controlled by Fausto G. Piaggio, of Callao, and its output, after treatment in a local refinery, finds a ready market in the cities and towns along the west coast of South America.

Important legislation enacted in 1917 affecting the petroleum industry of Peru is described [1] as follows by Commercial Attaché William F. Montavon, of Lima:

The National Legislature of Peru, which convened in regular session for 1917 on July 28, 1917, has enacted a law, under date of August 4, establishing a progressive export tax on crude petroleum and petroleum products, such as lubricating oils, benzine, gasoline, kerosene, and other light distillates.

The petroleum-bearing lands at present under exploitation in Peru are located near the Pacific coast in the northern part of the country adjoining the Ecuadorian frontier. The largest producer is the International Petroleum Co. Sr. Piaggio, an Italian, ranks second, and there are several smaller producers.

The law just enacted provides that crude petroleum and the distilled products of petroleum shall become subject to the payment of an export tax whenever the quotation in New York for Pennsylvania crude oil reaches $1.20 per barrel of 42 gallons, which is equivalent to a quotation of $8.40 per metric ton. Article 2 of the law provides that the tax shall be $0.10 per metric ton on crude petroleum and residues and $0.15 per metric ton on distilled products when the New York quotation is $1.20 per barrel of Pennsylvania crude. For every $0.10 rise in the New York quotation per barrel of Pennsylvania crude there shall be a corresponding increase of $0.06 per metric ton in the tax on crude petroleum and residues, and of $0.09 per metric ton in the tax on refined petroleum products. For the purpose of the law all products reaching 38° or above in the Baumé scale are to be considered refined.

The law provides for the payment of the tax in United States dollars, in the form of bills on New York, which will be approved by the Junta de Vigilancia, an agency of the Department of the Treasury.

The requirement of the payment of the tax in bills on New York will create a new, though limited, demand for this class of commercial paper in Peru.

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[1] Commerce Repts., Aug. 30, 1917.

PRODUCTION.

Petroleum produced in Peru, 1908–1917, in barrels of 42 gallons each.

Year.	Lobitos.	Negritos.	Zorritos.	Lake Titicaca (Huancane).	Lagunitos.	Total.	
						Barrels.	Metric tons.[a]
1907	[b] 279,000	396,750	65,476	15,000	....	756,226	100,830
1908	319,898	543,750	71,429	[b] 76,103	....	1,011,180	134,824
1909	429,195	740,070	70,750	[b] 76,103	....	1,316,118	175,482
1910	400,080	773,025	107,000	[b] 50,000	....	1,330,105	177,347
1911	391,290	882,698	64,286	[b] 30,000	....	1,368,274	182,436
1912	587,048	1,071,000	78,095	[b] 15,000	....	1,751,143	233,486
1913	557,355	1,136,490	83,343	[b] 10,000	346,073	2,133,261	284,434
1914	504,743	1,032,210	88,136	[b] 10,000	282,713	1,917,802	255,707
1915	664,972	1,355,925	72,736	[b] 1,000	392,618	2,487,251	331,633
1916	654,060	[c] 1,822,733	73,852	....	([d])	2,550,645	340,086
1917	686,595	[c] 1,771,560	75,262	....	([d])	2,533,417	337,789

[a] One metric ton=7.5 barrels.
[b] Estimated.
[c] Includes Lagunitos.
[d] Included in Negritos.

Petroleum produced, shipped, and in stock and number of producing wells in Lobitos oil field, Peru, 1908–1917.

Year.	Production.		Shipments.	Stock Dec. 31.	Producing wells Jan. 1.
	Metric tons.	*Barrels.*	*Metric tons.*	*Metric tons.*	
1908	42,653	319,898	36,131	8,860	26
1909	57,226	429,195	54,289	11,797	62
1910	53,344	400,080	....	....	....
1911	52,172	391,290	....	....	92
1912	78,273	587,048	....	....	105
1913	74,314	557,355	....	....	110
1914	67,299	504,743	....	....	....
1915	88,613	664,972	....	....	119
1916	88,208	654,060	....	....	131
1917	91,546	686,595	....	....	143

Petroleum produced in Negritos oil field, Peru, 1908–1917.

Year.	Metric tons.	Barrels.	Year.	Metric tons.	Barrels.
1908	72,500	543,750	1913	151,532	1,136,490
1909	98,676	740,070	1914	137,628	1,032,210
1910	103,070	773,025	1915	180,790	1,355,925
1911	117,693	882,698	1916	[a] 243,031	1,822,733
1912	142,800	1,071,000	1917	[a] 236,208	1,771,560

[a] Includes Lagunitos field.

Petroleum produced in Zorritos oil field, Peru, 1908–1917, in gallons.

Year.	Crude.	Refined.[a]	Gasoline.	Benzine.	Year.	Crude.	Refined.[a]	Gasoline.	Benzine.
1908	3,000,000	500,000	150,000	30,000	1913	3,500,424	565,320	324,000	....
1909	2,971,510	469,610	96,520	....	1914	3,701,718	482,850	277,440	....
1910	4,494,000	....	....	....	1915	3,054,900	461,510	362,230	....
1911	2,700,000	650,000	....	200,000	1916	3,101,790	468,790	396,720	....
1912	3,280,000	476,620	226,440	....	1917	3,161,017	377,645	461,206	....

[a] Kerosene.

ARGENTINA.

GENERAL STATEMENT.

Continued development of the petroleum resources of Argentina resulted in 1917 in the establishment of a new record for the production of crude oil in that republic. The output in 1917 was 182,000 cubic meters, or 1,144,737 barrels of 42 United States gallons, and was greater by 347,817 barrels, or 44 per cent, than the output in 1916. This output was derived wholly from the Comodoro Rivadavia district in the Territory of Chubut, and practically all of it came, as in other years, from the Government reserve in that district. From the field, which is adjacent to tidewater, the oil is transported by tank steamers to Bahia Blanca and Buenos Aires, where it finds a ready market for fuel. At the end of 1917 there were 39 producing oil wells in Argentina, all in the Comodoro Rivadavia district.

PRODUCTION.

Petroleum produced in Argentina, 1908–1917.

Year.	Metric tons.	United States barrels.	Year.	Metric tons.	United States barrels.
1908	1,680	11,472	1913	19,050	130,618
1909	2,700	18,431	1914	40,530	275,500
1910	3,050	20,753	1915	75,900	516,120
1911	1,920	13,119	1916	116,000	796,920
1912	6,850	47,007	1917	166,871	1,144,737

EURASIA.

RUSSIA.

GENERAL STATEMENT.

Efforts to evaluate the meager and fragmental data available concerning conditions in the petroleum industry in Russia result in an estimate that the production of crude petroleum in that country in 1917 was about 575,000,000 poods or about 69,000,000 barrels of 42 United States gallons each. This output implies a loss of between 3,000,000 and 4,000,000 barrels compared with 1916, a loss that is remarkably small in consideration of the handicaps under which production was effected and the condition of political chaos existing in Russia throughout the year.

The insistent need for petroleum fuel in the interior of Russia augmented by the similar requirements of the Baltic provinces, resulting from the cessation of imports of coal from Great Britain, account largely for the fact that the production of petroleum showed no greater decline than that indicated. As it was, the decline can not be charged to lack of demand, which was most insistent throughout the year, but to the disorganization of facilities for the transport of oil from the fields in southeastern Russia to the distant centers of consumption, and to conditions in the oil fields themselves that resulted in an advance of the cost of producing oil beyond the return allowed for the production under the system of price fixation put into effect by the Russian Government about January 1, 1916.

Aside from the costly precautions necessary to protect their valuable properties from the depredations of the lawless bands of pillaging marauders that invaded the oil regions in the days succeeding the collapse of the Russian monarchy, oil operators in Russia in 1917 were forced to overcome more serious difficulties in the matters of shortage of drilling and refinery supplies, shortage, unrest, and extreme wage demands of labor, and increasing scarcity of available territory on which to drill new wells necessary to sustain production.

Official prices for crude oil in the Baku district ranged in ascending scale from 45 kopecks per pood (about $1.93 a barrel at ordinary rates of exchange), the price in effect January 1, 1917, to 96 kopecks per pood ($4.12 a barrel), the price in effect December 31 of that year.

Although the immediate future of the petroleum industry of Russia is so intimately involved in the outcome of the war as to prevent forecast at this time, its ultimate future is assuredly bright, for the resources of petroleum in Russia are enormous, and the demand for oil in Europe after the war is certain to be unprecedented. Of interest in connection with the possible trend of future development, the following abstract [1] of a report by the Russian Geological Committee is of especial interest:

The Russian Geological Committee has for some time been occupied with the question which of the new petroliferous districts are worth opening for exploitation and which should undergo further geological investigations. The following is an extract of the report on this subject.

The Apsheron Peninsula has exhaustively been investigated by the geologist D. W. Golubiatnikoff, who especially recommends the following districts:

Kanlinsk.—The geological structure of this district and the conditions under which petroleum and gas are deposited there connect it with the Surakhani district, and there is every reason to suppose that it is as rich in oil as the latter. Many exploration plots were formed in this district and were distributed to various enterprises, but no conclusive exploration works have as yet been there carried out with the exception of some drilling undertaken on plots belonging to Nobel Bros. and Benkendorf. A study of these drillings made by Mr. Golubiatnikoff has established the fact that a continuation of the Surankhani petroliferous strata will be found here at 600 feet.

Mountain Atashki.—This district was pointed out to the Mining Department in 1907, and the southern slope of it has been recognized as being of industrial importance. At present it is exploited by means of thousands of hand-dug wells. Drilling there in 1914 has resulted in considerable spouting.

Kirmaki.—The eastern and southern parts of this district are worthy of careful attention and drilling there will undoubtedly prove the importance of the Kirmaki suite of strata forming the lower part of the productive thickness. According to Mr. Golubiatnikoff, there are there 52 oil-containing strata. The same lower branch of the productive thickness is also located at Fatmagi, where it is successfully exploited by way of hundreds of hand-dug wells, but where no drilling has as yet been undertaken. This applies also to Novkhani, where exploration drilling is highly desirable. Petroliferous strata belonging to the same lower branch of the productive thickness are to be found at Khurdalak, Gekmali, and Kobi, where there is but hand-dug production and where drilling would be desirable.

Puto.—The conditions here are very favorable, especially near the station Puto. A great number of petroliferous strata belonging to the above lower branch of the productive thickness will be found here.

Isle Sviatoi.—A considerable increase in the present production may be effected here by way of bringing under exploitation the plots explored by Nobel Bros. But there are also there many other oil outbreaks well worthy of further investigation, and this also applies to the district Miatli-Nap-Kutan, situated on the River Sulaku, where oil is now obtained by means of shallow hand-dug wells and where some small drilling has already taken place.

[1] Examination of petroliferous areas: Oil and Gas Journal, vol. 16, No. 1, p. 36, June 7, 1917.

On the Gudermess Ridge, in the locality Istis, there are considerable outbreaks of petroleum and of hot water, and to the northwest from Gudermess, along the Vladikavkaz Railway, on the northern slope of the Karakh Ridge, there are many petroleum sources and kir formations, and large quantities of petroleum were there obtained from shallow depths.

The Sunja Ridge there includes the petroliferous areas Mikhailovsk, Slevzovsk, and Karabulak, in all of which there are very numerous outbreaks of petroleum and kir formations, but in view of deficient geological investigations it is yet difficult to decide on the industrial importance of this district.

Terski Ridge, and especially the Vosnesensk district, contains many petroliferous formations, the high value of which will be proved by deep drilling. In the old and new Grosny areas inundation of the petroliferous strata, owing to unsatisfactory shut-off of wells, is becoming of a more threatening nature.

In the Kuban Province petroleum outbreaks are encountered along a long stretch of hilly ground at the foot of the northeastern slope of the Caucasian Ridge, beginning from the Kertch Strait through the Taman Peninsula and down to the River Pshekha in the Maikop district. Along all this considerable stretch of petroliferous ground there are as yet only two districts industrially developed, namely, the Maikop deposit (including Neftianaia-Shirvanskaia Khodijinsk) and the Krimsk district (including Kudaki). In Ilsk and Anapa, the production is as yet very small and far from being on an industrial scale. Also at Kalujski, oil is not exploited as yet, although ascertained in commercial quantities. There are also undoubtful prospects for considerable extensions in all the above districts.

There are many unexplored petroliferous areas in the Anapa district and on the Taman Peninsula, both being very favorably situated geographically. Especially interesting are the petroleum outbreaks near the locality Blagovestchensk and on the River Utata and also the Kapustin Ravine, where light oil is now obtained from a depth of 70 to 100 feet and where periodical spouting was obtained in 1915.

The petroliferous petroleum deposits in the Ferghana district have been fairly well geologically investigated into by way of drilling, and the results obtained by the geologist K. P. Kalizki do not speak favorably for this district. The production there now amounts to but 2,000,000 poods a year, half of which is obtained by the Santo Co. at Sel-Rokho and half by the Tchimion Co.

The geological investigations already carried out by the Geological Committee on the above areas have already resulted in sufficient data of great use and in favor of a further development of drilling there. Still further systematic observation is necessary in order to point out new directions in which this highly important Russian industry can be extended and developed in the very near future.

PRODUCTION.

Petroleum produced in Russia, 1907–1917.

Year.	Baku.		Grosny.		Maikop.	
	Poods.[a]	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.
1907	476,002,000	57,143,097	39,214,612	4,707,637		
1908	465,954,221	55,936,880	52,058,895	6,249,567		
1909	492,500,000	59,123,650	57,033,015	6,846,700		
1910	508,456,121	61,039,149	74,048,358	8,889,359	1,304,800	156,640
1911	454,206,853	54,526,633	75,189,591	9,026,361	7,933,936	952,453
1912	473,200,000	56,806,723	65,400,000	7,851,140	9,200,000	1,104,442
1913	404,538,000	48,563,985	73,659,265	8,842,649	4,802,926	576,582
1914	412,246,851	49,489,418	98,445,187	11,818,150	3,956,906	475,019
1915	431,139,305	51,757,419	88,159,052	10,583,320	7,582,000	910,204
1916 [b]	464,902,000	55,810,564	102,731,246	12,332,683	2,000,000	240,096
1917 [c]	413,000,000	49,560,000	123,000,000	14,760,000	([d])	([d])

[a] 61.05 poods=1 metric ton crude; 8.33 poods crude=1 United States barrel of 42 gallons; 8 poods illuminating oil=1 United States barrel of 42 gallons; 8.18 poods lubricating oil=1 United States barrel of 42 gallons; 9 poods residuum=1 United States barrel of 42 gallons; 7.50 poods naphtha=1 United States barrel of 42 gallons; 8.3775 poods other products=1 United States barrel of 42 gallons, estimated; 1 pood=36.112 pounds; 1 kopeck=0.515 cents.

[b] Estimated in part.

[c] Estimated.

[d] Included in other.

Petroleum produced in Russia, 1907–1917—Continued.

Year.	Emba.		Other.		Total.	
	Poods.	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.
1907					515,216,612	61,850,734
1908					518,013,116	62,186,447
1909					549,533,015	65,970,350
1910			*a* 2,094,381	251,426	585,903,660	70,336,574
1911			*b* 13,979,771	1,678,244	551,310,151	66,183,691
1912			*c* 18,800,000	2,256,903	566,600,000	68,019,208
1913	7,182,000	862,184	*d* 33,228,000	3,988,956	523,410,191	62,834,356
1914	16,675,000	2,001,801	26,957,000	3,236,134	558,280,944	67,020,522
1915	16,632,000	1,996,639	27,493,000	3,300,480	571,005,357	68,548,062
1916 *e*	15,200,000	1,824,730	21,600,000	2,593,037	606,433,246	72,801,110
1917 *f*	15,000,000	1,800,000	16,000,000	1,920,000	575,000,000	69,000,000

a Includes as follows: Sviatoi, 1,392,306 poods; Ferghana, 610,500 poods, and Taman, 91,575 poods.
b Includes as follows: Sviatoi, 2,515,363 poods; Tcheleken, 10,205,740 poods; and Ferghana, 610,500 poods; other districts, 648,158 poods.
c Includes as follows: Sviatoi, 3,300,000 poods; Tcheleken, 13,300,000 poods; and Ferghana, 2,200,000 poods.
d Includes as follows: Sviatoi, 4,733,000 poods; Balakhani, 13,860,000 poods; Berekei, 6,000,000 poods- Ferghana, 1,406,000 poods; and Tcheleken, 7,229,000 poods.
e Estimated in part.
f Estimated.

Petroleum produced from pumping and flowing wells in Russia in 1916 and 1917.

District.	1916 *a*		1917 *b*	
	Barrels.	Poods.	Barrels.	Poods.
Apsheron Peninsula or Baku:				
Balakhani	10,204,082	85,000,000		
Sabunchi	12,004,802	100,000,000	33,000,000	275,000,000
Romani	6,962,785	58,000,000		
Bibi-Eibat	10,768,307	89,700,000		
Binagadi	4,141,056	34,495,000	3,360,000	28,000,000
Surakany	11,729,532	97,707,000	13,200,000	110,000,000
	55,810,564	464,902,000	49,560,000	413,000,000
Grosny	12,332,683	102,731,246	14,760,000	123,000,000
Emba	1,824,730	15,200,000	1,800,000	15,000,000
Sviatoi	840,336	7,000,000	960,000	8,000,000
Maikop	240,096	2,000,000		
Ferghana	240,096	2,000,000		
Tcheleken	360,144	3,000,000	1,920,000	16,000,000
Balakany (hand wells)	1,152,461	9,600,000		
Schubany (hand wells)				
Grand total	72,801,110	606,433,246	69,000,000	575,000,000

a Estimated in part. *b* Estimated.

GALICIA.

GENERAL STATEMENT.

Such statistics as are available from neutral sources indicate that the output of petroleum from the Galician fields in 1917, amounting to some 829,629 metric tons, or 5,965,447 barrels, was less by about 8 per cent than the output in 1916. This decrease is accounted for in part by the natural reaction of the fields following their forced development in 1916 as the only source of urgently needed supplies of petroleum then available to the Central Powers and in part by the lessened activity in development resulting from a diversion of much of the drilling equipment and drilling supplies available to the Central Powers to the Rumanian fields, in which it was thought the results of their use would be more satisfactory.

Prices of crude oil in Galicia ranged from 14 kronen to 23 kronen per 100 kilos ($4.00 to $6.50 a barrel, at normal rates of exchange) for oil requisitioned by the Austrian Government, to as high as 46 kronen per 100 kilos, ($13.00 a barrel) for oil sold in the open market, the average for oil of the latter class being at the rate of about 40 kronen per 100 kilos, or roughly $11.25 a barrel. Between 50 and 60 per cent of the production is understood to have been requisitioned by the Austrian Government for refining at the Government refineries at Drohobycz and Limanowa.

PRODUCTION.

Petroleum produced in Galicia, 1913–1917, in metric tons.[a]

Field.	1913	1914	1915	1916	1917
East Galicia:					
Tustanowice	691,382	[b] 356,447		483,840	403,212
Boryslaw	205,904	[b] 116,613		254,095	247,926
Schodnica				....	....
Urycz				....	....
Mraznica				32,172	51,929
Other fields				....	6,562
West Galicia:			578,388		
Potok					
Rogi	190,000	....			
Rowne					
Krosno				128,563	[c] 120,000
Tarnawa-Wielopole-Zagorz					
Kobylanka, Kyrg, Zalawie, Lipinki, Libusza, etc					
	1,087,286	[b] 700,000	578,388	898,670	829,629

[a] 1 metric ton=7.1905 barrels of crude petroleum of 42 gallons=2,204.62 pounds.
[b] Figures for first six months only.
[c] Estimated.

Petroleum produced in Galicia, 1908–1917.

Year.	Metric centners.[a]	Barrels of 42 gallons.	Year.	Metric centners.[a]	Barrels of 42 gallons.
1908	17,540,220	12,612,295	1913	10,872,860	7,818,130
1909	20,767,400	14,932,799	1914	[b] 7,000,000	5,033,350
1910	17,625,600	12,673,688	1915	5,783,880	4,158,899
1911	14,629,400	10,519,270	1916	8,986,700	6,461,706
1912	11,870,070	8,535,174	1917	8,296,290	5,965,447

[a] 1 metric centner or quintal=100 kilograms (220.462 pounds); 1 metric centner or quintal of crude petroleum=0.71905 barrel of 42 gallons.
[b] Estimated.

RUMANIA.

GENERAL STATEMENT.

As anticipated in the report of this series for 1916, the urgent need by the Central Powers for petroleum and its products led in 1917 to the adoption of prompt and energetic measures designed to repair as far as practicable the damage done to the Rumanian oil fields prior to their invasion near the end of 1916 by the Teutonic armies, and to retrieve as fast as possible the interrupted production of those fields.

As the work of destruction so ably carried out by Col. Griffiths in the closing days of November, 1916, consisted in effectively plugging the wells and wrecking all surface equipment, rather than in the irreparable ruin of the productive capacity of the fields, the task of the Germans on occupying the devastated fields was one that required only patience and skill.

The methods adopted and the results accomplished by the Imperial Royal Oil Kommando and his staff of technically trained assistants, made up of German soldiers, Rumanian oil-field workers, and prisoners of war, in seeking to rehabilitate the Rumanian fields are described by Ranisteano [1] as follows:

The uncorking of the wells was at first considered hopeless by the specialists, but after unremitting labor the results have been unexpectedly satisfactory. The majority of the borings were plugged by throwing into them pieces of iron, iron pipes jammed into fantastic shapes, chains and rope, pieces of wood, stones, etc., and when clogged far down the well was filled with other material.

The question arose how to remove this débris and the pieces of metal which had been plugged and jammed into the casing at depths ranging from 300 to 600 meters. Special fishing tools had to be constructed to grasp these uneven pieces and remove them from the pipes. It was necessary to make special paraffin impressions in the depths of the wells in order to get an idea of the forms assumed by the obstructions and then make the necessary fishing claws, etc. This once done, the plugs were removed piece by piece and pumps were again put into play. It took from a week to a month each to unload these varied accumulations from the wells, with some particularly difficult jobs lasting even longer. It was, indeed, slow and difficult work.

The first well thus uncorked was wide open again on February 12, the work having been begun on February 6. As a rule the work became effective quickly, so that from the start the production has been on an ascending line. Although the former production will not be reached for a long period the revival of the Rumanian oil industry is already supplying the Germans with quantities of oil products which bring sorely needed help to the German war administration. Satisfactory increases in production are to be expected in the near future. * * *

It is learned from reliable sources that in April of this year (1917) the Rumanian oil companies organized with neutral capital were allowed to begin the restoration work necessary to place their plants upon a producing basis again, and that the military administration of Rumania rendered considerable assistance in aiding the work of cleaning out the wells. The Astra-Romana Co. was asked especially to start work on their producing wells at Moreni, and much of the preparatory effort has been accomplished. * * *

Reports received from Rumania as late as May, 1917, indicate that the situation in the oil fields at that time shows a substantial improvement over that cited in information obtained up to that time, and that quite a number of wells could be unloaded of their débris and plugs, with a resulting increase in production. This new production, however, would not amount to more than one-tenth part of the normal output of the fields prior to the war. * * *

Continued progress in field development and reestablishment is shown in reports from Rumanian petroleum centers received in June, and the change there is shown to have effected decidedly advantageous results. The production nearly doubled in the last ten days of June, owing to the bringing in of a "gusher" by the Steaua Romana Co. This company's production following the bringing in of this well amounted to four-fifths of the total output of the Rumanian fields at that time.

Developments subsequent to June included continued progress in the opening of plugged wells and in the completion of new wells in the shallow-sand districts with such success that at the end of the year the output of petroleum was estimated to have attained a rate of 2,000 to 2,500 tons a day or nearly 50 per cent of the average daily output in 1915 and in the first half of 1916.

[1] Ranisteano, J., Bringing back the Rumanian oil field after British "demolition": Oil, Paint, and Drug Reporter (New York) vol. 92, No. 9, p. 16, Aug. 27, 1917.

PRODUCTION.

Petroleum produced in Rumania in 1915, 1916, and 1917, in metric tons.[a]

Month.	Prahova.					Dambovitza.	Buzeu.	Bacau.	Total.
	Buste-nari-Calinet-Bordeni.	Campina Poiana.	Moreni.	Other.	Total.				
1915.									
January	24,148	10,909	81,072	33,489	149,618	8,232	7,548	3,413	168,811
February	22,555	10,186	59,248	27,019	119,008	8,557	7,415	3,306	138,286
March	23,806	11,132	80,981	29,034	144,953	9,691	5,462	2,302	162,408
April	25,074	10,795	68,147	31,295	135,311	8,182	5,462	1,761	150,716
May	25,498	11,172	68,681	26,997	132,348	8,673	6,914	1,773	149,738
June	24,624	10,541	58,529	20,973	114,667	8,995	10,999	1,944	136,605
July	24,557	10,639	57,470	18,083	110,749	8,797	12,557	2,354	134,457
August	22,949	10,884	53,335	18,272	105,440	7,449	13,517	2,402	128,808
September	22,294	9,524	56,601	18,293	106,712	7,290	12,354	2,498	128,854
October	24,609	9,370	56,299	21,462	111,740	9,160	11,584	2,519	135,003
November	23,454	9,252	47,940	24,079	104,725	8,432	10,407	2,605	126,169
December	22,467	6,253	52,860	14,441	96,021	7,366	7,819	2,054	113,290
	286,035	120,657	741,163	283,437	1,431,292	100,824	112,098	28,931	1,673,145
1916.									
January	14,597	8,751	60,185	24,479	108,012	7,119	11,790	2,664	129,585
February	13,912	8,245	59,561	20,553	102,271	5,955	9,980	2,707	120,913
March	14,306	8,376	63,523	24,781	110,986	5,850	11,131	2,724	130,961
April	12,860	7,862	57,201	20,994	108,917	6,044	8,916	2,488	126,365
May	13,218	8,538	53,320	55,551	130,727	7,685	9,404	2,467	150,283
June	13,210	8,568	47,042	50,168	118,988	10,491	9,548	2,510	141,537
July	12,964	8,898	58,542	25,592	105,996	13,026	10,878	2,752	132,652
August	....	....	....	....	....	....	....	....	[b] 125,000
September	....	....	....	....	....	....	....	....	[b] 125,000
October	....	....	....	....	....	....	....	....	[b] 125,000
November	....	....	....	....	....	....	....	....	[b] 125,000
December	....	....	....	....	....	....	....	....	....
	....	....	....	....	....	....	....	....	1,432,296
1917	....	....	....	....	....	....	....	....	[b] 373,000

[a] 1 metric ton=7.19 barrels of 42 gallons. [b] Estimated.

BRITISH ISLES.

Although petroleum as such has never been proved to exist in commercial quantities in Great Britain the possibilities of such occurrence have long been the source of much profound speculation which in 1917 was carried into Parliament through the instrumentality of a bill known as the Petroleum (production) bill, introduced in the House of Commons by Hon. Walter Long on August 25. The declared object of the bill according to the Mining Journal (London), as quoted [1] by the Engineering and Mining Journal (New York) is to "vest all petroleum in the Government." As abstracted by the London Journal, the bill

places in the hands of the Government all rights to "get" petroleum and to lease and define petroliferous areas; it provides for the payment of oil obtained within the defined zone by fixed royalties. It also prescribes the terms and conditions under which operators must work in accordance with schemes to be fixed by the Board of Trade, and sets up the machinery necessary for the purpose. During the war, work must be done under the defense of the realm act. After the war the acquisition of surface on which to drill or to erect works may be made under those provisions, by private bill, or by provisional order.

[1] Oil legislation in Great Britain: Eng. and Min. Jour., Oct. 6, 1917.

According to the Petroleum World[1] (London),

The bill was for all practical purposes wrecked by a majority of 9 in the House of Commons Committee division in which only 79 members voted, the question being the trival one of a payment of a royalty of 9d. a ton to landlords on all oil produced.

Following the introduction of this bill renewed interest was taken in the possibilities of petroleum development in England and before the end of the year tentative plans for settling the question once and for all with the drill were under consideration by a number of private interests.

Scotland.—Despite the continuation of abnormal working conditions and of substantial advances in the costs both of mining and of plant operation, the year 1917 was a successful one for the shale-oil industry of Scotland by reason of the fact that the products of that industry, which are in great demand, commanded higher prices than in 1916.

During the year negotiations between the boards of the several Scottish shale-oil companies resulted in the formation of a central agency for the sale and distribution of the products of all the companies. This agency known as the Scottish Oil Agency Co. (Ltd.) is registered in Scotland, with a capital of £100,000, shares having a par value of £1 each.

In consideration of the increasing interest in the oil-shale resources of the United States the following discussion,[2] by Vice Consul T. H. Bevan, of Glasgow, of the Scottish shale oil industry is particularly timely:

Oil shale exists in many parts of the world but has been profitably worked only in Scotland, where it is found in practically unlimited quantities. The Scottish shale industry is located chiefly in a belt of territory about 6 miles broad which stretches from Dalmeny and Abercorn on the southern shore of the Firth of Forth southward across a tract of land between the Almond River and the Bathgate Hills, as far as Tarbrax in the County of Lanark. Throughout this region there are various important mining centers, such as Broxburn, Uphall, East Calder, Mid Calder, West Calder, and Addiewell, with large populations which are mainly, if not wholly, dependent on this branch of production for their support.

Changes during period of development.—The rapid development of this industry within the last 40 years is strikingly exemplified by the fact that when this section was first mapped by the Geological Survey in 1857 not one of the existing oil-shale fields was being worked.

Originally there were many small companies, which were interested mainly in the manufacture of burning oil. As the American competition became keener, the smaller manufacturers tended to decrease in number and the larger ones to increase in size, thus concentrating and cheapening production. Retorts were improved to suit the circumstances, and to yield a purer oil, with a large production of heavy products. Mechanical labor-saving arrangements were devised, refining was improved and cheapened, and economies of every kind were introduced. The chemicals used in refining were recovered, and the tars separated by them, the removal of which had involved expense, now are a source of profit as fuel. It is possible, therefore, for the Scotch producers to compete with foreign producers on a profitable basis.

Physical characteristics of oil shale.—The Scotch oil-bearing shale is a fine black or brownish clay shale with certain special features which enable it to be easily distinguished in the field. Among Scottish miners it is termed "shale," and the stratified rock described by geologists as "carbonaceous shale" is distinguished as "blaes," from the bluish color which it often assumes, especially when decomposed into clay.

These two types are readily recognized, but bituminous blaes may graduate into regular oil shale in such a way that it is impossible sometimes to draw a dividing line between them. Bituminous blaes, if fairly rich in ammonia and volatile hydrocarbons, may pass for shale if a practical test proves it to be workable for oil and ammonia on a profitable scale. As a general rule, good oil shale can be distinguished

[1] Delay in home production: Petroleum World, vol. 15, No. 208, p. 6, January, 1918.
[2] Conditions in the Scotch oil-shale industry: Commerce Repts., Dec. 12, 1917.

by its brown streak, toughness, and resistance to disintegration by the weather. Ordinary dark blaes is far heavier, brittle, and often gritty, and when exposed to the air cracks and crumbles into fragments which ultimately revert to their original condition of clay or mud. Oil shale, on the other hand, resembles hard dark wood or dry leather, and its quality in the field is measured by the degree of facility with which it can be cut and curled up with the edge of a sharp knife. It is free from grittiness, and is often flexible as well as tough.

Products of the shale.—The raw material is bituminous shale, which, after being broken up by machines of special construction and subjected to destructive distillation in retorts, gives crude oil, ammonia water, and gas used as fuel. The crude oil is refined by repeated distillations and treatments with chemicals, and the marketable products are:

Shale spirit or naphtha, with specific gravity from 0.66 to 0.75 at 60° F. (15.5° C.); oils too volatile for safety in domestic illumination and used chiefly as solvents and for motor spirit.

Burning or lamp oils, specific gravity 0.77 to 0.83, the average being about 0.80; used for lamps and internal-combustion engines.

Gas or intermediate oils, specific gravity 0.84 to 0.865, with properties intermediate between those of the burning and lubricating oils, and used for gas making, gas enriching, fuel for the Navy, internal-combustion engines, and for cleaning purposes.

Lubricating oils, specific gravity 0.865 to 0.895, of high boiling point and viscosity, used for lubricating machinery.

Solid paraffin, melting point from 100° to 130° F. (38° to 54° C.), used for candle making and other purposes.

Still coke, still grease, etc.

Still gases used for illuminating the neighboring villages.

Sulphate of ammonia, obtained from the ammonia water.

Statistics of the industry.—The following estimates show the extent of the oil-shale industry in Scotland: Shale distilled in 1916, 3,500,000 tons; crude oil produced, 300,000 tons, or 80,500,000 gallons; marketable products in gallons—motor spirit, 660,000; naphtha, 4,840,000; burning oil, 22,000,000; gas or fuel oils, 13,100,000; lubricating oils, 11,000,000; paraffin wax, 27,500; sulphate of ammonia, 59,400.

At present only four companies are producing refined products, and two producing crude oil. They employ about 5,946 miners and 5,054 men in the refineries. The industry has practically been at a standstill since 1910, when 3,130,280 tons of shale were distilled, as compared with about 3,500,000 tons during 1916.

The quantities of shale and products for years ending important periods in the history of the industry were:

Products.	1871 (51 works).	1879 (18 works).	1887 (13 works).	1893 (13 works).	1916 (6 works).
Shale ... tons	800,000	850,000	1,869,300	1,947,842	3,500,000
Crude oil ... gallons	25,000,000	29,000,000	52,876,700	48,696,050	80,500,000
Naphtha, burning, and gas oil ... do	11,250,000	11,400,000	21,680,000	20,452,341	39,940,000
Lubricating oil ... do	2,500,000	5,000,000	9,000,000	8,765,289	11,000,000
Paraffin, solid ... tons	5,800	9,200	22,846	19,130	27,500
Sulphate of ammonia ... do	2,350	4,750	18,483	28,000	59,400

The respective prices of the various products in the years 1873, 1883, 1893, 1903, 1910, 1912, and 1917 were as follows: Burning oil, per gallon, 34, 12, 10, 12, 10, 16, and 36 cents; heavy oil, per ton, \$97.33, \$46.22, \$24.33, \$29.19, \$26.76, \$29.19, and \$141.12; refined paraffin, per pound, 20, 8, 10, 6, 4, 4, and 13 cents; ammonium sulphate, per ton, \$97.33, \$82.73, \$48.66, \$60.82, \$62.04, \$66.91, and \$74.20; crude paraffin scale, per pound, 10 cents in 1873, and 5 cents in 1893.

Oil shale produced in Great Britain, 1908–1917.

Year.	England.		Scotland.		Wales.		Total.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1908	....	....	2,892,039	\$3,870,118	....	....	2,892,039	\$3,870,118
1909	40	\$34	2,967,017	3,970,723	....	....	2,967,057	3,970,757
1910	....	....	3,130,280	4,189,114	....	....	3,130,280	4,189,114
1911	....	....	3,116,803	4,171,174	....	....	3,116,803	4,171,174
1912	....	....	3,184,826	3,726,425	....	....	3,184,826	3,726,425
1913	....	....	3,279,903	4,001,839	240	\$341	3,280.143	4,002,180
1914	....	....	3,268,435	4,074,190	231	282	3,268,666	4,074,472
1915	5,976	6,779	2,992,676	4,064,501	....	....	2,998,652	4,071,280
1916	....	....	....	....	....	....	2,994,386	....
1917	....	....	....	....	....	....	3,113,003	....

ITALY.

Conditions in the petroleum industry of Italy are described [1] as follows:

The prevalent opinion that Italy is a country poorly endowed with petroleum is to-day contradicted by a number of natural phenomena which indicate the existence of the valuable liquid in numerous localities: Parma, Piacenza, Tuscany, Bologna, Rome, Calabria, Catania, Palermo, the Lipari Islands, etc. It is generally admitted that only America, Russia, Galicia, and Roumania are favored with petroleum fields which can be readily developed and that the world-wide invasion of American petroleum has retarded petroleum development in Italy. Some few trial borings made by companies in the country failed because of the lack of capital or for want of experts to carry it on; only a few enterprises have survived. Deposits at Montechio, Velviano, and Giovanni Incarico were exploited with some degree of success from 1890 to 1914, and production that is satisfactory considering the small number of wells involved is still obtained in those localities. In this industry the war has resulted in a gratifying renewal of interest.

Among the companies operating at the present time may be mentioned the Petroli d'Italia, the greater part of whose capital is under French control, and the Petrolifera Italiana, whose capital is exclusively Italian. There is some talk of the organization of another company under the name of Petroleo Italiano, for the purpose of exploiting the deposits at Rivanazzano, in the Province of Voghera, where there is evidence of the existence of petroleum of a superior quality.

The Società Petroli d'Italia was founded in 1906 with a capital of 15,000,000 lire, which was decreased to 6,000,000 lire in 1911 because of the reduction of the import tariff on refined petroleum. Its concessions are at Velleia and Montechio. Since their acquisition it has rented another concession in Montechio, and it also owns a refinery in Fiorenzuola d'Arda, in the Province of Piacenza. It produces annually some 8,000 metric tons of crude petroleum, 4,318 tons of illuminating oil, and 3,900 tons of gasoline. It employs 2,000 agents. The results obtained are remarkable in consideration of the fact that the rate of production in 1894 was scarcely 12 tons a year.

The Società Petrolifera Italiana controls the deposits at Neviado dei Rossi, Marzolara, and Castellichio and produces only 316 tons with 200 workmen and a capital of 500,000 lire. It seems that it is necessary to invest great sums of money in these petroleum enterprises.

The following statistics are taken from the Rivista del Servizio minerario:

Petroleum produced in Italy, 1908–1917.

Year.	Number of wells in operation.	Quantity.		Value.	
		Metric tons.[a]	Barrels of 42 gallons.	Lire.[b]	Dollars.
1908	14	7,088	50,966	1,415,640	273,219
1909	12	5,895	42,388	1,178,660	227,481
1910	9	7,069	50,830	1,413,800	272,863
1911	9	10,390	74,709	1,454,600	280,737
1912	9	7,479	53,778	1,196,640	230,952
1913	9	6,564	47,198	1,641,000	316,713
1914	7	5,542	39,849	1,385,500	267,402
1915	7	6,105	43,898	1,712,700	330,551
1916	7	7,035	50,585		
1917[c]	7	7,000	50,334		

[a] 1 Metric ton, crude=7.1905 barrels. [b] 1 lira=$0.193. [c] Estimated.

SWITZERLAND.

Application was made to the Swiss Council of State in 1917 by Sulzer Bros., of Winterthur, for permission to exploit an area in which indications of petroleum are reported to have been found

[1] La production du pétrole en Italie: Journal du pétrole, vol. 17, No. 10, p. 5, October, 1917. (Translated by Miss I. M. Patnoe, U. S. Geological Survey.)

south of Aar River on the border between the cantons of Aargau and Solothurn.

GERMANY.

No statistics relating to the production of crude petroleum in Alsace-Lorraine and in Hanover have been forthcoming from Germany in the last five years. Although the minor oil fields in those States have doubtless been worked to capacity since 1914, their capabilities of response to intensive development are not believed to be such as to warrant an estimate of increased production.

Petroleum produced in the German Empire, 1908–1917.

Year.	Alsace-Lorraine.	Prussia.	Total.		Total value.	
	Metric tons.	*Metric tons.*	*Metric tons.*	*Barrels (42 gallons).*	*Marks.*	*Dollars.*
1908	a 28,898	113,002	141,900	1,009,278	9,942,000	2,366,196
1909	a 29,726	113,518	143,244	1,018,837	10,118,000	2,408,084
1910			145,168	1,032,522	10,146,000	2,414,748
1911			142,992	1,017,045	10,045,000	2,390,710
1912			144,961	1,031,050	10,190,000	2,425,220
1913 b			140,000	995,764	9,790,285	2,330,088
1914 b			140,000	995,764	9,790,285	2,330,088
1915 b			140,000	995,764	9,790,285	2,330,088
1916 b			140,000	995,764	9,790,285	2,330,088
1917 b			140,000	995,764	9,790,285	2,330,088

a Includes Bavaria. b Estimated.

1 metric ton, crude=7.1126 barrels.

PERSIA.

Concerning the substantial progress made by the petroleum industry of Persia, Nutting[1] writes:

Continued progress is being made by the oil-producing industry of Persia. Contracts have been obtained by the Anglo-Persian Oil Co. for 12,000,000 to 15,000,000 tons of fuel oil and other products. The concern thus has a certainty of profits for some years, regardless of the prices at which it disposes of its gasoline and kerosene. The Government of India has decided after experiments with oil to utilize it to a large extent in place of coal on the railroads in its western section. This will result in a saving of tonnage, as oil is said to be twice as effective as coal for locomotives, while time will be saved, inasmuch as the period of transit from the Persian Gulf to the west coast of India is only 15 days, as against 30 days occupied in carrying coal from Bengal. It is understood that similar action is probable on the Mesopotamian railroads.

The purchase by this company of the shares of the German concerns known as British Petroleum Co., Homelight Oil Co., and Petroleum Steamship Co., recently made, will eventually prove valuable. The first two are distributing companies, and in the sale of the gasoline and kerosene products of the company the proportion of profits which otherwise would go to intermediaries will be saved.

The present production of gasoline by the Anglo-Persian Oil Co. reaches 150,000 tons per annum, but, ultimately, when certain extensions have been completed, it is estimated that it will amount to 600,000 or 700,000 tons annually. The prewar trade of the United Kingdom in this product was less than 400,000 tons, but the increase in motor transportation that is practically certain to ensue after the conclusion of the war in the United Kingdom and in Europe generally as well as developments in aviation will, it is firmly believed, require all the gasoline produced in the world. In this connection emphasis is laid on the great increase in the use of gasoline in the United States, where, it is stated, the consumption has reached 5,000,000 to 6,000,000 tons per annum, equal to six times the total prewar requirements of the United Kingdom and Continental Europe, while the demands for aviation, it is anticipated, will lead to still larger requirements for gasoline in the United States.

[1] Nutting, Alfred, Increased oil production in Persia: Commerce Repts., Jan. 22, 1918.

It is now stated that the oil fields that are being developed and tested by the producing companies of the Anglo-Persian Oil Co. are among the most extensive and prolific in the world. Were refineries existing to deal with the oil, the field from which crude is now being obtained would produce about 4,000,000 tons annually. Most of the wells, however, have to be kept shut down for want of facilities to deal with the crude. Some idea of the richness of this field is given by the statement that the present obtainable production exceeds that of the whole of the Roumanian and Galician oil fields before the war.

Other fields, within the company's sphere of operations have been tested and wells sunk, with results of rich promise. One point is emphasized in connection with the crude—it is of an exceptionally high grade and claimed to be superior to the average of oils produced on the American continent. It contains, it is said, a very large percentage of gasoline and kerosene of high quality, excellent lubricating oils, fuel oils of high thermal utility, and a good percentage of first-grade paraffin. The cost of production is lower than is the case with fields in some other countries, inasmuch as the crude is obtained from flowing wells of big volume, thus requiring less field expenditure, and this fact more than balances any extra cost incurred for freight.

The capital of the company amounts to £6,000,000 ($29,199,000) of which £2,000,000 ($9,733,000) consists of debenture stock and the remainder of preference and ordinary shares. Of this total capital, £2,200,000 ($10,706,300) is held by the British Government, that sum representing the amount the Government in 1914 agreed to provide.

In order to provide funds to carry out additional extensions and other necessary work, a further issue of £1,000,000 ($4,866,500) preference shares is to be made immediately, thus increasing the total capital to $34,065,500. By an alteration in the articles of association of the company, the voting powers of the ordinary and preference shares have undergone a change, the effect of which is to maintain the majority of votes held by the Government notwithstanding the lower proportion of the total capital thus held.

The company now owns 22 vessels of a total dead-weight capacity of 130,915 tons, including the nine tankers of the Petroleum Steamship Co. that were recently purchased. In addition there are other nine tankers of 74,500 tons dead-weight capacity, which are being managed, thus providing a total fleet of 31 vessels of 205,415 tons. Additional tonnage will be obtained as soon as it is practicable to purchase or build it.

The concession of the Anglo-Persian Oil Co. covers an area of some 500,000 square miles, only a small part of which has been examined or tested. Its producing properties are in the Maidan-i-Naphtun district about 50 miles northeast of Ahwaz on Karun River and about 140 miles north-northeast of Mohammerah, which is at the junction of the Shatt-al-Arab and Karun rivers. From that field the oil is transported by two pipe lines, 145 miles long, to a refinery on the Island of Abadan, at the head of the Persian Gulf.

Field operations are carried out by the Bakhtiari Oil Co. (Ltd.), and the First Exploitation Co. (Ltd.).

BRITISH INDIA.

Despite the imposition of a special duty of 6 annas per imperial gallon (about 10 cents per United States gallon) in addition to the regular customs duty of about 2.5 cents per United States gallon on gasoline imported into India there was a marked decrease in the output of crude petroleum from domestic sources in India in 1917.

The principal feature of drilling operations in Burma was the discovery of a fairly prolific sand at a depth of about 2,500 feet in a part of the Yenangyaung field in which previous development work had failed to yield particularly encouraging results.

In Assam continued development of the Bappapoong and Hawsapoong extensions of the Digboi district was attended by gratifying success.

In Punjab a moderate amount of new work in the Khaur field in the Attock district resulted in no developments of especial significance.

Petroleum produced in India, 1908–1917.

Year.	Quantity.		Value.	
	Imperial gallons.	Barrels (42 United States gallons).	Rupees.[a]	Dollars.
1908	176,646,320	5,047,038	10,530,135	3,416,327
1909	233,678,087	6,676,517	13,652,580	4,429,352
1910	214,829,647	6,137,990	12,538,905	4,068,039
1911	225,792,094	6,451,203	13,265,970	4,303,923
1912	249,083,518	7,116,672	14,629,170	4,746,190
1913	277,555,225	7,930,149	15,518,790	5,035,803
1914	259,342,710	7,409,792	14,378,475	4,664,857
1915	287,093,576	8,202,674	18,852,045	6,116,232
1916	297,189,787	8,491,137	16,791,075	5,447,584
1917	282,759,523	8,078,843	16,394,460	5,318,909

[a] The value of the rupee is taken as 32.44⅓ cents; 15 rupees=£1.

Petroleum produced in India, 1913–1917, in imperial gallons.

Province.	1913	1914	1915	1916	1917
Burma	272,865,397	254,652,963	282,291,932	291,769,083	272,795,191
Eastern Bengal and Assam	4,688,628	4,688,547	4,550,150	5,236,890	9,344,815
Punjab	1,200	1,200	251,494	183,814	619,517
	277,555,225	259,342,710	287,093,576	297,189,787	282,759,523

CHINA.

The Mining Journal (London)[1] summarizes as follows the results of the only serious effort made in recent years to exploit the petroleum resources of China:

It will be in the recollection of most of our readers that shortly before the war an important concession was granted by the Chinese Government to the Standard Oil Co., providing for the testing and, if approved, the subsequent working of the oil deposits believed to exist in Yengchang, Yenanfu, and the adjoining fields of Shensi and Chentehfu (Jehol) and the adjoining fields of Chihli. These occurrences were considered the most promising in China, as in some instances oil has been produced from wells for many years. By the terms of concession, which were signed on February 10, 1914, the Chinese Government was to participate with the Standard Oil in the capitalization of any companies formed to work the field. The Far Eastern Review of May last contains some account of the steps taken to prove the concession. As soon as the contract was settled the Standard Oil Co. sent six leading oil geologists with a staff of assistants, first of all, to the region of Chengtehfu, in Chihli, and after an exhaustive examination turned the proposition down. Subsequently, at Yengchang, in Shensi, three modern drilling rigs were started after encountering difficulties of all kinds. These drills put down seven bores to a depth of approximately 3,000 feet at Yengchang, Huailiho, Yenanfu, Shihmentz, Chiaoerkau, Changpu, and Chinniuchuang. In the majority of cases oil was found from 400 to 600 feet, but after that the further the drills went down the less oil they got. Up to the end of March, 1916, the company spent about $2,500,000 (Mex.). While the wells were being bored, Mr. W. E. Bemis, vice president of the Standard Oil, came to Peking to negotiate with regard to the formation of a joint concern. After a considerable lapse of time the negotiations were suspended, and early in April it was announced that the Standard had abandoned the enterprise. The failure of the company to locate oil has undoubtedly been a considerable surprise, as the native wells were producing up to 20,000 catties of oil per day a few years ago.

[1] Standard Oil abandons Chinese option: Min. Jour. (London), Aug. 11, 1917.

JAPAN AND FORMOSA.

The combined output of petroleum in Japan and Formosa in 1917 was about 3 per cent less than in 1916, the decrease, amounting to 98,524 barrels, being shared by all the major producing fields.

Continued development of its prolific Kurokawa property by the Nippon Oil Co. resulted in the completion of a number of new oil wells of excellent capacity, but principal interest in oil-field development in Akita Prefecture was centered in the Toyakawa district near by, in which material extensions of the producing area were proved during 1917 along the Urayama anticline. In this district the center of activity in drilling was at Makata and Kusodsu.

In the Santo field, Echigo Province, well No. 1 Katsumi, of the Nippon Oil Co., planned as a deep test, attained a depth of 3,620 feet before the end of 1917.

In Formosa wildcat tests, drilled by the Hoden Oil Co., resulted in the discovery of petroleum testing 29° Baumé gravity at a depth of about 900 feet at Shinchiku. At the end of 1917 tests were in progress by the Dai-Nippon Oil Co. at Tainan and Kagi and by the Imperial Japanese Navy at Akow.

Geologic examination of the oil regions of Japan was begun in September, 1917, in Akita Prefecture, Province of Echigo, by the imperial mining bureau.

The following figures are reported by the imperial mining bureau of the department of agriculture and commerce, Tokyo:

Petroleum produced in Japan and Formosa, 1913–1917, in koku.[a]

Field.	1913	1914	1915	1916	1917
Akita	76,830	625,719	989,223	879,188	874,484
Hokkaido	4,218	6,270	8,846	6,627	5,763
Niigata	1,610,117	1,761,792	1,728,687	1,733,934	1,655,250
Shizuoka	1,983	2,055	1,720	1,646	1,551
Yamagata	336				
Others	98				
	1,693,582	2,395,836	2,728,476	2,621,395	2,537,048
Formosa	15,933	14,708	16,651	16,966	12,340
Grand total	1,709,515	2,410,544	2,745,127	2,638,361	2,549,388

[a] 1 koku=39.7 English gallons=47.46 United States gallons=1.136 United States barrels.

Petroleum produced in Japan and Formosa, 1908–1917.

Year.	Japan.		Formosa.		Total.	
	Koku.	*Barrels.*	*Koku.*	*Barrels.*	*Koku.*	*Barrels.*
1908	1,815,001	2,061,841	7,310	8,304	1,822,311	2,070,145
1909	1,657,036	1,882,393	5,664	7,170	1,662,700	1,889,563
1910	1,520,458	1,727,240	3,208	4,062	1,523,664	1,730,882
1911	1,529,593	1,737,618	1,442	1,638	1,531,035	1,739,256
1912	1,458,290	1,656,617	3,040	3,454	1,461,330	1,660,071
1913	1,693,582	1,923,909	15,933	18,100	1,709,515	1,942,009
1914	2,395,836	2,721,670	14,708	16,708	2,410,544	2,738,378
1915	2,728,476	3,099,549	16,651	18,915	2,745,127	3,118,464
1916	2,621,395	2,977,905	16,966	19,273	2,638,361	2,997,178
1917	2,537,048	2,884,624	12,340	14,030	2,549,388	2,898,654

AFRICA.

EGYPT.

Increased activity in development in the Gemsah and Hurgada oil fields, the entire output of which is reported to be under requisition by the British Government, resulted in 1917 in an increase of more than 100 per cent in the production of petroleum credited to Egypt.

The Egyptian fields are operated exclusively by the Anglo-Egyptian Oilfields (Ltd.), in which company the Egyptian Government participates to a moderate extent. In addition to its producing properties, that company owns tank-storage facilities at Gemsah, Hurgada, and Suez; a refinery at Suez, the rated capacity of which was increased from 500 to 1,000 tons of crude oil a day in 1917; and shipping facilities at Port Tewfik.

Petroleum produced in Egypt, 1911–1917.

Year.	Metric tons.	Barrels of 42 gallons.
1911	1,220	9,150
1912	27,454	205,905
1913	12,618	94,635
1914	103,605	777,038
1915	34,961	262,208
1916	54,800	411,000
1917	134,500	1,008,750

ALGERIA.

The history and present status of the quest for petroleum in Algeria are concisely related in the following article:[1]

On request, we have received from the Director of Mines a general report dated February 26 on the petroleum deposits of Algeria, from which we have extracted the following statements:

In the Département d'Oran the principal indications of hydrocarbons are found in the three regions of Dahra, Tilouanet, and Bel-Hacel.

In the first of these regions, the most important indications have been confirmed at Ain-Zeft, and in the Oulad-Sidi-Brahim, at Beni-Zentis, and in Auarizane.

In Oulad-Sidi-Brahim four wells have been sunk without appreciable success to respective depths of 290, 322, and 361 meters, and no work has been done since 1898.

At Ain-Zeft, petroleum was first exploited on the surface, then six wells were drilled to depths varying between 105 and 474 meters. Since 1903 the exploitation has passed successively into the hands of a series of English companies, which drilled 10 new wells, a few of which attained a depth between 600 and 700 meters.

A few of these wells produce a small quantity of petroleum. In 1911–12 the African Society of research and mineral exploitation, whose base is at Nancy, drilled two wells to depths of 544 and 594 meters, respectively, which wells produced only traces of gas and petroleum, and Paul Paix and associates, of Douai, sunk a well 1,100 meters in depth without obtaining any encouraging results.

At Beni-Zentis and in the Oued Auerizane a few wells were drilled but likewise abandoned.

The first researches made in this region were made in 1897 and the first campaign of drilling was finished in 1902. A second campaign was begun in 1910 and still continues. It has recently (May 15, 1917) resulted in the completion of a well which produces 8 to 9 tons of oil a day.

During the first period the wells drilled rarely exceeded a depth of 300 meters and the results obtained were wholly insignificant.

[1] Le pétrole en Algérie: Journal du pétrole (Paris), vol. 17, No. 10, pp. 15-16, October, 1917. (Translated by Miss I. M. Patnoe, of the United States Geological Survey.)

During the second period the Algerian Oil Fields (Ltd.) commenced two wells, one at Abd-er-Rahim, subsequently drilled to a depth of 902 meters and abandoned, and another at Messila, likewise abandoned at a depth of 147.5 meters. This company, following these failures, ceded its rights of research to Mr. Harry Macconochie, who encountered petroleum in the Messila well at a depth of 167.10 meters. This well flowed to the surface at first, but now produces only when pumped.

This prospector was succeeded by the Algerian Consolidated Oil Estates (Ltd.), which in turn ceded its rights to the Société Algérienne des Pétroles de Tilouanet, whose address is 12, Rue Blanche, Paris.

This company has three wells, one of which furnishes from 5 to 6 tons of oil a day from a depth of 126 meters; the other two produce very little petroleum.

No real exploitation has been done in this region, which has simply been the object of some little geologic study.

These concessions, which were granted to Mr. Hope Crush, an engineer at St.-Aime, by decision of a prefect of July 16, 1913, were very recently accorded to Mr. Eggleston Smith, who has asked for eight permits in this region.

In connection with these three regions, it is not amiss to mention the investigations carried on at Lake Momlats, which, however, furnished only indications of petroleum. In the departments of Alger and Constantine no significant results have yet been attained.

Summarizing, it may be gained from this report that the results of these undertakings have furnished conclusive evidence that the three wells bored in this region south of Relizane in the last three years justified by their production the hope that they have their source in rich petroleum deposits of our colony and that the works briefly enumerated above have demonstrated the truth of the statement that petroleum exists in Algeria and waits only the intensive exploitation that has been the origin of the prosperity of the present known petroleum regions—the United States, Mexico, Russia, Galicia, and Rumania.

MOROCCO.

The occurrence of petroleum in Morocco has been mentioned a number of times in the French press in connection with that of Algeria, but little specific information is available on the subject. Indications of petroleum are known to exist over a considerable area between El Araish and Fez in the northwestern part of Morocco, and in 1912 wildcat operations in this district conducted by Rigaud, chief engineer of mines, are reported to have resulted in the discovery of crude oil at Oued-Mellah at the shallow depth of 13 meters. Early in 1916 the Algeria & Morocco Drilling Co. (capital, 125,000 francs) began exploratory work in the district. The drilling machinery, however, was inadequate for more than shallow tests and was eventually discarded. After investigation of the properties by a commission of experts from France the company is reported to have acquired appropriate drilling equipment and to have undertaken a thorough test, by deep drilling, of its holdings.

PORTUGUESE WEST AFRICA.

A company formed with American, Belgian, and Portuguese capital is reported [1] to have been prospecting for petroleum in Angola since 1913. More than 400 tons of drilling machinery have been imported from America, and tests to the depth of 1 mile are said to have been drilled in the Alto Daude district, near Loanda, and also at Ambrizette. The greater part of the casing used is $8\frac{3}{4}$ inches, but several tests have been made with 15-inch casing. Indications of petroleum are said to be promising.

[1] Commerce Repts., Feb. 21, 1918.

MADAGASCAR.

In October, 1917, announcement was made that encouraging showings of both oil and gas had been found at a depth of about 450 feet in test well No. 5 drilled by the Sakalava (Ltd.) on its holdings in Betsiriry Valley, Madagascar.

OCEANIA.

EAST INDIES.

Primary interest in oil-field development in the Dutch East Indies in 1917 was centered in the opening of a new oil field of much promise in Sumatra. This resulted from the completion on May 5 by the Batavia Petroleum Co., at Pangalan Soesoe, of a well that was credited with an initial flow at the rate of 1,200 tons of light gravity oil a day. The results obtained in this well are interpreted as proof of the discovery of an important new field, as the well was drilled to test the worth of a broad anticlinal fold several miles in length.

The production of petroleum in the Dutch East Indies in 1917 was slightly less than in 1916, owing to the failure of increased production in Java and Sumatra to offset wholly the decreased output charged to Borneo and Ceram.

Concerning the progress made by the Australian Government in its investigation of the petroleum resources of Papua a correspondent of the London Mining Journal writes,[1] under date of May 29, 1917, as follows:

> The minister for home and territories has had several conferences with Dr. Arthur Wade, the oil expert engaged by the Federal Government to develop the oil fields of Papua, and it is now announced that the indications are favorable for the establishment of an oil industry, which should prove a valuable asset to the British Empire. The Papuan oil fields cover an area of 2,000 miles. Several bores were put down before Dr. Wade took charge. Oil has been struck on most of the bores, but they became blocked with mud, which resulted in some of them being closed down. New machinery is being provided capable of boring to a depth of 4,000 feet. The quality of the Papuan oil is of the highest, and generally the prospects of an important industry being established are good. The home and territories department has 2,000 gallons of refined oil from Papua, which is said to be suitable for use in motors, and it is intended to give this oil a practical trial in the departmental motor car at an early date.

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[1] Papuan oil: Min. Jour. (London), July 28, 1917.

Petroleum produced in Dutch East Indies, 1908–1917.

Year.	Borneo.		Java.		Sumatra.		Total.		
	Metric tons.	Liters.	Metric tons.	Liters.	Metric tons.	Liters.	Metric tons.	Liters.	Barrels.
1908..	511,049	566,209,890	137,013	158,974,000	738,588	909,715,827	1,386,650	1,634,899,717	10,283,357
1909..	411,506	455,922,397	140,351	162,846,428	922,894	1,136,720,015	1,474,751	1,755,488,840	11,041,852
1910..	633,472	701,853,114	142,503	165,344,877	719,740	886,505,130	1,495,715	1,753,703,121	11,030,620
1911..	814,707	902,654,621	172,438	190,766,435	683,523	841,895,279	1,670,668	1,935,316,335	12,172,949
1912..	671,662	744,167,950	184,989	214,641,699	621,481	765,481,929	1,478,132	1,724,291,578	10,845,624
1913..	797,059	883,061,666	207,135	240,334,598	529,947	652,735,720	[a]1,534,223	1,776,227,127	11,172,294
1914..	[c]931,903	1,032,455,334	226,590	262,907,845	475,423	585,578,509	[b]1,634,403	1,881,506,744	11,834,492
1915..	[d]960,896	1,064,576,678	256,838	298,003,995	491,611	605,517,269	[e]1,710,445	1,969,316,632	12,386,800
1916..	[f]1,047,462	1,160,483,150	243,442	282,460,884	526,080	647,972,736	[g]1,820,247	2,094,531,848	13,174,399
1917..	[h]946,737	1,048,889,923	246,126	285,575,408	583,384	718,554,073	[i]1,778,495	2,055,509,963	12,928,955

[a] Includes 82 metric tons produced in Ceram.
[b] Includes 487 metric tons produced in Ceram.
[c] Includes 65,185 metric tons produced in British Borneo.
[d] Includes 67,000 metric tons produced in British Borneo.
[e] Includes 1,100 metric tons produced in Ceram.
[f] Includes 90,067 metric tons produced in British Borneo.
[g] Includes 3,263 metric tons produced in Ceram.
[h] Includes 77,614 metric tons produced in British Borneo.
[i] Includes 2,248 metric tons produced in Ceram.

1 gallon Borneo crude=7.5322 pounds.
1 gallon Java crude=7.1924 pounds.
1 gallon Sumatra crude=6.7754 pounds.
1 United States barrel=158.985 liters; 1 liter=1.0567 quarts.

AUSTRALIA.

SOUTH AUSTRALIA.

The results of wildcat operations in the Robe district, South Australia, in 1917, included the completion and abandonment at a total depth of 4,504 feet, of well No. 1 of the South Australian Oil Wells Co., of Melbourne, and the beginning of a second test by the same company near Tantanoola, close to the Hanging Rocks and midway between Millicent and Mount Gambier. In well No. 1, at Robe, encouraging showings of oil are reported to have been encountered at depths of 1,033 feet and 4,442 feet.

QUEENSLAND.

Drilling was continued in 1917 on the test well at Roma begun in 1916 under the supervision of the minister of mines, Queensland, and satisfactory progress was reported.

NEW SOUTH WALES.

The deposits of "kerosene shale" in Capertee and Wolgan valleys, in the Blue Mountain region, constitute the only source of mineral oil thus far developed in New South Wales. The shale-oil industry in this district is controlled by the Commonwealth Oil Corp. (Ltd.), of Sidney. Its properties comprise some 12,000 acres of shale land, estimated to contain not less than 20,000,000 tons of oil shale, in Glen Alice, Capertee, and Gindantherie parishes, a 32-mile railroad connecting its properties with the government railway system, and extensive retorting and refining works at Newnes.

The quantity of shale mined in 1917 was nearly double the quantity taken out in 1916.

Near the end of 1917 considerable stimulus was afforded the struggling shale-oil industry of Australia by the decision of the Commonwealth Government to offer a bounty on the production of mineral oil in that country. The bounty is to be payable for a period of four years from September 1, 1917, and the limit of the amount payable each year is fixed at £67,500. On each gallon up to 3,500,000 the bounty is 2¼ pence per gallon; on each gallon between 3,500,000 and 5,000,000 gallons, 2 pence per gallon; on each gallon between 5,000,000 and 8,000,000 gallons, 1¾ pence per gallon; and on each additional gallon 1½ pence. If the entire annual payment is not absorbed in any one year the balance becomes available for payment in subsequent years, if needed.

Oil shale produced in New South Wales, 1908–1917.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1908	46,303	$126,855	1913	*a* 16,985	$35,715
1909	48,718	114,932	1914	50,049	133,205
1910	68,293	164,955	1915	15,474	62,729
1911	75,104	179,963	1916	17,425	86,487
1912	*a* 86,018	169,208	1917	31,661	177,939

a Estimated.

NEW ZEALAND.

The petroleum industry of New Zealand is restricted to the operations of a single company, the Taranaki Oil Wells (Ltd.), which controls a few deep oil wells of small capacity and a petroleum refinery at New Plymouth, Taranaki, North Island. The usual small production of oil was obtained from the New Plymouth district in 1917.

COAL—PART A, PRODUCTION.

By C. E. Lesher.

INTRODUCTION.

GENERAL STATEMENT.

Like the report for 1915, the report on coal in 1917 treats of production in Part A and distribution and consumption in Part B. Information on distribution and consumption was not compiled for 1916 because of the limitation of clerical assistance and the more than ordinary demands, in the early part of 1917, for special data from the newly created Governmental agencies dealing with the war.

During the summer of 1917 the United States Geological Survey actively cooperated with the Committee on Coal Production of the Council of National Defense, the first official body which dealt with the coal problem after the United States entered the war.

In October, 1917, the small force in the Geological Survey concerned with the preparation of statistics on coal and coke was put at the disposal of the United States Fuel Administrator, the personnel and activities were greatly enlarged, and the immediate duties were changed from the compilation of the regular annual reports of the Geological Survey to the preparation both of current reports on operations and of special reports for the information and guidance of the officials of the Fuel Administration. The result has been the accumulation of a vast fund of information on the production, distribution, consumption, and stocks of coal in the United States in 1917, and particularly in 1918, in such detail and at such frequent intervals as would ordinarily not be considered expedient or possible. The supervision of the force necessary in the collection and preparation of these current reports (more than 400 clerks were employed in September, 1918, compared with 6 in the pre-war period) precluded the setting aside by the writer of time to prepare any reports for publication.

As soon after the signing of the armistice as it became evident that the supply of coal for the winter of 1918-19 would be ample and the activities of the Fuel Administration were diminished, plans were begun to put its records in shape for publication in order that the history of coal in the war should be made available to all.

ACKNOWLEDGMENTS.

So general and hearty was the response of coal producers and shippers, railroad officials, and consumers to the many request made of them for information that individual mention is not possible. Appreciation is expressed of the loyal support rendered by the secretaries

of the local coal operators' associations, who through their intelligent and persevering efforts in the collection and interpretation of information lightened the work of the writer and his assistants. The State geologists of Alabama, Illinois, Iowa, Georgia, Maryland, Oregon, Pennsylvania, Virginia and Washington cooperated in the collection of reports from the coal operators. Special credit is due to Miss Lida Mann and Mrs. H. L. Bennit, of the United States Geological Survey, under whose direction the statistics of production of bituminous coal and anthracite, respectively, were compiled, and to other members of the staff, in both the Geological Survey and the Fuel Administration.

Much of the responsibility for the statistics for 1917 was assumed by the writer's assistants, W. T. Thom, jr., W. P. Ellis, and Benjamin Robin, for whose enthusiastic and untiring efforts appreciation can be expressed here in but small measure.

UNIT OF MEASUREMENT.

The standard unit of measurement adopted for this report is the net ton of 2,000 pounds, although for certain uses the gross ton of 2,240 pounds is employed. Pennsylvania anthracite is mined and sold by the gross ton, and that unit is used in the part of the report dealing with anthracite. In all other statistics of production reported to the Geological Survey in gross tons the figures have been reduced to net tons, and unless otherwise expressly stated the net ton is meant where any statement of quantity is made in the text.

There is a steadily growing sentiment in favor of the universal use of the net ton of 2,000 pounds as the standard of the coal trade, particularly for bituminous coal in the Eastern States, where now both gross and net tons are used. Two units are, of course, undesirable; but State and municipal laws in many places require the gross ton, and freight rates throughout a section of the Eastern States are now fixed on this basis, and these facts make it difficult to effect any immediate change in standard. Foreign trade and shipping rates are expressed in either gross or metric tons, and here, too, the use of two units is undesirable. The general use of the net ton in the United States, even in the anthracite region, is advocated.

REVIEW OF THE COAL INDUSTRY IN 1917.

The period from 1914 through 1917 and 1918 and into 1919 will at some future date be viewed as a separate epoch in the coal industry of this country, of which the year 1917 represented only one section, but a section which, if not the most remarkable for its achievements, was at once the most chaotic and the most momentous in the history of the industry.

It is not difficult to marshal the events and factors that mark 1917 as unusual: An extraordinary demand, increasing after April, when this country entered the war, and unsatisfied throughout the year; high prices and speculation in free coal; the first effort at regulation of prices through the Committee on Coal Production; the Pomerene amendment to the Lever Act and the fixing of prices and appointment of the Fuel Administrator by the President; labor troubles; priority orders; car shortage and other difficulties in transportation; severe storms in December that blocked the railroads; the withdrawal of ships from the coastwise trade to New England; unequal distribution of coal and constant fear of a fuel famine in many sections; reluctance on the part of many producers and distributors of coal to accept governmental regulations in general and the program of the Fuel Administration as it was developed in particular.

The extraordinary demand, general in all sections of the country and continuing throughout the year, a demand that absorbed every ton of coal produced and called for more and that practically nowhere in the country was satisfied from the first day to the last day of the year, was the most remarkable feature and the fundamental fact on which hinged every other turn of events in the industry. The demand for coal was great because the war had created an immensely greater demand for transportation and for almost every material known to industrial life for the production of which coal was essential.

The response of the industry to this demand was notable. The production of bituminous coal increased more than 49,000,000 net tons over 1916, or nearly 10 per cent, and of anthracite, 12,000,000 net tons, or 13.7 per cent—records for both never before attained or approached. These records of big production were matched by those of high prices, sales of "free" coal in the early months of 1917 being reported at prices two, three, and four times as high as those in the corresponding period of 1916. The total amount realized for bituminous coal produced in 1917 was over half a billion dollars, or 88 per cent more than in 1916.

It is necessary at this point to note that conditions in the anthracite industry are different from those in the bituminous industry; the two can not be discussed in parallel terms. Pennsylvania anthracite is produced largely for domestic fuel and used mainly in the eastern portion of the country; bituminous coal is primarily the fuel of transportation and industry. Anthracite comes from one small, compact field largely in the control of a few companies, which, if not organized as a unit, are bound together by common interest; bituminous coal comes from twenty or more important fields, each with its separate problems. Until late in 1917 the producers had no common council but instead were represented by various groups with divergent interests, and a year of war was necessary to bring them to act in unison.

The principal factor limiting the production of anthracite in 1917 was labor; that limiting the production of bituminous coal was lack of transportation, or, as it was commonly called, "car shortage." The price of anthracite was held at a steady level by the larger companies; the price of bituminous was in no wise controlled until July 1, 1917, but was instead largely speculative. The demand for anthracite was not abnormal, for, except as population had shifted with the expansion in certain industrial centers and except as consumption was affected by the unusually severe winter of 1917–18, the requirements of householders represented no great increase. On the contrary, the necessity for maximum production of war materials called for increasing quantities of bituminous coal.

The direct result of the high prices for bituminous coal, which in turn were the result of the insistent demand, was governmental regulation. The Committee on Coal Production of the Council of National Defense, an official body but with no legal powers, had in

June effected an agreement among the producers of bituminous coal to establish, as of July 1, prices at a level considerably below those then prevailing, but this price level was declared by the chairman of the Council of National Defense to be too high, and so, except for a brief interval in July and August, it was inoperative. The Lever Act, approved August 10, 1917, authorized the fixing of prices by the President and the establishment of a Fuel Administration, to the head of which the President called H. A. Garfield, president of Williams College, as United States Fuel Administrator, on August 23, two days after he had announced a schedule of mine prices for bituminous coal.

The immediate concern of the Fuel Administrator was the administration of these prices and the setting up of an organization to make them effective at the points of consumption. This was accomplished through State administrators and local committees in each county and city.

Another problem thrust upon the Fuel Administrator soon after he took office was the readjustment of mine-labor wages. In 1916 the union miners had signed a two-year contract with the operators that had until April 1, 1918, to run, and an advance on this scale was agreed upon in the spring of 1917. The cost of living was advancing in 1917, and the miners, aware of the profits being made by the operators, asked for an increase in the wage scale in October. This was granted by the Fuel Administration with the approval of the President to be effective until the termination of the war. A corresponding advance (45 cents a net ton) in the price of coal at the mines was allowed the operators, effective October 29, 1917.

More bituminous coal would have been produced in 1917 had the railroads been able to furnish the transportation. The bituminous mines worked an average of 243 days in 1917, or 80 per cent of a possible 304 working days in the year. Data compiled during the second half of the year on the causes limiting production (see pp. 924–929) indicate average losses of mine operation because of lack of cars ranging from 6.4 to 30.8 per cent over the country and an average from June to December of nearly 16 per cent.

The causes limiting the transportation of coal by the railroads were many, complex, and difficult to evaluate. Car shortage at the mines was not due to an actual lack of cars, but rather to the inability of the carriers to move them, loaded and empty, with sufficient promptness, a condition for which congestion and lack of motive power were primarily responsible.

The tremendous burden placed by the war upon transportation, on land and sea was felt by the railroads in the United States before this country entered the conflict. The increase in other freight in 1917 literally crowded coal off the rails, and this situation was aggravated by the advent of the priority orders, which were primarily designed to expedite the movement of shipments specially needed in the development of the war program of the United States. A priority order from the Priorities Committee of the War Industries Board or from some official of the Government (these orders were largely used by the War Department) calling for the special handling of a certain car or cars usually meant an endless amount of switching to get those cars out of a railroad yard and often special trains which, in turn, delayed other freight. A condition was created in which everything was "special" and therefore nothing was special. The use and abuse of this privilege so increased the congestion of the railroads that they resorted to assigned cars[1] for the transportation of coal to many plants whose product was considered essential to the war program.

The experience of the winter of 1916–17 with car shortage and the active demand for bituminous coal led many to look forward to the contract season beginning in April, 1917, with something of alarm. There was at that time no suspicion of the possibility of Governmental control or regulation of prices. Contract prices for bituminous coal in the early part of 1917 were generally at higher levels than in any previous year. The general range throughout the central competitive field and farther east was from $3 a net ton upward, some contracts for Lake coal having been made at $5 a ton, compared with less than $2 a ton in the years immediately preceding. The operator who made such contracts did so in the expectation that prices would drop. Those who held the contrary view retained control of their output in the expectation of a still higher spot market later in the season. Consumers were likewise of two classes and made contracts if they had confidence in their opinion that the price was up to stay or waited if they believed that prices would decline, or, later in the season, that Governmental control would lower prices.

The bituminous "coal shortage" of 1917, about which so much has been written and said and to remedy which so little was or could be done, really did not begin until the 1st of October. Except to provide for helpless governmental departments, bound by the precedent of hopelessly involved contracts that no operator cared to bother with when selling was so easy elsewhere, the Committee on Coal Production had few calls for assistance during the spring and early summer of 1917. The Fuel Administration, as soon as it was organized, became the target of all consumers with complaints, real or imaginary, regarding their supply of coal. By October the number and apparent importance of these complaints became sufficient to be a cause of much concern.

Railroads and public utilities in particular, manufacturers engaged in the production of war materials, and, later on, retail dealers and domestic consumers wrote, wired, telephoned, and called in person upon the Fuel Administration to increase their supply of coal. Most of these complaints and supplications arose from a fear of being out of coal at some future date rather than because of actual shortage at the time. Comparatively few industrial plants were obliged in the fall of 1917 to cease operation because of lack of coal; public utilities and the railroads managed to keep going.

From April until the middle of December, when severe storms greatly interfered with transportation, the rate of production of bituminous coal tended upward; in June and July and from August to November the rate was in excess of 565,000,000 tons a year. (See fig. 20, p. 913.) Stocks of bituminous coal, which were in the fall of 1917 at a higher average level than in 1916 were not evenly distributed, nor was the increasingly higher production evenly distributed. In fact, the increased demand was not so distributed

[1] An assigned car is one placed at a mine for loading as a result of previous agreement that the empty has been furnished for shipment of coal to a designated consignee.

that all fields could help meet it, and in many sections of the country the distribution of coal to consumers was likewise uneven. Thus, because of unequal distribution of an output never before equaled, so large a number of consumers were unable to procure more than enough coal to meet requirements from day to day that a veritable panic resulted. The total quantity of coal produced in 1917 is confidently believed to have been sufficient for the current aggregate actual needs of the country.

There was, however, a shortage of coal in the sense that consumers were demanding more than they could obtain, whether or not they actually needed it. The shortage therefore lay in the quantity of coal required to change the fear of the consumer to confidence in his supply. The measure of this quantity it is impossible to state, but it is believed that, had there been produced in the last 10 weeks of the year 1917 an additional 10,000,000 tons, or an average of a million tons a week, and had this coal been furnished largely in the area east of Columbus, Ohio, and north of the Carolinas, no coal shortage would have been recorded.

An examination of the details of production and requirements makes clear many features of the condition in 1917 not evident from the statistics in the aggregate. Contracts placed by the War Department represented new business for industrial plants, which, in turn, meant increased requirements for coal or power. A tabulation of the geographic location of 1,295 firms holding 30,000 such contracts at the end of 1917 is a good index of the areas of greatest increases in demand for coal. These data, presented graphically in figure 1, show that 65 per cent of the total number of firms were in the area bounded on the west by the Ohio-Pennsylvania State line and on the south by Potomac River, and that 77 per cent were in this area and Ohio. Fifteen per cent were in New England alone. Thus the demand for coal was unevenly distributed, and more than an even share of the war burden was placed on one section of the country. At the same time the railroads that served the industries in this section had to carry a large increase in freight.

The increased demand for bituminous coal was largely in the area along the Atlantic seaboard and in the New England States. The coal fields in Pennsylvania, Maryland, West Virginia, and Virginia that supply this territory suffered the most from car shortage in 1917. Whereas for the country as a whole production of bituminous coal increased 49,300,000 tons, or nearly 10 per cent, in 1917, compared with 1916, the fields in these States had an increase of only 2,801,000 tons, or 1 per cent. In 1916 these same producing fields had an increase of 23,480,000 tons, or 9.5 per cent, compared with 1915. The significance of this is brought out by the table on page 910, which shows comparative statistics of production for 1915, 1916, and 1917 by groups of States whose coal reaches more or less common markets.

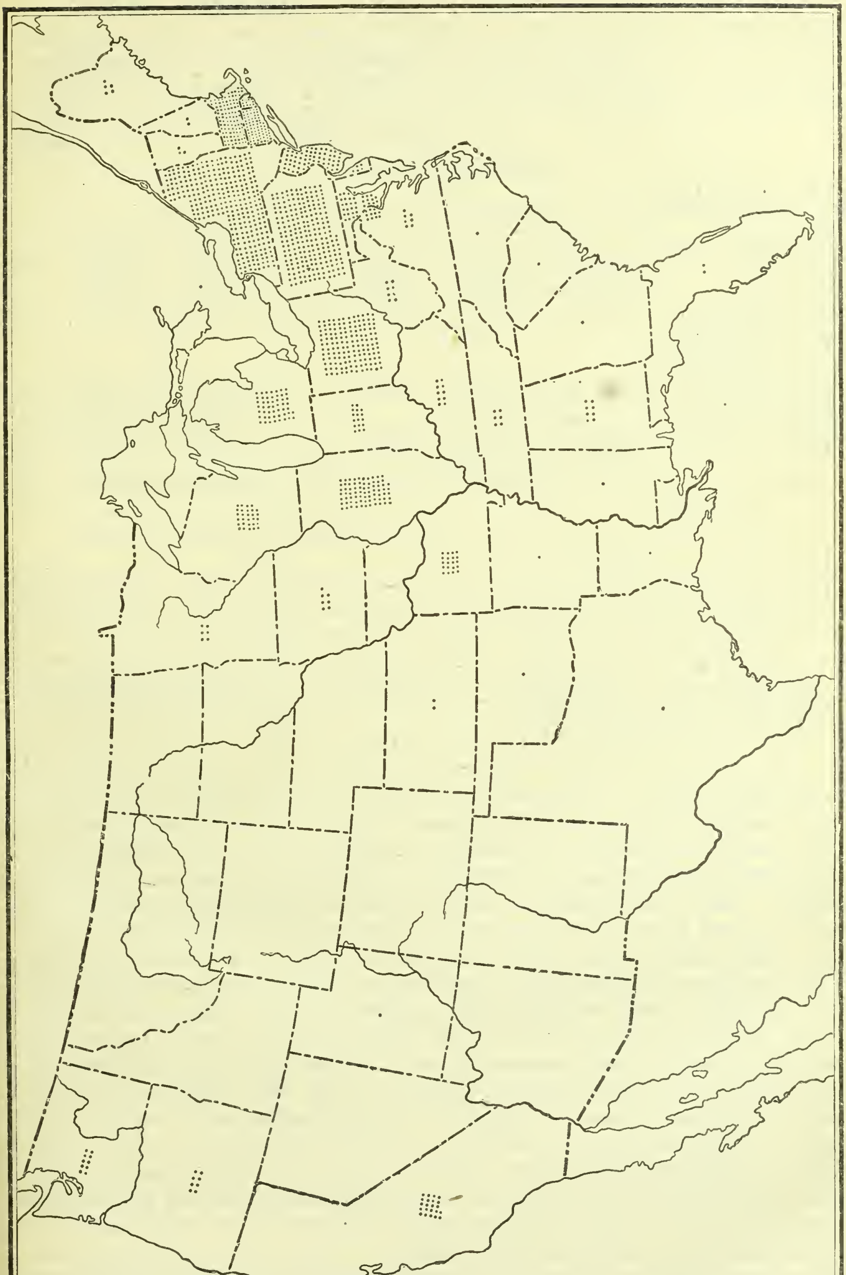

FIGURE 18.—Geographic distribution of 1,295 firms holding about 30,000 war contracts, Dec. 31, 1917.

Bituminous coal and lignite produced in 1915–1917, by groups of States.

	Production (net tons).		Increase in 1916 over 1915.		Production, 1917 (net tons).	Increase in 1917 over 1916.	
	1915.	1916.	Net tons.	Percentage.		Net tons.	Percentage.
Pennsylvania, Maryland, West Virginia, and Virginia	247,442,000	270,922,000	23,480,000	9.5	273,723,000	2,801,000	1.0
Eastern Kentucky, Ohio, and Michigan	37,371,000	53,480,000	16,109,000	43.1	59,693,000	6,213,000	11.6
Tennessee	5,730,000	6,137,000	407,000	7.1	6,194,000	57,000	.9
Alabama	14,928,000	18,086,000	3,158,000	21.2	20,068,000	1,982,000	11.0
Illinois, Indiana, and western Kentucky	83,418,000	94,110,000	10,692,000	12.8	122,976,000	28,866,000	30.7
North Dakota, South Dakota, Iowa, Missouri, Kansas, Oklahoma, Arkansas, and Texas	26,224,000	27,119,000	895,000	3.4	31,507,000	4,388,000	16.2
Colorado, Montana, Wyoming, Utah, and New Mexico	24,896,000	29,388,000	4,492,000	18.0	33,411,000	4,023,000	13.7
Washington	2,429,000	3,039,000	610,000	25.1	4,010,000	971,000	32.0
Total [a]	442,438,000	502,281,000	59,843,000	13.5	551,582,000	49,301,000	9.8

[a] Does not include production in California, Alaska, Oregon, Georgia, Idaho, and Nevada.

Uneven distribution among consumers in every section followed the fixing of prices, first by producers' agreement on July 1 and later by the President on August 21. The prices on contracts made in 1917 were generally above the Government's prices for the same coal, and contracts were not disturbed. Operators with such contracts were but human in applying their product to the greatest possible extent on these contracts, and consumers who early in the year had agreed to take the coal considered themselves fortunate in having an ever increasing supply. Consumers without contracts to cover their requirements were powerless, because they could not bid against the other more far-sighted or at least more fortunate consumers.

Uneven distribution of increases in demand, of increases in production, and of increases in shipments to individuals was the big problem that faced the Fuel Administration in the last months of 1917. Production was absolutely limited by the disability of the railroads; the mines and miners were working every day and every hour that they could with the car supply afforded; conservation was a dream of the future; distribution that would evenly spread the available supply and that would help rather than entangle the railroads was the real immediate problem. The first efforts of the Fuel Administration to meet the situation admittedly failed because they were not applied along broad lines. What in 1918 proved to be the solution of the problem was not found until the last month of 1917, when efforts were concentrated on a rigid control of the distribution of coal through a budget system and the plans for an organization to administer this control were first laid.

The year 1917 was the most momentous in the history of the coal industry, not so much because of the largeness of the problems presented as because of the agencies that were called into being to meet these problems.

Bituminous coal operators had never before acted in concert; in 1917 they formed a national association, primarily because of the inspiration of the war emergency. Governmental regulation of the industry was a condition unthought of four months before it became a fact. The reluctant acceptance by the industry of these two agencies and the concerted action of both in getting into step marked the real beginning of the solution of the coal problems created by the war.

PRODUCTION.

Summary of statistics of coal produced in 1916 and 1917.

	1916		1917	
	Quantity (net tons).	Value.	Quantity (net tons).	Value.
Bituminous coal and lignite	502,519,682	$665,116,077	551,790,563	$1,249,272,837
Pennsylvania anthracite	87,578,493	202,009,561	99,611,811	283,650,723
	590,098,175	867,125,638	651,402,374	1,532,923,560

	Increase, 1917.			
	Quantity.		Value.	
	Net tons.	Per cent.	Dollars.	Per cent.
Bituminous coal and lignite	49,270,881	9.8	$584,156,760	87.8
Pennsylvania anthracite	12,033,318	13.7	81,641,162	40.4
	61,304,199	10.4	665,797,922	76.8

The production in 1917 of 551,791,000 net tons of bituminous coal and of 99,612,000 net tons of Pennsylvania anthracite established new high records in both industries. The increase in the production of bituminous coal over 1916 was 49,271,000 tons, or 9.8 per cent, and in anthracite it was 12,033,000 net tons, or 13.7 per cent. For bituminous coal 1917 marks the third successive year of increase following the depression of 1914; for anthracite it marks the first increase following three years of decreasing output after the previous high record of 1913. The progress of the industry from 1890 to 1917 is shown graphically in figure 19. It will be noted that the development of the anthracite industry has in no way kept pace with that of bituminous coal. In 28 years the production of anthracite slightly more than doubled; that of bituminous coal increased fourfold. The reason for this discrepancy is found primarily in the limited reserves of anthracite as compared with the almost boundless resources of bituminous coal, but it also lies in the fact that anthracite is essentially a domestic fuel whose production has followed more closely the increase in population, whereas bituminous coal is the fuel of industry and has kept pace with industrial expansion in the country. Furthermore, the yearly variations in the production of anthracite are largely the result of weather conditions; but the yearly variations in the production of bituminous coal follow the curve of industrial expansion and depression.

The production of bituminous coal and lignite in the United States, by months, in 1915, 1916, and 1917, is shown graphically in figure 20. The significant feature of this diagram is the seasonal drop in the curve in 1915 and 1916 during the summer months. The monthly rate of production in 1917 was at no time greatly in

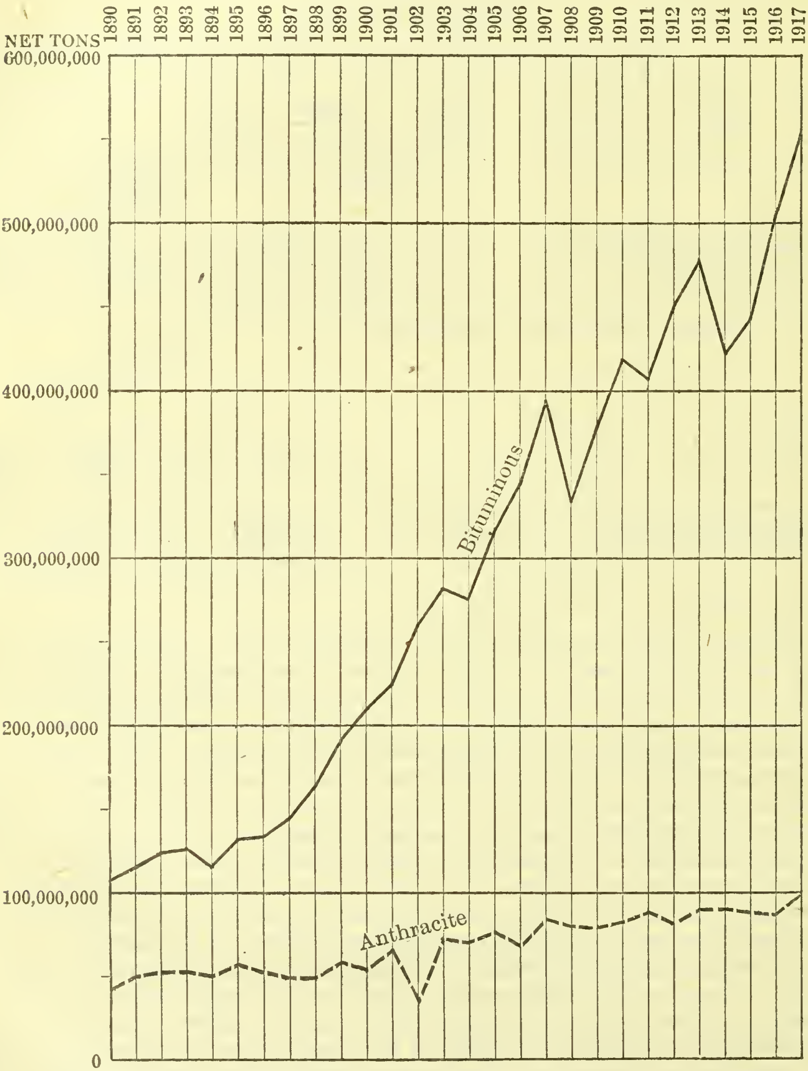

FIGURE 19.—Production of bituminous coal and anthracite in the United States, 1890–1917.

excess of that reached in January, 1916. The increases in 1916 over 1915 and in 1917 over 1916 were accomplished more as the result of increase in the number of days worked than as the result of increase in mine capacity or in the amount of mine labor employed.

The production of bituminous coal in 1917, by weeks, is shown in figure 21 and in the accompanying table, which bring out clearly the fluctuations in the rate of production. The comparison of production by weeks shows even more clearly the fluctuations in the rate of production than the comparison by months, which is affected by the

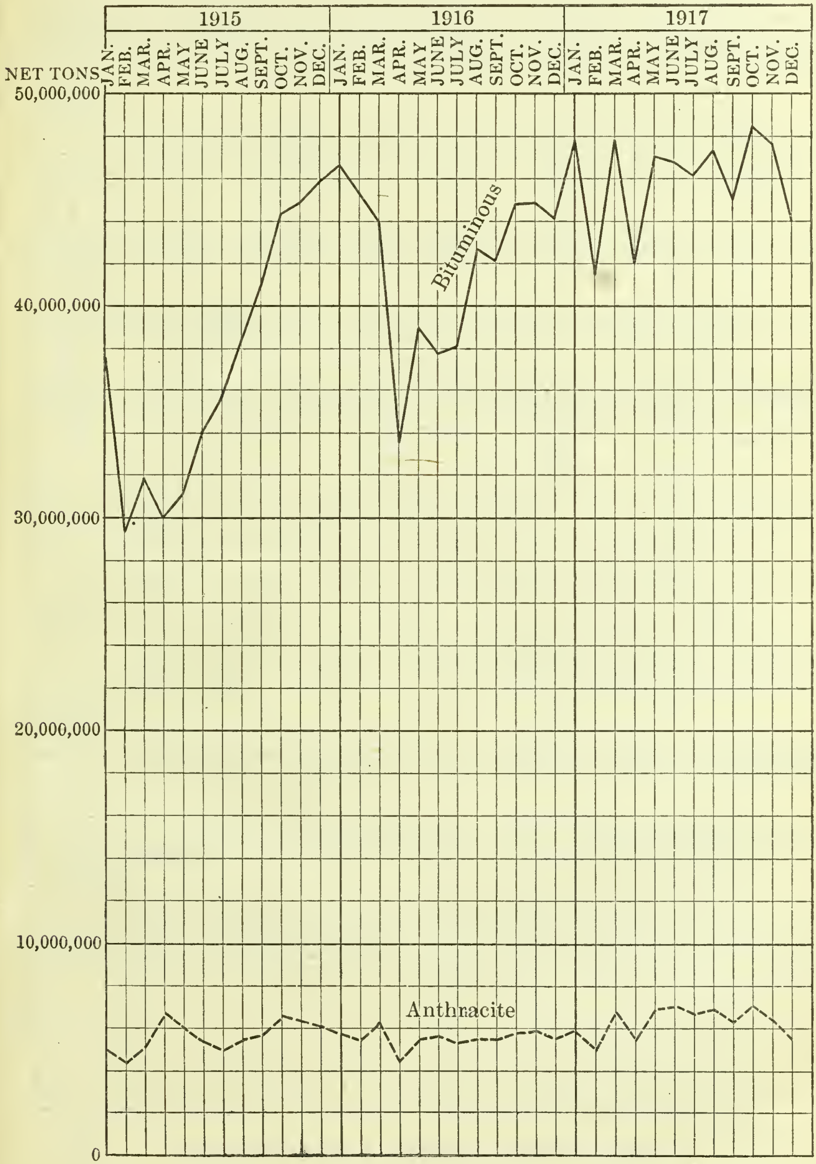

FIGURE 20.—Production of bituminous coal and shipments of anthracite, by months, 1915–1917.

difference in the number of working days in the months. On the diagram (fig. 21) are indicated the causes of the low points in the curve, mainly holidays.

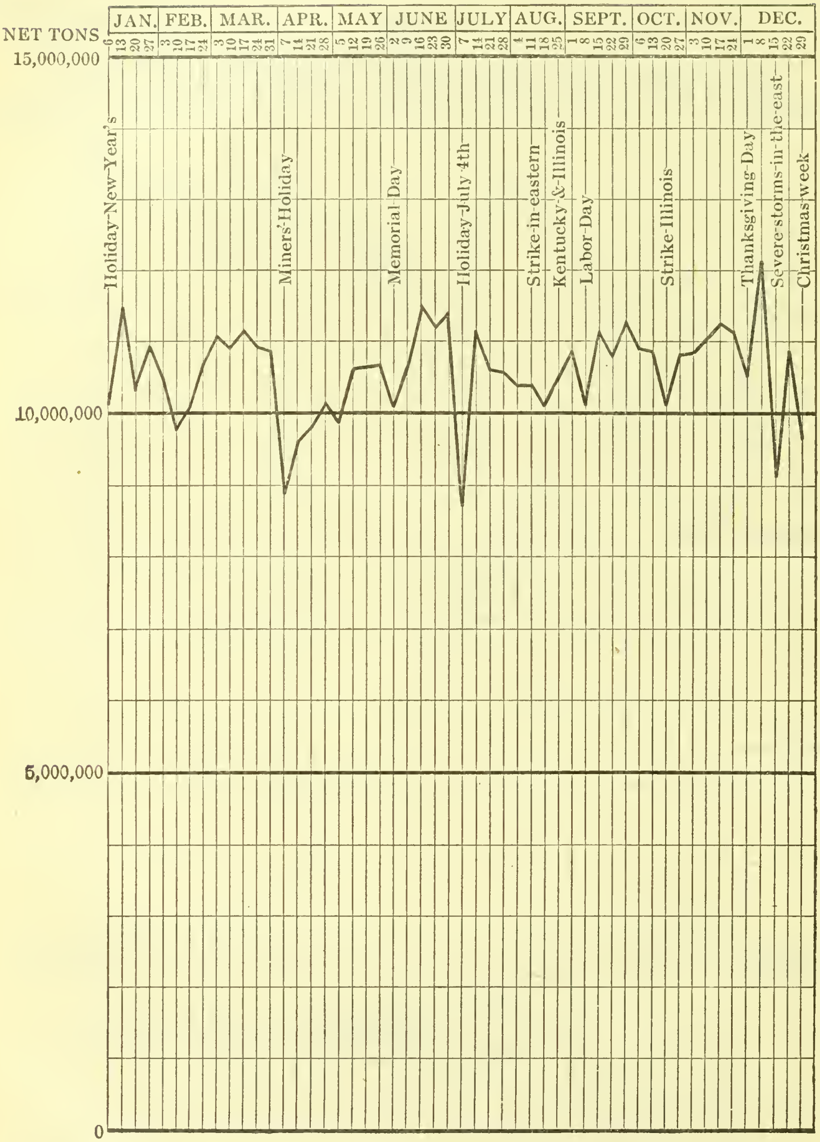

FIGURE 21.—Production of bituminous coal, by weeks, 1917.

Bituminous coal produced in the United States in 1917, by States, by weeks, estimated in net tons.

Week ended—	Total.	Alabama.	Arkansas.	Colorado.	Georgia.	Illinois.	Indiana.	Iowa.	Kansas.	Kentucky.	Maryland.	Michigan.	Missouri.
Jan. 6 a	10,168,981	378,743	42,930	290,528	1,905	1,634,505	518,736	176,028	128,302	571,761	88,021	28,708	109,309
Jan. 13	11,487,854	426,532	49,518	292,012	2,372	1,828,330	539,487	194,138	164,335	591,986	43,804	32,801	128,687
Jan. 20	10,372,305	401,975	48,752	301,096	2,332	1,724,843	461,532	201,479	156,249	511,854	89,835	33,340	126,724
Jan. 27	10,950,542	402,022	51,341	289,649	2,452	1,763,974	511,634	201,000	169,236	545,403	98,517	30,010	131,256
Feb. 3	10,511,634	393,510	44,986	147,640	2,243	1,777,329	492,128	201,474	148,481	546,901	88,103	33,570	120,037
Feb. 10	9,768,600	396,515	47,407	260,713	1,871	1,666,384	468,241	199,802	147,489	517,030	82,960	29,851	121,071
Feb. 17	10,130,494	434,985	50,627	269,164	2,281	1,817,877	513,926	177,022	162,510	547,451	73,743	27,019	129,415
Feb. 24	10,680,993	422,995	40,606	255,100	1,936	1,862,313	556,033	180,618	142,407	595,053	101,338	27,966	116,277
Mar. 3	11,057,990	426,738	41,295	270,976	2,366	1,804,969	551,184	178,925	146,128	571,117	96,907	32,256	115,323
Mar. 10	10,978,729	422,440	41,177	247,478	2,685	1,813,304	555,585	189,098	153,008	578,151	92,417	30,212	120,960
Mar. 17	11,190,597	400,759	40,748	272,503	2,170	1,757,612	537,399	174,556	144,873	565,949	94,201	33,165	112,315
Mar. 24	10,983,305	404,463	41,636	231,082	2,506	1,690,916	536,433	169,551	147,064	560,731	95,348	31,694	115,733
Mar. 31	10,940,489	426,206	46,464	213,981	2,442	1,589,913	472,873	155,547	149,504	556,234	101,798	28,922	103,986
Apr. 7	8,983,892	359,995	33,314	208,227	1,877	1,246,391	399,908	108,678	115,652	497,185	91,661	24,792	82,098
Apr. 14	9,563,537	371,479	34,727	208,850	2,291	1,429,267	455,697	135,364	118,042	508,356	88,751	24,897	74,216
Apr. 21	9,844,405	361,832	33,663	217,041	2,240	1,474,737	437,959	142,774	126,868	501,278	88,647	23,559	98,486
Apr. 28	10,171,290	371,752	35,502	216,653	2,237	1,533,025	459,194	151,517	124,945	482,659	93,829	28,514	95,109
May 5	9,951,888	363,532	35,705	212,377	2,533	1,459,369	441,634	156,841	122,145	511,030	91,305	28,019	97,459
May 12	10,677,483	372,485	39,917	232,168	2,688	1,693,841	528,317	172,557	151,584	530,444	84,863	28,494	116,671
May 19	10,726,802	395,879	39,049	222,277	2,704	1,680,458	531,804	174,393	140,345	550,820	100,995	25,175	111,954
May 26	10,769,566	411,281	43,338	232,904	2,632	1,571,716	505,697	165,079	139,857	550,023	100,922	26,084	105,052
June 2	10,112,384	395,831	41,946	212,110	2,562	1,481,996	476,162	162,253	132,180	528,473	96,865	25,045	100,124
June 9	10,789,399	377,079	41,141	223,711	2,257	1,629,829	488,139	167,294	148,629	558,606	95,322	25,646	107,878
June 16	11,485,326	414,660	43,031	238,648	2,415	1,755,585	536,828	171,999	148,444	565,772	97,964	27,407	109,618
June 23	11,243,060	395,746	39,967	261,041	2,410	1,675,838	488,836	189,391	134,137	548,452	100,683	15,151	106,320
June 30	11,446,386	436,457	43,681	224,075	2,673	1,684,156	508,664	183,247	152,775	591,401	91,807	25,007	112,425
July 7	8,765,856	308,378	32,994	164,854	2,046	1,380,751	432,097	143,742	108,906	444,788	68,173	19,714	88,568
July 14	11,153,598	395,189	41,144	212,044	2,131	1,649,242	502,812	182,975	130,982	587,409	88,129	24,393	107,923
July 21	10,622,797	368,457	39,186	232,115	2,348	1,659,621	496,588	168,794	130,537	554,030	89,745	24,355	102,712
July 28	10,649,973	358,085	40,073	224,458	2,165	1,603,166	456,950	162,870	141,946	533,959	93,456	23,196	102,791
Aug. 4	10,411,548	357,581	35,843	229,573	2,169	1,535,104	467,306	157,045	118,591	583,843	88,786	20,729	98,954
Aug. 11	10,476,766	351,591	37,527	227,089	2,265	1,543,800	476,734	160,460	130,891	477,863	89,708	27,797	99,474
Aug. 18	10,114,496	318,988	35,990	239,807	2,285	1,355,078	479,900	131,060	132,609	450,062	97,146	20,608	93,487
Aug. 25	10,586,017	325,856	39,869	237,076	2,263	1,605,563	508,900	161,453	119,039	480,022	100,054	27,333	101,027
Sept. 1	10,882,746	354,642	43,054	239,277	2,546	1,773,162	510,915	160,159	141,057	476,226	101,468	23,334	113,038
Sept. 8	10,058,631	328,889	38,349	223,398	2,421	1,428,665	463,868	152,453	128,145	477,162	83,054	31,962	94,622
Sept. 15	11,115,847	363,496	42,044	256,640	2,496	1,653,703	525,288	181,122	142,510	494,097	97,177	27,008	111,830
Sept. 22	10,830,915	353,622	37,930	254,217	2,535	1,641,503	517,128	164,957	128,426	494,017	92,287	23,901	104,923
Sept. 29	11,278,576	390,488	40,569	243,885	2,558	1,796,894	520,320	184,316	138,079	511,183	97,867	23,251	110,011
Oct. 6	10,961,700	341,899	39,296	241,698	2,150	1,636,637	523,339	167,197	131,033	498,708	99,906	26,779	107,120
Oct. 13	10,924,052	383,851	37,819	254,901	2,061	1,696,583	537,994	175,513	126,378	525,546	94,257	24,166	103,556
Oct. 20	10,124,762	364,286	37,338	219,789	1,607	1,315,158	474,851	172,151	124,870	502,762	92,055	23,218	89,951
Oct. 27	10,844,240	394,807	44,706	242,629	1,609	1,742,733	581,383	186,521	139,676	571,528	101,960	25,863	113,549

a To be excluded from total for 1917.

Bituminous coal produced in the United States in 1917, by States, by weeks, estimated in net tons—Continued.

Week ended—	Total.	Alabama.	Arkansas.	Colorado.	Georgia.	Illinois.	Indiana.	Iowa.	Kansas.	Kentucky.	Maryland.	Michigan.	Missouri.
Nov. 3	10,893,325	401,208	42,568	225,510	2,075	1,835,637	544,971	188,555	134,574	584,718	106,737	26,160	117,103
Nov. 10	11,071,343	393,956	42,656	244,339	2,294	1,852,594	562,986	195,634	134,703	555,520	100,324	26,411	111,645
Nov. 17	11,279,343	397,241	45,985	237,456	2,633	1,870,999	558,754	186,962	148,552	568,424	106,220	23,625	118,947
Nov. 24	11,187,437	414,312	44,567	239,684	2,547	1,830,969	573,425	193,569	143,097	590,843	101,842	26,982	113,886
Dec. 1	10,565,312	406,920	42,252	245,841	2,547	1,655,778	527,640	165,341	145,573	618,967	87,103	25,030	110,922
Dec. 8	12,143,493	463,544	47,024	267,095	2,088	1,963,760	631,276	209,283	168,230	602,173	109,614	29,676	127,294
Dec. 15	9,193,242	370,267	36,640	244,762	1,974	1,453,903	411,718	170,210	138,441	413,858	67,835	29,406	109,241
Dec. 22	10,923,147	420,954	46,026	252,208	2,168	1,999,562	547,682	198,307	152,339	536,346	88,720	29,361	128,638
Dec. 29	9,736,694	330,016	39,920	244,212	1,670	1,634,599	454,317	164,665	137,365	433,182	75,811	25,895	108,397
	a 551,736,608	20,068,074	2,143,579	12,483,336	119,028	86,199,387	26,539,329	8,965,830	7,184,975	27,807,971	4,745,924	1,374,805	5,670,549
Portion of week of Jan. 6, 1917, to be included in 1917	7,854,720	346,214	34,147	290,528	1,905	1,334,368	518,736	140,071	54,174	517,425	28,320	10,736	100,100
Portion of week of Jan. 5, 1918, to be included in 1917	2,267,082	76,189	8,525	86,775	297	335,883	276,157	35,848	27,365	110,951	15,585	5,320	21,646

Week ended—	Montana.	New Mexico.	North Dakota.	Ohio.	Oklahoma.	Pennsylvania.	Tennessee.	Texas.	Utah.	Virginia.	Washington.	West Virginia.	Wyoming.
Jan. 6 b	73,526	73,887	18,478	779,203	84,886	2,972,590	113,282	45,214	80,206	196,013	63,508	1,531,875	166.105
Jan. 13	92,420	81,600	18,209	809,865	102,205	3,570,908	117,497	50,419	87,539	215,126	72,539	1,767,159	207,366
Jan. 20	82,450	82,611	18,883	673,279	97,063	3,192,729	109,671	49,513	88,216	198,209	62,790	1,446,912	208,823
Jan. 27	88,378	81,893	20,559	745,647	99,010	3,345,664	112,059	52,099	81,957	200,638	77,611	1,646,836	201,027
Feb. 3	90,398	85,179	18,334	753,211	96,746	3,204,340	108,978	49,846	75,398	192,916	98,115	1,554,458	186,528
Feb. 10	87,844	81,001	17,173	634,496	85,415	2,924,283	103,531	49,241	75,709	182,902	84,416	1,344,823	157,447
Feb. 17	89,845	87,061	20,320	635,668	89,353	2,851,884	117,304	47,832	73,293	202,041	80,712	1,444,808	183,292
Feb. 24	85,192	84,290	14,384	711,056	77,112	3,141,298	114,969	43,767	68,311	202,349	70,899	1,605,547	158,233
Mar. 3	80,560	82,107	15,588	816,557	84,165	3,428,173	112,675	41,956	73,431	203,943	78,795	1,639,090	162,295
Mar. 10	83,889	82,452	18,738	785,570	74,808	3,465,013	120,201	43,219	76,509	182,755	70,575	1,573,593	154,053
Mar. 17	91,198	72,151	19,887	770,954	76,621	3,605,860	109,825	43,599	70,414	205,072	77,701	1,752,115	158,157
Mar. 24	92,406	83,500	17,001	756,762	67,801	3,573,674	114,051	42,161	76,232	217,230	75,087	1,687,690	152,114
Mar. 31	80,814	75,128	15,671	761,545	67,098	3,682,854	117,586	45,916	72,974	207,479	71,732	1,749,580	143,708
Apr. 7	55,023	70,609	11,961	576,966	54,773	2,953,958	105,688	39,944	67,424	180,428	65,025	1,489,774	142,004
Apr. 14	71,327	69,365	11,964	640,861	49,873	3,134,443	94,276	40,375	71,201	177,323	70,223	1,537,779	141,955
Apr. 21	67,937	75,352	12,382	729,740	62,174	3,259,510	105,512	43,253	69,422	172,632	66,549	1,518,827	151,353
Apr. 28	72,803	70,346	10,894	756,842	69,538	3,417,359	106,054	38,896	67,623	179,577	70,634	1,575,978	139,174
May 5	63,746	69,388	11,415	717,304	76,883	3,289,657	107,319	46,780	70,364	182,575	58,704	1,581,658	153,546
May 12	79,081	86,065	13,293	774,276	83,923	3,313,941	116,180	45,589	73,491	200,360	68,985	1,700,423	167,377
May 19	74,874	76,966	11,329	787,336	85,708	3,302,303	122,050	48,406	70,087	193,568	67,225	1,738,601	172,153
May 26	78,324	61,320	11,886	810,613	81,980	3,438,423	120,401	44,192	73,050	205,966	69,195	1,765,988	153,136

June 2	74,807	65,067	11,386	722,378	77,640	3,206,520	120,510	44,810	64,991	187,485	71,317	1,674,582	134,944
June 9	67,015	74,830	10,020	821,046	80,626	3,429,281	119,751	45,938	65,973	192,317	69,744	1,772,052	174,791
June 16	61,104	81,203	10,996	894,879	88,778	3,701,473	130,084	48,614	70,160	203,988	70,424	1,836,307	174,572
June 23	69,609	73,019	10,257	873,908	90,914	3,627,866	130,551	45,628	94,924	194,491	74,938	1,830,908	167,724
June 30	75,985	82,763	12,242	847,890	89,381	3,661,722	126,395	46,455	53,579	203,931	78,881	1,950,458	160,040
July 7	62,544	54,920	11,329	696,066	68,907	2,752,337	88,471	38,873	34,343	154,149	65,656	1,407,580	135,333
July 14	80,085	68,954	12,570	873,175	82,186	3,549,854	128,080	43,792	56,882	201,073	70,866	1,888,071	173,268
July 21	80,757	70,425	13,405	789,309	71,699	3,338,323	110,220	38,997	59,124	188,323	79,416	1,756,733	157,044
July 28	82,102	69,239	11,892	802,183	84,046	3,390,239	118,841	43,838	57,993	171,900	73,973	1,846,832	153,139
Aug. 4	78,202	71,097	12,890	816,569	77,020	3,275,222	123,506	45,256	58,891	193,775	67,683	1,735,718	159,680
Aug. 11	82,834	71,795	13,566	857,547	83,994	3,400,343	125,557	46,790	61,401	190,881	70,669	1,690,146	155,527
Aug. 18	75,249	73,096	12,449	859,957	76,341	3,244,256	107,174	47,157	63,336	175,130	72,485	1,787,836	162,404
Aug. 25	81,192	66,571	14,310	812,880	85,056	3,323,762	114,336	48,578	71,558	179,384	74,720	1,832,199	172,503
Sept. 1	82,411	78,007	15,104	800,092	82,146	3,441,382	121,047	48,663	72,795	192,469	76,142	1,774,534	158,163
Sept. 8	76,216	74,763	13,787	769,499	73,669	3,186,130	114,558	38,588	76,196	191,650	67,194	1,785,500	137,180
Sept. 15	84,041	85,136	13,690	871,351	89,226	3,569,097	120,454	48,004	84,182	194,353	70,180	1,829,499	158,506
Sept. 22	85,316	78,450	15,348	859,802	80,028	3,452,531	122,008	41,986	89,542	190,084	77,729	1,765,655	156,236
Sept. 29	84,745	78,789	14,772	831,511	89,611	3,619,220	119,514	47,122	78,295	196,447	74,699	1,826,364	157,439
Oct. 6	80,302	77,460	14,857	853,231	82,121	3,547,409	120,752	41,997	80,946	204,029	70,080	1,835,809	136,068
Oct. 13	81,786	79,494	14,663	812,556	84,749	3,450,897	126,803	45,494	111,889	195,995	72,592	1,732,806	150,734
Oct. 20	81,646	73,994	13,959	784,211	82,430	3,367,158	121,111	43,077	94,311	184,057	71,817	1,653,630	134,596
Oct. 27	87,689	76,800	15,184	843,540	87,633	3,207,630	126,435	46,208	102,995	198,040	76,120	1,676,946	150,703
Nov. 3	76,005	73,374	16,870	851,766	93,535	3,120,967	125,220	46,808	100,898	196,971	80,025	1,728,190	171,598
Nov. 10	98,531	70,989	21,047	835,705	92,662	3,308,031	132,393	44,418	94,909	202,240	105,101	1,660,563	180,685
Nov. 17	92,870	76,852	17,839	857,602	90,653	3,329,700	131,249	46,815	86,042	208,738	99,431	1,790,067	184,791
Nov. 24	98,872	77,791	17,634	796,419	96,407	3,347,879	136,574	45,338	98,253	204,173	97,252	1,709,961	183,424
Dec. 1	90,699	83,272	17,358	753,029	83,930	3,196,565	132,833	42,149	94,051	198,694	91,199	1,574,727	171,141
Dec. 8	105,769	100,452	20,639	872,665	133,204	3,716,046	145,015	56,714	107,498	213,292	103,023	1,739,696	206,480
Dec. 15	98,453	87,348	20,842	557,719	80,993	2,861,981	118,427	47,193	104,630	181,404	106,671	1,280,477	196,880
Dec. 22	107,462	98,067	20,985	771,264	96,265	3,186,889	133,189	47,804	115,372	202,101	84,083	1,447,565	208,023
Dec. 29	93,342	88,949	18,367	767,020	81,078	3,008,628	99,169	34,741	113,724	162,422	81,695	1,344,790	190,779
	4,226,689	4,000,527	790,548	40,748,734	4,386,844	172,448,142	6,194,221	2,355,815	4,125,230	10,087,091	4,009,902	86,441,667	8,575,619
Portion of week of Jan. 6, 1917, to be included in 1917	23,122	43,611	15,970	779,203	84,886	2,023,288	113,282	45,214	80,206	194,421	63,508	879,440	131,119
Portion of week of Jan. 5, 1918, to be included in 1917	17,118	15,566	4,450	164,214	62,781	509,242	54,885	5,753	42,696	35,595	43,077	274,387	36,364

a Excludes Alaska; includes California and Oregon, which are not shown by weeks.

b To be excluded from total for 1917.

The increase in production in 1917 compared with 1916 was not shared equally by all producing fields. As is shown in the table on page 910, the increase was mainly in the fields west of the Pennsylvania-Ohio State line. The only States to record decreases were Georgia, Oregon, South Dakota, and West Virginia, all of which, with the exception of West Virginia, are of minor importance. The largest and most significant increases were in Illinois, 30 per cent; Indiana, 32 per cent; and Ohio, 17 per cent. The statistics of production by States in 1916 and 1917 are given in the tables on pages 920–921, which are discussed in proper sequence later in the report.

In the first column of the tables the quantities loaded at the mines on railroad cars or on boats for shipment are given. Some of the coal reported under this heading, however, is shipped only a short distance and is really used locally. For instance, a considerable portion of the coal mined in the Birmingham, Ala., district is used locally by the iron and steel industry, but as the coal is loaded on railroad cars and as the tonnage appears in the statistics of movement of coal it is placed under the heading of shipped coal. A portion of the coal made into beehive coke in the mining regions is loaded on cars, and, although transported perhaps only a mile or less, is recorded as shipped coal. It should be noted that not all the coal shipped carries a freight charge or furnishes revenue for the railroads, as the coal for the use of the roads that enter the coal fields is non-revenue freight.

In the second column the quantities used locally are given. Under that designation are included wagon trade, coal used by employees, coal loaded directly from the tipple into engine tenders, and that part of the product used in the immediate vicinity of the mine by such industries as brick and sewer pipe plants, power plants, and mills of various kinds. It is presumably transported from the mine to the place of consumption in the mine cars, by wagons or on private tramroads.

The coal used to generate steam and heat for the operation of the mine is shown in the third column, and that charged into coke ovens directly is given in the fourth column.

The total quantity, which is the sum of these items, represents only the usable fuel. Refuse, slate, and bone brought out of the mine or picked or sorted from the coal in the tipple and refuse from washeries and dry-cleaning plants are not considered as part of the quantity of coal produced, although the cost per ton of bringing this material to the surface is as great as that of the coal. The total value is the sum of all the values reported by the individual operators, and the average value is the total divided by the total tons.

The schedules sent out by the Geological Survey request that the total number of full days each mine was operated be given, and also the average number of employees, exclusive of office force and coke workers. The number of days a mine was operated is shown directly by the mine records, and the average number of employees is obtained by dividing the number of days into the total shifts, or "men-days," recorded in the pay rolls or time books at each operation. The sum of the number of men thus reported (obtained in the Survey) is considered the total for each county and State, or for the United States, as the case may be. The sum of the men-days for all mines is divided by the total number of days on which the total number of men were at work or that the mines were active.

The quantity and value of the coal produced in each State in the five years 1913–1917 and the change and percentage of change in 1917 are shown in the third of the following tables. The annual production of coal in each State from the time of earliest recorded output until the end of 1917 is given in the tabular statement in the pocket.

Coal produced in the United States in 1916.

State.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.			Average number of days worked.
								Under-ground.	Surface.	Total.	
Alabama	14,422,356	390,682	587,211	2,685,948	18,086,197	$24,859,831	$1.37	21,453	3,855	25,308	262
Alaska	7,913	5,098	62		13,073	52,317	4.00	69	14	83	179
Arkansas	1,881,105	44,254	69,556		1,994,915	3,836,845	1.92	3,055	717	3,772	184
California and Idaho	1,593	4,647	1,000		7,240	15,367	2.12	11	7	18	188
Colorado	8,057,820	396,376	271,484	1,758,557	10,484,237	16,964,104	1.62	10,456	2,648	13,104	233
Georgia	76,954	1,672	7,200	87,728	173,554	310,093	1.79	322	89	411	280
Illinois	61,486,342	3,086,157	1,622,837		66,195,336	82,457,954	1.25	68,127	7,411	75,538	198
Indiana	18,839,568	790,345	463,615		20,093,528	25,506,246	1.27	20,992	2,973	23,965	187
Iowa	6,521,770	591,717	147,313		7,260,800	13,530,383	1.86	12,960	1,483	14,443	202
Kansas	6,577,064	145,053	159,338		6,881,455	12,252,723	1.78	10,325	1,807	12,132	204
Kentucky	23,473,421	783,268	484,741	652,567	25,393,997	30,193,047	1.19	26,501	4,721	31,222	208
Maryland	4,320,720	74,113	65,213		4,460,046	6,947,623	1.56	4,719	914	5,633	256
Michigan	1,097,107	51,770	31,483		1,180,360	2,653,182	2.25	2,124	411	2,535	216
Missouri	4,219,414	435,868	86,864		4,742,146	9,044,505	1.91	7,877	1,777	9,654	207
Montana	3,350,665	142,130	139,732		3,632,527	6,286,197	1.73	3,065	716	3,781	244
New Mexico	2,873,313	50,421	25,194	844,083	3,793,011	5,580,369	1.47	3,304	1,218	4,522	292
North Dakota	440,752	173,936	20,224		634,912	946,082	1.49	553	161	714	244
Ohio	31,995,913	2,123,678	607,908	720	34,728,219	46,150,907	1.33	36,680	4,714	41,394	197
Oklahoma	3,395,363	34,000	178,648		3,608,011	7,525,427	2.09	6,620	1,180	7,800	178
Oregon	28,373	7,482	6,737		42,592	113,976	2.68	78	28	106	236
Pennsylvania (bituminous)	123,181,649	4,212,186	3,375,483	39,526,106	170,295,424	221,685,175	1.30	139,186	29,026	168,212	259
South Dakota	891	7,995			8,886	18,021	2.03	26	12	38	145
Tennessee	5,266,733	99,289	174,093	597,334	6,137,449	7,522,445	1.23	7,661	1,550	9,211	239
Texas	1,939,947	17,670	29,886		1,987,503	3,092,663	1.56	3,901	580	4,481	218
Utah	2,686,880	65,260	78,435	736,853	3,567,428	5,795,944	1.62	2,397	732	3,129	228
Virginia	7,513,641	156,730	113,376	1,923,727	9,707,474	10,261,424	1.06	7,359	2,418	9,777	272
Washington	2,701,031	75,954	124,740	136,863	3,038,588	6,907,428	2.27	3,764	1,033	4,797	217
West Virginia	79,760,681	1,768,827	1,171,205	3,759,414	86,460,127	102,366,092	1.18	64,618	13,449	78,067	237
Wyoming	7,547,706	96,055	266,886		7,910,647	12,239,707	1.55	6,041	1,214	7,255	248
Total bituminous	423,666,685	15,832,633	10,310,464	52,709,900	502,519,682	665,116,077	1.32	474,244	86,858	561,102	230
Pennsylvania (anthracite)	75,601,526	2,216,087	9,760,880		87,578,493	202,009,561	2.30	116,705	43,164	159,869	253
Grand total	499,268,211	18,048,720	20,071,344	52,709,900	590,098,175	867,125,638	1.47	590,949	130,022	720,971	235

Coal produced in the United States in 1917.

State.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees. Underground.	Surface.	Total.	Average number of days worked
Alabama	15,272,716	508,398	641,733	3,645,227	20,068,074	$45,616,992	$2.27	22,925	5,461	28,386	273
Alaska		53,955			53,955	265,317	4.92	(a)	(a)	(a)	(a)
Arkansas	2,009,408	59,104	75,067		2,143,579	5,492,777	2.56	3,135	863	3,998	187
California and Idaho	2,800	3,383	240		6,423	14,791	2.30	11	6	17	173
Colorado	9,770,529	450,392	304,492	1,957,923	12,483,336	27,669,129	2.22	11,285	2,946	14,231	263
Georgia	37,855	1,284	7,200	72,689	119,028	301,391	2.53	205	76	281	269
Illinois	80,283,345	3,541,792	2,374,250		86,199,387	162,281,822	1.88	75,085	9,005	84,090	243
Indiana	24,991,177	905,601	642,551		26,539,329	52,940,106	1.99	22,664	3,864	26,528	221
Iowa	7,954,466	784,970	226,394		8,965,830	21,096,408	2.35	12,672	1,594	14,266	251
Kansas	6,838,507	161,004	185,464		7,184,975	16,618,277	2.31	8,816	1,864	10,680	216
Kentucky	25,674,798	893,580	639,977	599,616	27,807,971	60,297,653	2.17	28,162	6,764	34,926	214
Maryland	4,582,436	104,578	58,910		4,745,924	11,667,852	2.46	4,696	1,223	5,919	254
Michigan	1,244,795	82,045	47,965		1,374,805	4,426,314	3.22	2,154	252	2,406	254
Missouri	4,942,689	576,079	151,781		5,670,549	13,755,864	2.43	7,680	1,988	9,668	240
Montana	3,882,919	176,066	167,704		4,226,689	8,919,136	2.11	3,338	811	4,149	268
New Mexico	2,927,954	44,636	36,449	991,488	4,000,527	7,455,166	1.86	3,191	935	4,126	321
North Dakota	559,571	196,900	34,077		790,548	1,425,750	1.80	619	202	821	255
Ohio	37,462,479	2,534,344	751,281	630	40,748,734	100,897,148	2.48	38,569	6,940	45,509	210
Oklahoma	4,152,162	45,492	189,190		4,386,844	12,335,413	2.81	7,017	1,478	8,495	211
Oregon	13,736	9,087	5,504		28,327	95,663	3.38	77	27	104	251
Pennsylvania (bituminous)	128,965,937	5,275,741	3,499,727	34,706,737	172,448,142	421,268,808	2.44	143,687	30,281	173,968	261
South Dakota	647	7,395			8,042	23,346	2.90	34		34	154
Tennessee	5,170,586	135,348	164,698	723,589	6,194,221	13,592,998	2.19	8,053	2,368	10,421	241
Texas	2,292,358	14,102	49,355		2,355,815	4,177,608	1.77	3,683	692	4,375	263
Utah	3,292,758	77,028	86,128	669,316	4,125,230	8,531,382	2.07	2,569	916	3,485	219
Virginia	7,733,626	173,535	145,231	2,034,699	10,087,091	20,125,713	2.00	8,607	2,561	11,168	273
Washington	3,614,329	71,606	166,399	157,568	4,009,902	10,727,362	2.68	4,072	1,240	5,312	271
West Virginia	77,996,698	2,494,393	1,194,951	4,755,625	86,441,667	200,659,368	2.32	69,155	19,267	88,422	225
Wyoming	8,179,694	125,484	270,441		8,575,619	16,593,283	1.93	6,024	1,334	7,358	246
Total bituminous	469,850,975	19,507,322	12,117,159	50,315,107	551,790,563	1,249,272,837	2.26	498,185	104,958	603,143	243
Pennsylvania (anthracite)	86,788,848	2,382,362	10,440,601		99,611,811	283,650,723	2.85	109,989	44,185	154,174	285
Grand total	556,639,823	21,889,684	22,557,760	50,315,107	651,402,374	1,532,923,560	2.35	608,174	149,143	757,317	251

a Not available.

Coal produced in the United States, 1913–1917, and increase or decrease in 1917.

State.	1913		1914		1915	
	Quantity (net tons).	Value.	Quantity (net tons).	Value.	Quantity (net tons).	Value.
Alabama	17,678,522	$23,083,724	15,593,422	$20,849,919	14,927,937	$19,066,043
Arkansas	2,234,107	3,923,701	1,836,540	3,158,168	1,652,106	2,950,456
California and Alaska	26,911	95,173	a 13,974	a 39,821	a 13,903	a 35,354
Colorado	9,232,510	14,035,090	8,170,559	13,601,718	8,624,980	13,599,264
Georgia	255,626	361,319	166,498	239,462	134,496	231,861
Idaho and Nevada	2,177	5,285	(b)	(b)	(b)	(b)
Illinois	61,618,744	70,313,605	57,589,197	64,693,529	58,829,576	64,622,471
Indiana	17,165,671	19,001,881	16,641,132	18,290,928	17,006,152	18,637,476
Iowa	7,525,936	13,496,710	7,451,022	13,364,070	7,614,143	13,577,608
Kansas	7,202,210	12,036,292	6,860,988	11,238,253	6,824,474	11,360,630
Kentucky	19,616,600	20,516,749	20,382,763	20,852,463	21,361,674	21,494,008
Maryland	4,779,839	5,927,046	4,133,547	5,234,796	4,180,477	5,330,845
Michigan	1,231,786	2,455,227	1,283,030	2,559,786	1,156,138	2,372,797
Missouri	4,318,125	7,468,308	3,935,980	6,802,325	3,811,593	6,595,918
Montana	3,240,973	5,653,539	2,805,173	4,913,191	2,789,755	4,526,509
New Mexico	3,708,806	5,401,260	3,877,689	6,230,871	3,817,940	5,481,361
North Dakota	495,320	750,652	506,685	771,379	528,078	766,072
Ohio	36,200,527	39,948,058	18,843,115	21,250,642	22,434,691	24,207,075
Oklahoma	4,165,770	8,542,748	3,988,613	8,204,015	3,693,580	7,435,906
Oregon	46,063	116,724	51,558	143,556	39,231	111,240
Pennsylvania (bituminous)	173,781,217	193,039,806	147,983,294	159,006,296	157,955,137	167,419,705
South Dakota	10,540	20,648	11,850	20,456	10,593	16,384
Tennessee	6,860,184	7,839,721	5,943,258	6,776,573	5,730,361	6,479,916
Texas	2,429,144	4,288,920	2,323,773	3,922,459	2,088,908	3,445,487
Utah	3,254,828	5,384,127	3,103,036	4,935,454	3,108,715	4,916,916
Virginia	8,828,068	8,952,653	7,959,535	8,032,448	8,122,596	7,962,934
Washington	3,877,891	9,243,137	3,064,820	6,751,511	2,429,095	5,276,299
West Virginia	71,254,136	71,822,804	71,707,626	71,391,408	77,184,069	74,561,349
Wyoming	7,393,066	11,510,045	6,475,293	10,033,747	6,554,028	9,555,804
Total bituminous	478,435,297	565,234,952	422,703,970	493,309,244	442,624,426	502,037,688
Pennsylvania (anthracite)	91,524,922	195,181,127	90,821,507	188,181,399	88,995,061	184,653,498
Grand total	569,960,219	760,416,079	513,525,477	681,490,643	531,619,487	686,691,186

a California, Idaho, and Nevada in 1914; California, Alaska, Idaho, and Nevada in 1915; and California, Alaska, and Idaho in 1916.
b Included with California.

Coal produced in the United States, 1913–1917, and increase or decrease in 1917—Continued.

State.	1916		1917		Increase or decrease, 1917.			
					Quantity.		Value.	
	Quantity (net tons).	Value.	Quantity (net tons).	Value.	Net tons.	Per cent.	Dollars.	Per cent.
Alabama	18,086,197	$24,859,831	20,068,074	$45,616,992	+ 1,981,877	+ 11.0	+$20,757,161	+ 83.5
Arkansas	1,994,915	3,836,845	2,143,579	5,492,777	+ 148,664	+ 7.5	+ 1,655,932	+ 43.2
California and Alaska	a 20,313	a 67,684	a 60,378	a 280,108	+ 40,065	+197.2	+ 212,424	+313.8
Colorado	10,484,237	16,964,104	12,483,336	27,669,129	+ 1,999,099	+ 19.1	+ 10,705,025	+ 63.1
Georgia	173,554	310,093	119,028	301,391	− 54,526	− 31.4	− 8,702	− 2.8
Idaho and Nevada	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)
Illinois	66,195,336	82,457,954	86,199,387	162,281,822	+20,004,051	+ 30.2	+ 79,823,868	+ 96.8
Indiana	20,093,528	25,506,246	26,539,329	52,940,106	+ 6,445,801	+ 32.1	+ 27,433,860	+107.6
Iowa	7,260,800	13,530,383	8,965,830	21,096,408	+ 1,705,030	+ 23.5	+ 7,566,025	+ 55.9
Kansas	6,881,455	12,252,723	7,184,975	16,618,277	+ 303,520	+ 4.4	+ 4,365,554	+ 35.6
Kentucky	25,393,997	30,193,047	27,807,971	60,297,653	+ 2,413,974	+ 9.5	+ 30,104,606	+ 99.7
Maryland	4,460,046	6,947,623	4,745,924	11,667,852	+ 285,878	+ 6.4	+ 4,720,229	+ 67.9
Michigan	1,180,360	2,653,182	1,374,805	4,426,314	+ 194,445	+ 16.5	+ 1,773,132	+ 66.8
Missouri	4,742,146	9,044,505	5,670,549	13,755,864	+ 928,403	+ 19.6	+ 4,711,359	+ 52.0
Montana	3,632,527	6,286,197	4,226,689	8,919,136	+ 594,162	+ 16.4	+ 2,632,939	+ 41.9
New Mexico	3,793,011	5,580,369	4,000,527	7,455,166	+ 207,516	+ 5.5	+ 1,874,797	+ 33.6
North Dakota	634,912	946,082	790,548	1,425,750	+ 155,636	24.5	+ 479,668	+ 50.7
Ohio	34,728,219	46,150,907	40,748,734	100,897,148	+ 6,020,515	+ 17.3	+ 54,746,241	+118.6
Oklahoma	3,608,011	7,525,427	4,386,844	12,335,413	+ 778,833	+ 21.6	+ 4,809,986	+ 63.9
Oregon	42,592	113,976	28,327	95,663	− 14,265	− 33.5	− 18,313	− 16.1
Pennsylvania (bituminous)	170,295,424	221,685,175	172,448,142	421,268,808	+ 2,152,718	+ 1.3	+199,583,633	+ 90.0
South Dakota	8,886	18,021	8,042	23,346	− 844	− 9.5	+ 5,325	+ 29.6
Tennessee	6,137,449	7,522,445	6,194,221	13,592,998	+ 56,772	+ 0.9	+ 6,070,553	+ 80.7
Texas	1,987,503	3,092,663	2,355,815	4,177,608	+ 368,312	+ 18.5	+ 1,084,945	+ 35.1
Utah	3,567,428	5,795,944	4,125,230	8,531,382	+ 557,802	+ 15.6	+ 2,735,438	+ 47.2
Virginia	9,707,474	10,261,424	10,087,091	20,125,713	+ 379,617	+ 3.9	+ 9,864,289	+ 96.1
Washington	3,038,588	6,907,428	4,009,902	10,727,362	+ 971,314	+ 32.0	+ 3,819,934	+ 55.3
West Virginia	86,460,127	102,366,092	86,441,667	200,659,368	− 18,460	− 0.02	+ 98,293,276	+ 96.0
Wyoming	7,910,647	12,239,707	8,575,619	16,593,283	+ 664,972	+ 8.5	+ 4,353,576	+ 35.6
Total bituminous	502,519,682	665,116,077	551,790,563	1,249,272,837	+49,270,881	+ 9.8	+584,156,760	+ 87.8
Pennsylvania (anthracite)	87,578,493	202,009,561	99,611,811	283,650,723	+12,033,318	+ 13.7	+ 81,641,162	+ 40.4
Grand total	590,098,175	867,125,638	651,402,374	1,532,923,560	+61,304,199	+ 10.4	+665,797,922	+ 76.8

a California, Idaho, and Nevada in 1914; California, Alaska, Idaho, and Nevada in 1915; and California, Alaska, and Idaho in 1916 and 1917.
b Included with California.

Coal produced in the United States from 1807 to the end of 1917 in net tons.

Year.	Pennsylvania anthracite.	Bituminous.	Total.	Year.	Pennsylvania anthracite.	Bituminous.	Total.
1807-1820	12,000	3,000	15,000	1871	19,342,057	27,543,023	46,885,080
				1872	24,233,166	27,220,233	51,453,399
1821	1,322	....	1,322	1873	26,152,837	31,449,643	57,602,480
1822	4,583	54,000	58,583	1874	24,818,790	27,787,130	52,605,920
1823	8,563	60,000	68,563	1875	22,485,766	29,862,554	52,348,320
1824	13,685	67,040	80,725				
1825	42,988	75,000	117,988	1876	22,793,245	30,486,755	53,280,000
				1877	25,660,316	34,841,444	60,501,760
1826	59,194	88,720	147,914	1878	21,689,682	36,245,918	57,935,600
1827	78,151	94,000	172,151	1879	30,207,793	37,898,006	68,105,799
1828	95,500	100,408	195,908	1880	28,649,812	42,831,758	71,481,570
1829	138,086	102,000	240,086				
1830	215,272	104,800	320,072	1881	31,920,018	53,961,012	85,881,030
				1882	35,121,256	68,429,933	103,551,189
1831	217,842	120,100	337,942	1883	38,456,845	77,250,680	115,707,525
1832	447,550	146,500	594,050	1884	37,156,847	82,998,704	120,155,551
1833	600,907	133,750	734,657	1885	38,335,974	72,824,321	111,160,295
1834	464,015	136,500	600,515				
1835	690,854	134,000	824,854	1886	39,035,446	74,644,981	113,680,427
				1887	42,088,197	88,562,314	130,650,511
1836	842,832	142,000	984,832	1888	46,619,564	102,040,093	148,659,657
1837	1,071,151	182,500	1,253,651	1889	45,546,970	95,682,543	141,229,513
1838	910,075	445,452	1,355,527	1890	46,468,641	111,302,322	157,770,963
1839	1,008,322	552,038	1,560,360				
1840	967,108	1,102,931	2,070,039	1891	50,665,431	117,901,238	168,566,669
				1892	52,472,504	126,856,567	179,329,071
1841	1,182,441	1,108,700	2,291,141	1893	53,967,543	128,385,231	182,352,774
1842	1,365,563	1,244,494	2,610,057	1894	51,921,121	118,820,405	170,741,526
1843	1,556,753	1,504,121	3,060,874	1895	57,999,337	135,118,193	193,117,530
1844	2,009,207	1,672,045	3,681,252				
1845	2,480,032	1,829,872	4,309,904	1896	54,346,081	137,640,276	191,986,357
				1897	52,611,680	147,617,519	200,229,199
1846	2,887,815	1,977,707	4,865,522	1898	53,382,644	166,593,623	219,976,267
1847	3,551,005	1,735,062	5,286,067	1899	60,418,005	193,323,187	253,741,192
1848	3,805,942	1,968,032	5,773,974	1900	57,367,915	212,316,112	269,684,027
1849	3,995,334	2,453,497	6,448,831				
1850	4,138,164	2,880,017	7,018,181	1901	67,471,667	225,828,149	293,299,816
				1902	41,373,595	260,216,844	301,590,439
1851	5,481,065	3,253,460	8,734,525	1903	74,607,068	282,749,348	357,356,416
1852	6,151,957	3,664,707	9,816,664	1904	73,156,709	278,659,689	351,816,398
1853	6,400,426	4,169,862	10,570,288	1905	77,659,850	315,062,785	392,722,635
1854	7,394,875	4,582,227	11,977,102				
1855	8,141,754	4,784,919	12,926,673	1906	71,282,411	342,874,867	414,157,278
				1907	85,604,312	394,759,112	480,363,424
1856	8,534,779	5,012,146	13,546,925	1908	83,268,754	332,573,944	415,842,698
1857	8,186,567	5,153,622	13,340,189	1909	81,070,359	379,744,257	460,814,616
1858	8,426,102	5,548,376	13,974,478	1910	84,485,236	417,111,142	501,596,378
1859	9,619,771	6,013,404	15,633,175				
1860	8,115,842	6,494,200	14,610,042	1911	90,464,067	405,907,059	496,371,126
				1912	84,361,598	450,104,982	534,466,580
1861	9,799,654	6,688,358	16,488,012	1913	91,524,922	478,435,297	569,960,219
1862	9,695,110	7,790,725	17,485,835	1914	90,821,507	422,703,970	513,525,477
1863	11,785,320	9,533,742	21,319,062	1915	88,995,061	442,624,426	531,619,487
1864	12,538,649	11,066,474	23,605,123	1916	87,578,493	502,519,682	590,098,175
1865	11,891,746	11,900,427	23,792,173	1917	99,611,811	551,790,563	651,402,374
1866	15,651,183	13,352,400	29,003,583		2,813,702,882	9,317,102,568	12,130,805,450
1867	16,002,109	14,722,313	30,724,422				
1868	17,003,405	15,858,555	32,861,960				
1869	17,083,134	15,821,226	32,904,360				
1870	15,664,275	17,371,305	33,035,580				

FACTORS LIMITING PRODUCTION OF BITUMINOUS COAL.

Coal mines are operated a scheduled number of hours a day—8, 9, or 10 (see pp. 934–935) unless for some cause the operations are curtailed to a less number of hours. The causes that may be responsible for less than full-time operation are (1) lack of railroad cars on which to load the coal—railroad disability; (2) lack of sufficient men to operate the mines—labor troubles, labor shortage, or strike; (3) an accident or breakdown of machinery that prevents the mining or loading of coal—mine disability; (4) no market for the coal.

Railroad disability or, as it is commonly called, "car shortage," may be due to actual lack of cars on the railroad or to inability of the railroad, because of congestion on its rails or by reason of wrecks or washouts to serve the mines with empty cars available or to take away the loaded cars.

Lack of men to operate the mine, causing loss of running time, may result from strikes or simply from absenteeism. It is not uncommon for mine laborers to celebrate local holidays, to have picnics, to attend funerals, to observe pay day as a holiday, and otherwise to absent themselves from the mines in number sufficient to prevent operation. The loss of time on such occasions may properly be described as due to labor shortage, for such it is at the time.

A breakdown in the machinery, a fall of roof in a main entry, or a failure in the power or in the ventilating system that prevents the operation of the mine or causes loss of running time of sufficient moment to interfere with the hourly output is described as mine disability. On the other hand, a breakdown on the tipple that for a short period prevents the dumping of coal into the railroad cars may not interfere with the day's loading, for mining underground and loading of mine cars may progress in the meantime and as great a quantity may be produced as if the tipple had not been temporarily disabled.

Lack of business from lack of market may be responsible for the idleness of a mine and in normal times is the most common cause of nonoperation. If no orders are at hand, the operators of bituminous coal mines have no choice but to close down. Railroad cars represent the only storage capacity available to nearly all soft-coal mines and the possibilities in this direction are soon exhausted, for the railroads will not permit more than a few "no-bills" to remain on track at the mines, and shipping coal to market centers in the hope of selling it after arrival is often a poor undertaking and unprofitable.

There are exceptional causes, other than those briefly described above, to which nonoperation may be attributed. For instance, certain river mines may be closed because of ice in the river or from lack of barges in which to load coal. This is disability in transportation but not in railroad transportation.

When, early in the summer of 1917, the Committee on Coal Production requested the Geological Survey to prepare a series of weekly reports on the production of bituminous coal including the factors limiting production, the inquiry was conducted to bring out the relative importance of the causes just described. This information was collected and published in the form of weekly bulletins, beginning with June, 1917, and is used in this report, particularly in some of the diagrams. It is believed that a detailed description of the method of collecting and compiling these data will be valuable, for the purpose and the limitations of these statistics have not always been fully understood.

The information was obtained weekly from the operators, either directly or through the secretaries of the local associations. In fact, the collection of these data from a sufficient number of operators to make the bulletins worth while would not have been possible except for the cooperation of these associations, nearly all of which not only gathered the information from their members but spared neither expense nor effort in getting it also from nonmember operators in their respective districts. The writer desires at this point to express his appreciation of the hearty and helpful assistance of the many local secretaries and officers of the associations and of the operators themselves whose combined aid made the weekly bulletins possible.

The information was requested and, for the most part, furnished in answer to the following inquiries, a report for each mine showing for the week: (1) Tons produced; (2) hours of mine operation; (3) hours lost, by causes, divided between (*a*) car shortage, (*b*) labor shortage, (*c*) mine disability, (*d*) no market.

It is important that reports of this character be promptly available and that they be presented on a comparable basis. The inherent difficulties in collecting so large a number of statements each week (more than 6,000 a week at the maximum) made it necessary to avoid depending on having each week reports from exactly the same operations. The results were therefore reduced to percentages of full-time operation, it being assumed each week that the returns received were representative of the fields covered. Thus, if reports were obtained from mines representing 80 per cent of the production of a given district, showing 70 per cent full-time operation in a given week, it was assumed that the 20 per cent not reporting also operated 70 per cent of full time.

In order properly to compare the results from week to week and as between districts or railroads by reports of this type, it is essential to convert the data presented in hours to tons before arriving at totals. This necessity may be illustrated by conceiving a district with but two mines, one able to produce 50 tons an hour, or 400 tons a day, and the other 500 tons an hour, or 4,000 tons a day, the two, representing the district, being able to produce 4,400 tons a day with full-time operation. If the small mine works 4 hours out of 8 and produces 200 tons and the large mine works 8 hours and produces 4,000 tons, the total of mine hours worked is 12 out of a possible combined 16, or 75 per cent. But the combined output on that day was 4,200 tons out of a total full-time capacity of 4,400 tons, or 95 per cent. On the contrary, if the smaller mine operated 8 hours and produced 400 tons and the larger mine operated 4 hours and produced 2,000 tons, the two mines again worked 75 per cent of the possible total hours but produced only 2,400 tons, or 55 per cent of the full-time capacity. Only if the two mines operated the same number of hours would the percentage of hours worked and lost and of capacity produced be equal.

The method pursued in thus "weighting" the returns from all mines, large and small, was to calculate for each mine each week the capacity in tons by dividing the tons produced by the hours worked and multiplying by the number of working hours in a week, generally 48. Thus a mine that in a given week produced 4,500 tons in 30 hours was considered capable of producing 4,500 divided by 32 or 150 tons in one hour and 7,200 tons in a week of 48 hours. If of the 18 hours lost that week, 12 hours was lost because of no cars and 6 hours because of mine disability, it was considered that 12 times 150 or 1,800 tons was lost because of car shortage and 6 times 150 or 900 tons because of mine disability. Similar calculations were made for each mine each week, and the quantities produced and lost for each cause were added and their percentage to the total capacity determined. District totals in tons were added and percentages for the United States were determined in the same way. The accompanying sample page of such calculations illustrates the method in detail.

It is at once apparent that this method gives a variable capacity from week to week. The hourly rate of production will vary under the influence of many factors, the most potent of which is the number of men at work. A mine equipped underground and on the surface to produce and load 1,000 tons of coal a day may have only sufficient labor to produce 800 tons a day and may, because of local conditions, produce an average of more or less than 800 tons a day over a period of time. What might be termed the potential capacity of that mine would be 1,000 tons; the present capacity would be 800 tons. The potential capacity is a theoretical figure, to determine which it is necessary to consider the thickness of the coal, the number of working places, the average number of tons of coal produced by each miner at each working place, the underground haulage equipment, the tipple capacity, the mine track capacity, the housing capacity for employees, and numerous other engineering data. The determination of potential capacity has been attempted by certain railroads as one of the factors in car rating, but the difficulties are so great and the application of the results so uncertain that the method has been almost generally abandoned.

Instead of the potential or theoretical calculated capacity, dependence is placed on actual performance. The quantity in tons produced per hour over a period of 6, 10, or 30 working days is used as the basis for calculating the daily or weekly car rating. This is exactly the method used by the Geological Survey in the weekly reports of operating conditions.

The inherent disadvantage of the method of calculating capacity on actual performance is that no account is taken of actual lack of mine labor. A mine may operate full time, 8 hours a day, 6 days a week, and still, because it is undermanned, produce only a portion of the possible output. This, as far as concerns bituminous coal, under conditions that have recently existed and will continue in the immediate future, is not a real disadvantage. Until the arrival of the time when operation of the mines with no loss of time except that arising from mine disability can not produce sufficient coal for the national needs it will be necessary regularly and systematically to chronicle the theoretical labor shortage.

The method described has the decided advantage of being based on easily ascertainable facts and not dependent on estimates. The operator reports tons produced and hours operated and lost, facts easily susceptible of checking. The assignment of the hours of operation lost to different causes may be difficult and in fact its correctness has been questioned. Although theoretically possible otherwise, it must be assumed that only one cause may be responsible for the idleness of a single mine at a given time. Two or more causes may, in succession, prevent operation of the same mine in the same day or during the same week, or as between two mines, at the same time.

Consolidated report of .... *State,* .... *district,* .... *County, for week ended* .... *191.., United States Fuel Administration and United States Geological Survey.*

[Sheet No. 1 of 4 sheets.]

Company and mine (grouped by railroads on which located.)		To be transcribed from operator's report.												To be calculated.									Railroad.	Remarks.
						Hours lost this week because of—									Tons lost this week because of—									
No.	Mine.	Tons produced (gross).	Tons produced (net).	Full-time hours.	Hours worked this week.	Total all causes.	Car shortage.	Labor shortage.	Strike.	Mine disability.	No market.	All other causes.	No cause given.	Full-time capacity.	Total all causes.	Car shortage.	Labor shortage.	Strike.	Mine disability.	No market.	All other causes.	No cause given.		
....	A-1	....	1,985	48	22	26	....	15	....	8	....	....	3	4,331	2,346	....	1,353	....	722	....	....	271	A.	
....	A-2	....	1,530	54	21	33	15	9	....	9	....	....	....	3,939	2,409	1,094	656	....	659	....	....	....	Do.	
....	A-3	....	4,883	48	42	6	....	....	....	2	....	....	4	5,579	696	....	....	....	232	....	....	464	Do.	
....	A-4	....	1,810	48	26	22	4	....	....	10	....	....	8	3,340	1,530	278	....	....	696	....	....	556	Do.	
....	A-5	....	9,492	48	44	4	....	2	....	....	2	....	....	10,356	864	....	432	....	....	432	....	....	Do.	
		....	19,700	....	....	....	....	....	....	....	....	....	....	27,545	7,845	1,372	2,441	....	2,309	432	....	1,291		
	Percentages	....	71.5	....	....	....	....	....	....	....	....	....	....	100.0	28.5	5.0	8.8	....	8.4	1.6	....	4.7		
....	B-1	....	870	48	27	21	....	13	....	8	....	....	....	1,548	678	....	420	....	258	....	....	....	B.	
....	B-2	....	2,398	48	35	13	8	5	....	....	....	....	....	3,289	891	548	343	....	....	....	....	....	Do.	
....	B-3	....	1,700	54	30	24	....	7	....	....	9	....	8	3,060	1,360	....	397	....	....	510	....	453	Do.	
....	B-4	....	1,400	54	42	12	3	....	....	....	9	....	....	1,800	400	100	....	....	....	300	....	....	Do.	
....	B-5	....	2,070	54	31	23	....	2	....	....	21	....	....	3,603	1,533	....	133	....	....	1,400	....	....	Do.	
....	B-6	....	1,880	54	38	16	3	2	....	....	....	....	11	2,670	790	148	99	....	....	....	....	543	Do.	
....	B-7	....	1,650	54	23	31	....	4	....	....	27	....	....	3,872	2,222	....	287	....	....	1,935	....	....	Do.	
		....	11,968	....	....	....	....	....	....	....	....	....	....	19,842	7,874	796	1,679	....	258	4,145	....	996	Do.	
	Percentages	....	60.3	....	....	....	....	....	....	....	....	....	....	100.0	39.7	4.0	8.5	....	1.3	20.9	....	5.0		
....	C-1	....	3,027	48	44	4	3	....	....	1	....	....	....	3,302	275	206	....	....	69	....	....	....	C.	
....	C-2	....	4,974	48	20	28	4	16	....	8	....	....	....	11,938	6,964	995	3,979	....	1,990	....	....	....	Do.	
....	C-3	....	827	48	6	42	....	2	....	....	40	....	....	6,624	5,797	....	276	....	....	5,521	....	....	Do.	
....	C-4	....	4,419	48	10	38	....	....	....	6	32	....	....	21,211	16,792	....	....	....	2,651	14,141	....	....	Do.	
....	C-5	....	802	48	16	32	....	16	....	....	8	....	8	2,409	1,607	....	803	....	....	402	....	402	Do.	
		....	14,019	....	....	....	....	....	....	....	....	....	....	45,484	31,435	1,201	5,058	....	4,710	20,064	....	402	Do.	

Percentages		30.9											100.0	69.1	2.6	11.1		10.4	44.1		0.9	
D-1		150	48	12	36	8				28			600	450	100				350			D.
D-2		40	48	4	44		4		40				472	432		40		392				Do.
D-3		2,123	48	30	18	1	12			3		2	3,398	1,275	71	850			212		142	Do.
D-4		520	48	30	18	4	12			2			832	312	69	208			35			Do.
D-5		815	48	32	16	14			2				1,222	407	356			51				Do.
D-6		150	48	8	40	8	16			16			900	750	150	300			300			Do.
D-7		965	48	17	31	3	20					8	2,721	1,756	170	1,133					453	Do.
		4,763											10,145	5,382	916	2,531		443	897		595	Do.
Percentages		46.9											100.0	53.1	9.0	24.9		4.4	8.9		5.9	
E-1		5,305	48	45	3	1			2				5,659	354	118			236				E.
E-2		2,966	48	36	12		4		8				3,953	987		329		658				Do.
E-3		285	48	10	38	6			16			16	1,370	1,085	171			457			457	Do.
E-4		1,568	48	21	27		3		24				3,582	2,014		224		1,790				Do.
E-5		1,188	48	33	15	9	6						1,728	540	324	216						Do.
		11,312											16,292	4,980	613	769		3,141			457	Do.
Percentages		69.4											100.0	30.6	3.8	4.7		19.3			2.8	
F-1		2,167	48	31	17		9		8				3,357	1,190		630		560				F.
F-2		1,500	48	13	35	4	8		10	13			5,547	4,047	463	925		1,156	1,503			Do.
F-3		1,102	48	28	20		8		12				1,890	788		315		473				Do.
F-4		60	48	3	45	8	29		8				978	918	163	592		163				Do.
F-5		389	48	25	23		15			8			748	359		234			125			Do.
		5,218											12,520	7,302	626	2,696		2,352	1,628			
Percentages		41.7											100.0	58.3	5.0	21.5		18.8	13.0			
Grand total		67,010											131,828	64,818	5,524	15,174		13,213	27,166		3,741	
Percentages		50.8											100.0	49.2	4.2	11.5		10.0	20.6		2.9	

RANK OF COAL-PRODUCING STATES.

There were no changes in the rank of the larger coal-producing States in 1917. Iowa and Wyoming exchanged positions, Iowa leading Wyoming in 1917. New Mexico dropped back from sixteenth place in 1916 to twentieth place in 1917; Alaska from twenty-eighth, or lowest position, in 1915, rose in two years to twenty-sixth place.

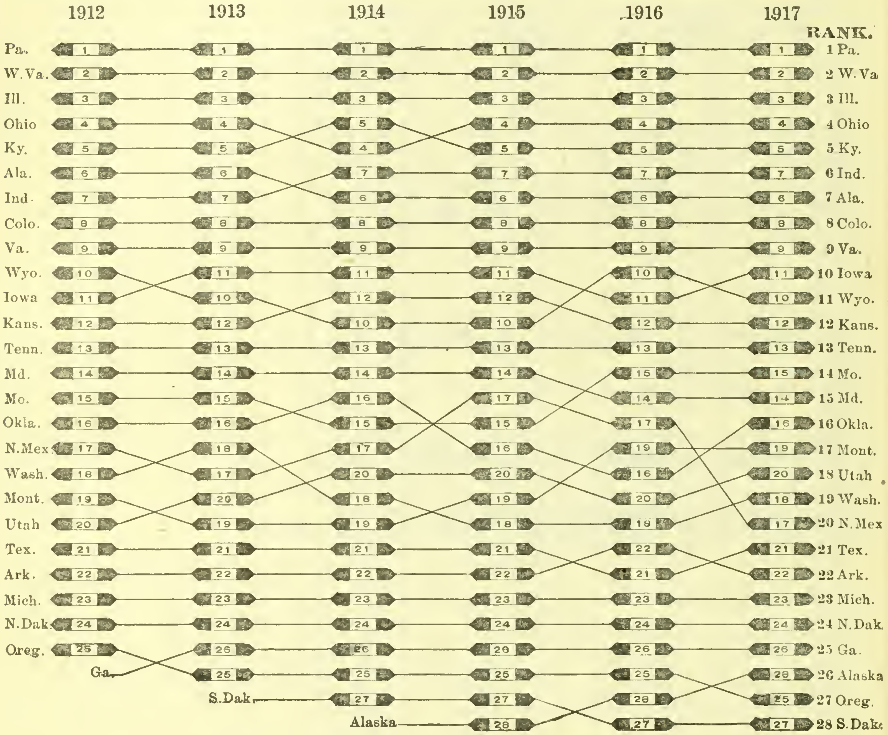

FIGURE 22.—Rank of coal-producing States, 1912-1917.

LABOR STATISTICS.

Abundant and efficient labor is essential to the maximum production of coal. For the country as a whole the average output per man per day has not yet reached 4 net tons of bituminous coal, and of anthracite an average output of 2.50 net tons per man per day has been recorded in only one year in the last seventeen. To obtain the enormous total of 651,400,000, tons of coal in 1917 more than 757,000 men, not including coke workers and office force, were employed in and about the mines, a record exceeded in only one previous year, 1914, when the total was 763,185 men.

Considered separately, the bituminous and anthracite industries presented contrasting conditions in 1917. The supply of labor in the bituminous fields was the largest recorded—603,000 men—a substantial increase compared with 561,100 in 1916 and 583,500 in 1914. In the anthracite regions the number of men employed was 154,174, compared with 159,869 in 1916, and was the lowest number recorded since 1903. Both bituminous and anthracite mines lost men in

1917 to the military service and to other industries. Reports from companies employing about 90 per cent of the total bituminous coal mining labor show a loss in 1917 of 21,000 men, or 4 per cent, to military service, and of 38,000 men, or 7 per cent, to other lines of industry. Similar reports from the operators in the anthracite region indicate a loss in 1917 of 3.5 per cent to the military service and of 5 per cent to other industries. In the bituminous industry these and other losses were more than made up by the addition of new labor, but in the anthracite regions the losses were more or less permanent, largely because the anthracite mines are close by the more important war manufacturing industries and are lacking in adjacent sources of urban population from which to recruit even common labor. The rigid requirements with respect to length of service and experience imposed by the laws of the Commonwealth of Pennsylvania also restricted the recruiting of miners in the anthracite regions.

The most striking feature presented by the statistics of labor for 1917 is the relatively larger increase in the number of outside or surface employees in comparison with the underground labor in both bituminous and anthracite mining. In the bituminous mines the increase in the total men employed was 7.5 per cent; the underground employees, representing 79 per cent of the total in 1917, increased only 5 per cent, compared with 1916, whereas the surface labor increased 21 per cent. The same was true in the anthracite mines, for although the total number of men decreased 3.6 per cent, inside labor decreased 5.7 per cent and outside labor increased 2.3 per cent.

The reason for this difference is found both in the circumstances surrounding the labor market and in the greatly increased demand for coal that prevailed in 1917. The demand for coal was so great and the prevailing market price of coal so good that operators exerted every effort to increase their capacity and output. The most certain way to increase capacity is to put on more men, and, as experienced inside men were more difficult to obtain than day laborers, the outside force was augmented more rapidly and out of proportion to the normal requirements. Under the pressure from increased output the operators, apparently without regard to its effect in costs, added labor of any description.

In the coal industry the productive labor is that done underground. Except for the very small percentage of the output obtained from steam-shovel pits, the coal is produced by the men inside. The average output per man per day (all labor considered) in 1917 was 3.77 tons of bituminous coal, a decrease of 3.3 per cent from 3.90 tons in 1916. If the largely increased number of total men in 1917 had worked no more days in 1917 than were worked in 1916 they would have produced, at the average daily rate per man, nearly 30,000,000 tons of bituminous coal less than they did. In other words, the decrease in the average effectiveness of bituminous mine labor in 1917 largely offset the increase in the supply of labor, and the large gain in output was the result of the greater number of days worked. Stated in another way, 7.5 per cent more men working 5.7 per cent more days produced in 1917 only 10 per cent more coal, because they were only 97 per cent as effective as in 1916.

The record for the anthracite industry contrasted with that of the bituminous industry shows a decrease in men but an increase in average daily output from 2.16 to 2.27 net tons, or 5 per cent, a record not equaled or exceeded since 1908. The anthracite mines, not hampered like the bituminous mines by lack of cars, were worked 285 days in 1917, compared with 253 days in 1916, 230 days in 1915, and 257 days in 1913, the previous high record.

Coal produced per man employed, 1890–1917.

Year.	Anthracite.				Bituminous.			
	Men employed.	Days worked.	Average tonnage per man per day.	Average tonnage per man per year.	Men employed.	Days worked.	Average tonnage per man per day.	Average tonnage per man per year.
1890	126,000	200	1.85	369	192,402	226	2.56	579
1891	126,350	203	1.98	401	205,803	233	2.57	573
1892	129,050	198	2.06	407	212,893	219	2.72	596
1893	132,944	197	2.06	406	230,365	204	2.73	557
1894	131,603	190	2.08	395	244,603	171	2.84	486
1895	142,917	196	2.07	406	239,962	194	2.90	563
1896	148,991	174	2.10	365	244,171	192	2.94	564
1897	149,884	150	2.34	351	247,817	196	3.04	596
1898	145,504	152	2.41	367	255,717	211	3.09	651
1899	139,608	173	2.50	433	271,027	234	3.05	713
1900	144,206	166	2.40	398	304,375	234	2.98	697
1901	145,309	196	2.37	464	340,235	225	2.94	664
1902	148,141	116	2.40	279	370,056	230	3.06	703
1903	150,483	206	2.41	496	415,777	225	3.02	680
1904	155,861	200	2.35	469	437,832	202	3.15	637
1905	165,406	215	2.18	470	460,629	211	3.24	684
1906	162,355	195	2.25	439	478,425	213	3.36	717
1907	167,234	220	2.33	512	513,258	234	3.29	769
1908	174,174	200	2.39	478	516,264	193	3.34	644
1910	169,497	229	2.17	498	555,533	217	3.46	751
1911	172,585	246	2.13	524	549,775	211	3.50	738
1912	174,030	231	2.10	485	548,632	223	3.68	820
1913	175,745	257	2.02	520	571,882	232	3.61	837
1914	179,679	245	2.06	505	583,506	195	3.71	724
1915	176,552	230	2.19	504	557,456	203	3.91	794
1916	159,869	253	2.16	548	561,102	230	3.90	896
1917	154,174	285	2.27	646	603,143	243	3.77	915

Coal produced per man and average number of days per year in 1916 and 1917.

State.	1916			1917		
	Days worked.	Average tonnage.		Days worked.	Average tonnage.	
		Per year.	Per day.		Per year.	Per day.
Alabama	262	715	2.73	273	707	2.59
Arkansas	184	528	2.87	187	536	2.87
Colorado	233	800	3.43	263	877	3.33
Illinois	198	876	4.42	243	1,025	4.22
Indiana	187	838	4.48	221	1,000	4.52
Iowa	202	503	2.49	251	628	2.50
Kansas	204	567	2.78	216	673	3.12
Kentucky	208	813	3.91	214	796	3.72
Maryland	256	792	3.09	254	802	3.16
Michigan	216	466	2.16	254	571	2.25
Missouri	207	491	2.37	240	587	2.44
Montana	244	961	3.93	268	1,019	3.80
New Mexico	292	839	2.87	321	970	3.02
North Dakota	244	889	3.64	255	963	3.78
Ohio	197	839	4.26	210	895	4.26
Oklahoma	178	463	2.60	211	516	2.45
Pennsylvania:						
Anthracite	253	548	2.17	285	646	2.27
Bituminous	259	1,012	3.91	261	991	3.80
Tennessee	239	666	2.79	241	594	2.46
Texas	218	444	2.04	263	538	2.05
Utah	228	1,140	5.00	219	1,184	5.40
Virginia	272	993	3.65	273	903	3.31
Washington	217	633	2.92	271	755	2.79
West Virginia	237	1,108	4.68	225	978	4.35
Wyoming	248	1,090	4.40	246	1,165	4.74

Statistics of labor employed in coal mines of the United States, 1913–1917.

State.	1913		1914		1915		1916		1917	
	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.
Alabama	255	24,552	226	24,042	223	22,591	262	25,308	273	28,386
Alaska	(a)	(a)	(b)	(b)	(b)	(b)	179	83	(b)	(b)
Arkansas	174	4,652	143	4,339	149	3,751	184	3,772	187	3,998
California	a 302	a 40	a 291	a 43	a 285	a 36	a 188	a 18	a 173	a 17
Colorado	229	11,990	244	10,098	194	12,372	233	13,104	263	14,231
Georgia	261	500	207	355	197	368	280	411	269	281
Idaho	c 183	c 12	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Illinois	189	79,529	173	79,499	179	75,610	198	75,538	243	84,090
Indiana	190	22,235	168	23,175	179	22,777	187	23,965	221	26,528
Iowa	195	15,757	204	16,057	220	15,549	202	14,443	251	14,266
Kansas	197	12,479	192	12,448	184	13,260	204	12,132	216	10,680
Kentucky	212	26,332	187	28,764	186	27,960	208	31,222	214	34,926
Maryland	248	5,645	241	5,403	242	5,664	256	5,633	254	5,919
Michigan	188	3,305	201	2,800	198	2,569	216	2,535	254	2,406
Missouri	187	10,418	179	9,549	186	9,173	207	9,654	240	9,668
Montana	228	3,630	209	3,350	201	3,158	244	3,781	268	4,149
New Mexico	289	4,329	283	4,178	262	4,205	292	4,522	321	4,126
North Dakota	221	641	216	558	219	590	244	714	255	821
Ohio	206	45,815	108	45,401	142	40,053	197	41,394	210	45,509
Oklahoma	197	9,044	205	8,078	167	8,457	178	7,800	211	8,495
Oregon	283	203	266	190	206	151	236	106	251	104
Pennsylvania (bituminous)	267	172,196	214	184,201	226	174,593	259	168,212	261	173,968
South Dakota	137	48	152	47	155	35	145	38	154	34
Tennessee	241	11,238	220	10,116	220	8,948	239	9,211	241	10,421
Texas	253	5,101	237	4,635	233	5,087	218	4,481	263	4,375
Utah	273	4,158	210	4,112	208	3,564	228	3,129	219	3,485
Virginia	280	9,162	235	9,183	235	8,959	272	9,777	273	11,168
Washington	260	5,794	191	5,805	169	4,850	217	4,797	271	5,312
West Virginia	234	74,746	201	78,963	208	75,882	237	78,067	225	88,422
Wyoming	232	8,331	192	8,117	201	7,244	248	7,255	246	7,358
Total bituminous	232	571,882	195	583,506	203	557,456	230	561,102	243	603,143
Pennsylvania (anthracite)	257	175,745	245	179,679	230	176,552	253	159,869	285	154,174
Grand total	238	747,627	207	763,185	209	734,008	235	720,971	251	757,317

a California includes Alaska in 1913; Idaho and Nevada in 1914 and 1915; Idaho in 1916 and 1917. b Number of men not reported. c Includes Nevada.

Material progress was made in 1917 in the efforts of coal-mining labor to establish the 8-hour working day. The percentage of the number of men working in mines at which the standard day was 8 hours increased from an average of about 60 per cent in the period from 1910 to 1916 to 79 per cent in 1917, the percentage of men working 9 hours decreased from 15.5 per cent in 1914 and 17.5 per cent in 1916 to 12.5 per cent in 1917, and the percentage of those working 10 hours decreased from about 25 per cent in the period from 1910 to 1916 to 8.5 per cent in 1917. This general change was largely the result of reduction in working hours in Kentucky, Maryland, Pennsylvania (bituminous), Tennessee, Virginia, and West Virginia, more particularly in the larger nonunion fields.

It should be remembered, however, that when the length of the working day is stated reference is made to the number of hours the mines are supposed to have been in operation and not to the number of hours worked by the miners. In both the anthracite and the bituminous fields practically all the coal is mined by contract at an agreed rate per ton or other basis of payment. The miner is an independent contractor and is not obliged to put in a certain number of hours at his working place. The figures in the following table really indicate the number of hours the men were given opportunity to work and do not mean that all the employees worked 8, 9, or 10 hours, as the case may have been.

Since the settlement of the anthracite strike of 1902 and until the new agreement in 1916 the mines in the anthracite region have been operated on a 9-hour basis, with the exception of engineers and pumpmen, who work 8 hours, and of the miners, who work by contract.

Length of working day in coal mines in the United States in 1916 and 1917.

State.	8 hours.		9 hours.		10 hours.		All others.
	Mines.	Men.	Mines.	Men.	Mines.	Men.	Men.
1916.							
Alabama	9	306	40	2,724	132	20,376	1,902
Arkansas	60	3,628					144
Colorado	159	12,542			1	2	560
Illinois	437	74,702	8	56	1	3	777
Indiana	184	22,932	2	39	6	106	888
Iowa	160	13,574	3	22	1	16	831
Kansas	131	11,522					610
Kentucky	62	5,482	87	6,736	183	16,355	2,649
Maryland	1	3	10	205	58	5,390	35
Michigan	16	2,535					
Missouri	158	9,340	1	6	4	92	216
Montana	41	3,776					5
New Mexico	24	2,890	2	48	1	2	1,582
North Dakota	17	87	5	41	17	554	32
Ohio	521	40,052	20	327	4	30	985
Oklahoma	95	7,521			3	81	198
Oregon	4	59					47
Pennsylvania (bituminous)	828	84,794	338	38,436	299	37,468	7,514
Tennessee	2	51	60	5,110	24	3,196	854
Texas	22	2,566	13	762	12	1,153	
Utah	20	3,051	1	3			75
Virginia	3	47	8	107	56	9,536	87
Washington	44	4,793					4
West Virginia	35	2,994	426	38,997	371	34,923	1,153
Wyoming	48	6,882					373
	3,081	316,129	1,024	93,619	1,173	129,283	21,521

Length of working day in coal mines in the United States in 1916 and 1917—Continued.

State.	8 hours.		9 hours.		10 hours.		All others.
	Mines.	Men.	Mines.	Men.	Mines.	Men.	Men.
1917.							
Alabama	38	3,586	27	1,900	143	20,766	2,134
Arkansas	68	3,636	1	5	1	3	354
Colorado	130	12,238					1,993
Illinois	402	82,435	4	50			1,605
Indiana	181	24,294	2	42			2,192
Iowa	130	13,328	1	11			927
Kansas	120	10,144					536
Kentucky	217	16,738	84	5,488	69	3,833	8,867
Maryland	61	4,766	1	25	5	359	769
Michigan	19	2,375					31
Missouri	130	9,141	1	10	1	25	492
Montana	34	4,105					44
New Mexico	26	a 2,617					1,509
North Dakota	10	109	2	30	15	320	362
Ohio	489	43,423	7	82	9	481	1,523
Oklahoma	98	7,890			2	56	549
Oregon	5	70					34
Pennsylvania (bituminous)	1,293	124,824	230	27,293	79	6,135	15,716
Tennessee	51	2,630	59	5,748	8	1,539	504
Texas	13	2,213	16	930	12	946	286
Utah	20	3,417	1	6			62
Virginia	27	1,484	17	1,141	39	4,160	4,383
Washington	47	5,085					227
West Virginia	601	41,199	244	25,552	99	7,126	14,545
Wyoming	52	7,349			1	9	
	4,262	429,096	697	68,313	483	45,758	59,644

a Includes 346 outside men with 9-hour working day.

The following diagram (fig. 23) shows the abrupt change in the established length of the working day in 1917.

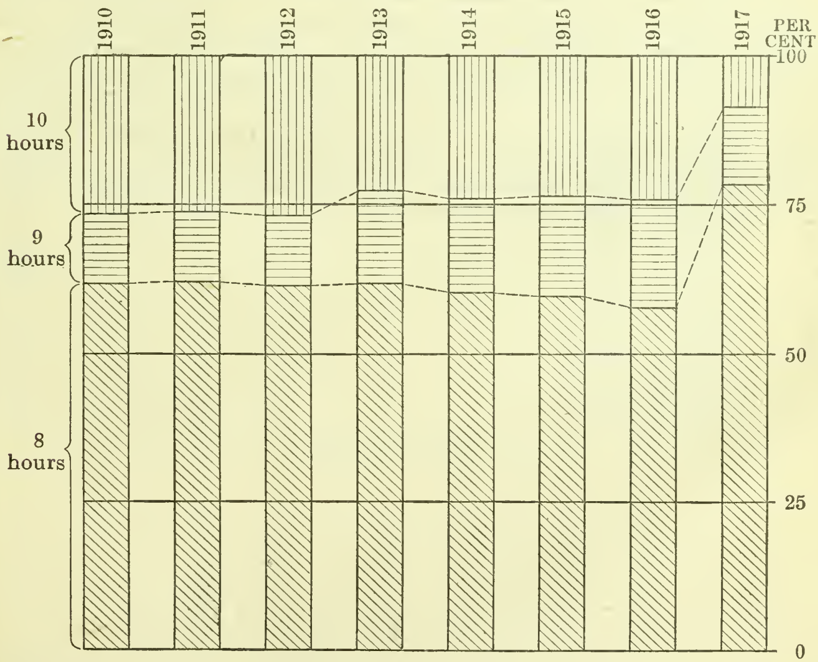

Figure 23.—Percentage of labor in bituminous coal mines with established working days of 8, 9, and 10 hours, 1910–1917.

STRIKES.

Time lost on account of labor trouble and strikes in 1917 in both bituminous and anthracite fields was only about two-thirds as much as in 1916—a year of wage agreements, which are usually provocative of considerable lost time—and was slightly less than in 1915. Time lost in the bituminous fields was less than in 1916 and in the anthracite regions was notably less than in 1916 or 1915.

There was a notable increase in the time reported lost because of strikes in the nonunion States of Alabama, eastern Kentucky, and Tennessee, and in Virginia. Illinois, a union State, practically free from labor trouble in 1916, reported nearly 500,000 men-days lost because of strikes in 1917. Time lost on this account in Pennsylvania in 1917 was only about one-half that lost in 1916, and the central Pennsylvania district was in 1917 the region most affected.

In the spring of 1916 and, in parts of the country, in the summer and fall a two-year wage agreement was entered into by miners and operators. This contract, made before the price of coal began to advance, had been in effect less than a year when it became evident that a readjustment would be necessary before the expiration of the contract. Wages in other industries were fast mounting, the cost of living was advancing, and the miners were aware that operators were realizing profits far in excess of those anticipated when the contract was signed. Some of the large employers of nonunion mine labor, such as the United States Steel Corporation, were voluntarily advancing wages, thereby throwing out of line the wage adjustments in neighboring fields.

In April, 1917, shortly after the United States entered the war, a joint conference of coal miners and operators was arranged at which a general advance of wages was agreed upon. In August there were labor disturbances in Illinois and in eastern Kentucky and Tennessee. Early in September negotiations for a new and higher wage scale in the central competitive fields (western Pennsylvania, Ohio, Illinois, and Indiana) were begun between the miners and operators and the Federal Fuel Administrator. While the matter was in process of settlement there was a short but more or less general strike in Illinois. The new wage scales were made effective November 1, 1917.

Labor strikes in the coal mines of the United States in 1916 and 1917.

State.	1916			1917		
	Number of men on strike.	Total days lost.	Average number of days lost per man.	Number of men on strike.	Total days lost.	Average number of days lost per man.
Alabama	300	920	3	1,835	10,220	6
Arkansas	1,009	30,847	31	2,417	27,315	11
Colorado	38	82	2	1,664	7,292	4
Illinois	5,043	55,416	11	38,781	464,511	12
Indiana	8,154	154,974	19	11,914	74,695	6
Iowa	2,244	32,587	15	3,275	18,407	6
Kansas	6,306	152,838	24	7,312	128,514	18
Kentucky	4,830	269,859	56	9,348	425,725	46
Maryland	181	6,546	36	1,523	24,605	16
Michigan	1,416	18,189	13	163	1,964	12
Missouri	2,331	14,837	6	2,175	31,767	15
Montana	396	1,530	4	1,063	23,680	22
New Mexico	....	....	....	85	775	9
North Dakota	26	78	3	82	811	10
Ohio	7,594	156,689	21	7,710	56,875	7
Oklahoma	6,240	126,452	20	1,668	37,301	22
Oregon	....	....	....	25	25	1
Pennsylvania (bituminous)	36,276	1,200,479	33	23,655	544,322	23
Tennessee	350	3,784	11	4,448	192,730	43
Texas	2,218	62,905	28	75	260	3
Utah	181	543	3	212	848	4
Virginia	....	....	....	232	2,283	10
Washington	1,203	13,304	11	192	840	4
West Virginia	4,540	86,352	19	6,166	111,479	18
Wyoming	276	308	1	....	....	....
Total bituminous	91,152	2,389,519	26	126,020	2,187,244	17
Pennsylvania anthracite	79,481	955,067	12	34,220	161,155	5

Summary of labor strikes in the coal mines of the United States, 1899–1917.

Year.	Number of men on strike.	Total working days lost.	Average number of days lost per man.
1899	45,981	2,124,154	46
1900	131,973	4,878,102	37
1901 [a]	20,593	733,802	35
1902	200,452	16,672,217	83
1903 [a]	47,481	1,341,031	28
1904	77,661	3,382,830	44
1905	37,542	796,735	21
1906	372,343	19,201,348	51.5
1907 [a]	32,540	462,392	14
1908 [a]	145,145	5,449,938	38
1909 [a]	24,763	723,634	29
1910	218,493	19,250,524	88
1911	41,413	983,737	24
1912	311,056	12,527,305	40
1913	135,395	3,049,412	22.5
1914	161,720	11,013,667	68
1915	67,190	2,467,431	37
1916	170,633	3,344,586	20
1917	160,240	2,348,399	15

[a] Bituminous mines only.

PRODUCTION CLASSIFIED BY MINING METHODS.

The term "mining method" as used here refers to the manner in which the coal is broken down in the mine and not to the system of mining, as by room and pillar or long wall. In the mine the coal is either blasted from a solid face—shot from the solid—as in hard-rock mining, or is shot loose or otherwise broken down after a preliminary cut into the coal has been made. This cut may be made by hand or by machine. Underground methods are therefore classified as shooting from the solid, mining by hand, and mining by machine. An increasing quantity of coal is being recovered each year by stripping the cover from the bed in open pits by steam shovels. The bed thus exposed is for the most part shattered by powder and the coal is shoveled into cars by hand, although in places it is picked up directly by small steam shovels.

Opposition to shooting from the solid has arisen because it is injurious to the mining property in that the heavy charges of powder weaken the roof and pillars, thus increasing the liability to falls of roof and coal, the most prolific cause of fatal accidents to coal miners. Another objection to this method is that the heavy charges of powder required to blow down the coal where it has not been previously undercut or sheared result in the production of a much higher proportion of fine coal and render the lump coal so friable that it disintegrates in handling and in transportation. With the growing use of mechanical stokers and of powdered coal the latter objection is losing much of its force, but the danger has been in no wise diminished and the method is forbidden by law in some of the coal-mining States.

The percentage of bituminous coal mined or undercut by hand decreased from 26.8 per cent in 1916 to 25.6 per cent in 1917, and the percentage of machine-mined coal from 56.4 to 55.5 per cent; the percentage of coal shot from the solid increased from 15.5 per cent in 1916 to 17.3 per cent in 1917. The quantity of coal mined from steam-shovel pits increased from nearly 4,000,000 tons in 1916 to about 5,800,000 tons in 1917.

Under the impetus of a strong demand for production and with the supply of labor largely diluted with inexperienced hands, it was to be expected that the percentage of coal shot from the solid would increase, for by this method coal is most easily produced. This result is well shown in the statistics for Illinois and Indiana, in both of which there was a large increase of production with a diluted labor supply. The proportion of coal shot from the solid in Illinois increased from 26 per cent in 1916 to 33 per cent in 1917 and the quantity from 17,400,000 to 28,200,000 tons; in Indiana the proportion increased from 29 per cent in 1916 to more than 32 per cent in 1917 and the quantity from 5,900,000 to 8,600,000 tons.

Bituminous coal mined by different methods in 1916.

State.	Mined by hand.		Shot from the solid.		Mined by machines.		From steam-shovel pits.		Not reported.		Total production (net tons).
	Quantity (net tons).	Percentage.	Quantity (net tons).	Percentage.	Quantity (net tons).	Percentage.	Quantity (net tons).	Percentage.	Quantity (net tons).	Percentage.	
Alabama	5,658,300	31.3	6,547,225	36.2	5,802,150	32.1	75,462	0.4	3,060	....	18,086,197
Arkansas	133,056	6.7	1,627,894	81.6	224,245	11.2	....	....	9,720	0.5	1,994,915
Colorado	5,393,195	51.4	1,686,824	16.1	3,342,345	31.9	....	....	61,873	.6	10,484,237
Georgia	6,000	3.5	167,554	96.5	....	....	....	....	....	....	173,554
Illinois	7,290,436	11.0	17,369,083	26.2	40,791,408	61.7	467,863	.7	276,546	.4	66,195,336
Indiana	1,822,130	9.1	5,904,187	29.4	11,367,758	56.6	849,838	4.2	149,615	.7	20,093,528
Iowa	1,237,257	17.0	5,302,218	73.0	636,892	8.8	....	....	84,433	1.2	7,260,800
Kansas	592,692	8.5	5,367,550	78.0	37,897	.6	858,370	12.5	24,946	.4	6,881,455
Kentucky	1,521,424	6.0	2,274,763	9.0	21,441,700	84.4	....	....	156,110	.6	25,393,997
Maryland	3,982,741	89.3	227,965	5.1	221,609	5.0	....	....	27,731	.6	4,460,046
Michigan	26,110	2.2	107,062	9.1	1,044,583	88.5	....	....	2,605	.2	1,180,360
Missouri	920,786	19.4	1,637,464	34.6	947,811	20.0	1,026,291	21.6	209,794	4.4	4,742,146
Montana	1,238,600	34.1	344,438	9.5	2,024,799	55.7	....	....	24,690	.7	3,632,527
New Mexico	3,102,162	81.7	168,804	4.5	510,219	13.5	....	....	11,826	.3	3,793,011
North Dakota	40,307	6.3	278,147	43.8	218,276	34.4	....	....	98,182	15.5	634,912
Ohio	1,271,373	3.7	731,801	2.1	31,669,049	91.1	551,190	1.6	504,806	1.5	34,728,219
Oklahoma	51,039	1.4	2,185,592	60.6	1,258,022	34.8	103,381	2.9	9,977	.3	3,608,011
Pennsylvania (bituminous)	59,598,251	35.0	15,848,717	9.3	94,391,391	55.4	....	....	457,065	.3	170,295,424
Tennessee	2,079,976	33.9	2,524,603	41.1	1,517,426	24.7	....	....	15,444	.3	6,137,449
Texas	1,550,257	78.0	418,246	21.0	19,000	1.0	....	....	....	....	1,987,503
Utah	1,486,714	41.7	30,309	.8	2,050,405	57.5	....	....	....	....	3,567,428
Virginia	426,605	4.4	3,266,701	33.7	6,011,262	61.9	....	....	2,906	....	9,707,474
Washington	1,768,549	58.2	992,803	32.7	277,236	9.1	....	....	....	....	3,038,588
West Virginia	31,480,529	36.5	450,501	.5	54,408,511	62.9	1,000	....	119,586	.1	86,460,127
Wyoming	1,802,804	22.8	2,626,099	33.1	3,477,081	44.0	....	....	4,663	.1	7,910,647
Other States	34,484	48.0	25,693	35.8	400	.6	....	....	11,214	15.6	71,791
Total bituminous	134,515,777	26.8	78,112,243	15.5	283,691,475	56.4	3,933,395	.8	2,266,792	.5	502,519,682
Pennsylvania (anthracite)	(a)	....	(a)	....	1,839,506	2.1	[b] 1,987,800	2.3	....	....	87,578,493

[a] This information not requested by the United States Geological Survey.
[b] Includes a small quantity of anthracite recovered from culm banks.

Bituminous coal mined by different methods in 1917.

State.	Mined by hand.		Shot off the solid.		Mined by machines.		From steam-shovel pits.		Not reported.		Total production (net tons).
	Quantity (net tons).	Percentage.	Quantity (net tons).	Percentage.	Quantity (net tons).	Percentage.	Quantity (net tons).	Percentage.	Quantity (net tons).	Percentage.	
Alabama	5,340,112	26.6	8,419,146	42.0	6,062,744	30.1	231,217	1.2	14,855	0.1	20,068,074
Arkansas	153,393	7.2	1,816,941	84.8	154,615	7.2	....	....	18,630	.8	2,143,579
Colorado	7,367,335	59.0	916,555	7.6	4,077,520	32.7	....	....	91,926	.7	12,483,336
Georgia	1,625	1.4	117,403	98.6	....	....	....	....	....	....	119,028
Illinois	8,498,917	9.9	28,257,083	32.8	48,576,462	56.3	542,801	.6	324,124	.4	86,199,387
Indiana	2,149,258	8.1	8,629,572	32.5	14,344,845	54.1	1,273,253	4.8	142,401	.5	26,539,329
Iowa	1,956,825	21.8	5,905,912	65.9	1,022,101	11.4	....	....	80,992	.9	8,965,830
Kansas	1,515,230	21.1	4,798,921	66.8	34,823	.5	806,985	11.2	29,016	.4	7,184,975
Kentucky	1,456,657	5.2	3,021,667	10.8	23,221,880	83.6	665	....	107,102	.4	27,807,971
Maryland	3,506,888	73.9	880,665	18.6	290,116	6.1	20,840	.4	47,415	1.0	4,745,924
Michigan	47,180	3.4	127,134	9.2	1,199,263	87.3	....	....	1,228	.1	1,374,805
Missouri	1,102,961	19.4	2,080,218	36.7	1,127,843	19.9	1,139,000	20.1	220,527	3.9	5,670,549
Montana	1,496,419	35.4	605,224	14.3	2,070,075	49.0	....	....	54,971	1.3	4,226,689
New Mexico	2,726,844	68.2	208,526	5.2	1,052,684	26.3	....	....	12,473	.3	4,000,527
North Dakota	49,209	6.2	339,240	42.9	300,417	38.0	7,351	.9	94,331	12.0	790,548
Ohio	1,636,066	4.0	1,360,217	3.3	35,828,497	87.9	1,249,181	3.1	674,773	1.7	40,748,734
Oklahoma	21,353	.5	2,587,942	59.0	1,605,117	36.6	155,740	3.5	16,692	.4	4,386,844
Pennsylvania (bituminous)	63,498,114	36.8	12,441,129	7.2	95,423,140	55.4	349,944	.2	735,815	.4	172,448,142
Tennessee	2,026,570	32.7	2,753,808	44.5	1,399,825	22.6	....	....	14,018	.2	6,194,221
Texas	1,875,510	79.6	477,617	20.3	2,688	.1	....	....	....	....	2,355,815
Utah	1,553,806	37.7	306,255	7.4	2,259,697	54.8	....	....	5,472	.1	4,125,230
Virginia	370,685	3.7	3,261,669	32.3	6,440,561	63.9	....	....	14,176	.1	10,087,091
Washington	2,395,479	59.7	1,382,567	34.5	231,856	5.8	....	....	....	....	4,009,902
West Virginia	28,935,091	33.5	1,259,902	1.5	56,075,883	64.8	6,000	....	164,786	.2	86,441,667
Wyoming	1,374,626	16.0	3,596,403	42.0	3,593,470	41.9	7,000	.1	4,120	....	8,575,619
Other States	28,414	29.4	60,291	62.3	....	....	....	....	8,042	8.3	96,747
Total bituminous	141,084,567	25.6	95,642,007	17.3	306,396,127	55.5	5,789,977	1.1	2,877,885	.5	551,790,563
Pennsylvania (anthracite)	(a)	....	(a)	....	1,955,223	2.0	2,301,588	2.3	....	....	99,611,811

a This information not requested by the United States Geological Survey.

PRODUCTION BY MACHINES.

The production of machine-mined bituminous coal for the first time in many years, if not in the history of coal mining in the United States, did not keep pace in 1917 with the total output. Machine-mined bituminous coal represented 55.5 per cent of the total output in 1917, against 56.5 per cent in 1916, 55 per cent in 1915, and 51.7 in 1914. The quantity so mined, however, increased from 218,000,000 tons in 1914, 243,000,000 tons in 1915, and 284,000,000 tons in 1916 to 306,000,000 tons in 1917. The number of machines in use was the highest recorded, 17,235, compared with 16,198 in 1916 and 16,507 in 1914, the previous high record. The average output per machine was 17,777 tons in 1917, also a new high record.

Bituminous coal mined by machines in the United States, 1916 and 1917.

State.	Machines in use.		Quantity mined by machines (net tons).		Percentage of total product mined by machines.	
	1916	1917	1916	1917	1916	1917
Alabama	320	332	5,802,150	6,062,744	32.1	30.1
Arkansas	20	18	224,245	154,615	11.2	7.2
Colorado	305	328	3,342,345	4,077,529	31.9	32.7
Illinois	1,938	2,049	40,791,408	48,576,462	61.7	56.3
Indiana	661	768	11,367,758	14,344,845	56.6	54.1
Iowa	56	71	636,892	1,022,101	8.8	11.4
Kansas	6	9	37,897	34,823	.6	.5
Kentucky	1,528	1,514	21,441,700	23,221,880	84.4	83.6
Maryland	16	20	221,609	290,116	5.0	6.1
Michigan	104	99	1,044,583	1,199,263	88.5	87.3
Missouri	93	100	947,811	1,127,843	20.0	19.9
Montana	103	115	2,024,799	2,070,075	55.7	49.0
New Mexico	51	75	510,219	1,052,684	13.5	26.3
North Dakota	13	16	218,276	300,417	34.4	38.0
Ohio	1,604	1,784	31,669,049	35,828,497	91.1	87.9
Oklahoma	167	145	1,258,022	1,605,117	34.8	36.6
Pennsylvania	5,768	6,004	94,391,391	95,423,140	55.4	55.4
Tennessee	213	209	1,517,426	1,399,825	24.7	22.6
Texas	10	1	19,000	2,688	1.0	.1
Utah	78	105	2,050,405	2,259,697	57.5	54.8
Virginia	194	226	6,011,262	6,440,561	61.9	63.9
Washington	55	32	277,236	231,856	9.1	5.8
West Virginia	2,702	3,054	54,408,511	56,075,888	62.9	64.8
Wyoming	192	161	3,477,081	3,593,470	44.0	41.9
Other States	1	....	400	....	.6	....
	16,198	17,235	283,691,475	306,396,127	a56.5	a55.5

a Average.

Bituminous coal mined by machines in the United States, 1891–1917.

Year.	Machines in use.	Quantity mined by machines (net tons).	Average production for each machine (net tons).	Year.	Machines in use.	Quantity mined by machines (net tons).	Average production for each machine (net tons).
1891	545	6,211,732	11,398	1907	11,144	138,547,823	12,432
1896	1,446	16,424,932	11,373	1908	11,569	123,183,334	10,648
1897	1,956	22,649,220	11,579	1909	13,049	142,496,878	10,920
1898	2,622	32,413,144	12,362	1910	13,254	174,012,293	13,127
1899	3,125	43,963,933	14,068	1911	13,829	178,158,236	12,854
1900	3,907	52,784,523	13,510	1912	15,298	210,538,822	13,763
1901	4,341	57,843,335	13,325	1913	16,379	242,421,713	14,801
1902	5,418	69,611,582	12,848	1914	16,507	218,399,287	13,231
1903	6,658	77,974,894	11,712	1915	15,692	243,237,551	15,501
1904	7,663	78,606,997	10,258	1916	16,198	283,691,475	17,514
1905	9,184	103,396,452	11,258	1917	17,235	306,396,127	17,777
1906	10,212	118,847,527	11,638				

Anthracite (Pennsylvania) mined by machines, 1912–1917.

Year.	Quantity (gross tons).	Year.	Quantity (gross tons).
1912	219,836	1915	1,167,639
1913	496,229	1916	1,642,416
1914	818,389	1917	1,745,735

PRODUCTION FROM STEAM-SHOVEL PITS.

Remarkable progress was made in 1917 in the development and operation of steam-shovel open-pit butuminous coal mines. Eight States reported 111 shovels in use in 1916 with a production of nearly 4,000,000 tons of coal. Thirteen States, a gain of 5, reported steam-shovel operations in 1917 with 182 shovels in use and a production of 5,790,000 tons of coal. Kentucky, Maryland, North Dakota, Pennsylvania (bituminous regions), and Wyoming were the States added to the list in 1917. Four shovels were reported in use in Maryland, 31 shovels in Pennsylvania, and 1 each in the other three States. In 1916 Missouri led with 27 shovels and an output of 1,026,000 tons; in 1917 Ohio led in the number of shovels in use (36), and Indiana led with 1,273,000 tons, in production from open pits.

Because of the dispatch with which a property suitable for this method of mining can be opened up and equipped for large-scale production and because of the lower labor costs, the use of steam shovels has been increasing during the recent period of good prices and strong demand for coal.

There was a decrease in the number of shovels in use in the Pennsylvania anthracite region but an increase in the quantity of coal obtained from the pits. It is customary in the anthracite region for the removal of the cover to be carried well in advance of the actual recovery of the coal, and for this reason the activity of the shovels does not at any given time indicate the quantity of coal being taken from the pits.

Coal recovered from steam-shovel strip pits in 1916 and 1917.

State.	Number of shovels.	Quantity of coal mined (net tons).	Average tonnage per man.	
			Per day.	Per year.
1916.				
Alabama	4	75,462	4.1	1,078
Illinois	10	467,863	8.7	1,982
Indiana	22	849,838	7.7	1,364
Kansas	24	858,370	5.8	1,148
Missouri	27	1,026,291	5.3	1,116
Ohio	18	551,190	10.6	2,250
Oklahoma	5	103,381	6.1	708
West Virginia	1	1,000		
Total bituminous	111	3,933,395	6.6	1,316
Pennsylvania anthracite	105	1,987,800		
Grand total	216	5,921,195		
1917.				
Alabama	9	231,217	5.5	1,217
Illinois	11	542,801	9.3	1,821
Indiana	26	1,273,253	9.1	1,675
Kansas	26	806,985	5.5	998
Kentucky	1	665		
Maryland	4	20,840	1.5	347
Missouri	30	1,139,000	5.4	1,010
North Dakota	1	7,351	3.8	919
Ohio	36	1,249,181	7.4	1,108
Oklahoma	5	155,740	6.7	1,189
Pennsylvania (bituminous)	31	349,944	3.5	468
West Virginia	1	6,000	1.7	333
Wyoming	1	7,000	4.7	70
Total bituminous	182	5,789,977	6.4	1,077
Pennsylvania anthracite	76	2,301,588		
Grand total	258	8,091,565		

COAL-WASHING OPERATIONS.

The demand for coal was so insistent in 1917 and the needs of the consumers so pressing that the incentives of competitive market conditions, which in past years have maintained the quality of coal by special preparation, were largely lost. Throughout the country the complaint was heard that coal was not being cleaned as in the past—that dirty coal was being shipped. However true this may have been locally, it is evident from the statistics of coal-washing operations that there was in general no cessation in the cleaning of coal by this method. The proportion of washed coal to the total output increased from 4.8 per cent in 1916 to 4.9 per cent in 1917 and the quantity increased from 22,900,000 to 25,500,000 tons.

Alabama ranked first in quantity of washed coal, with 57 per cent of the total output of the State so cleaned and 44 per cent of the total washed in the country. In the statement of total production of coal in the United States the refuse is deducted and only the cleaned coal is considered as the marketed or commercial product.

Bituminous coal washed at the mines in 1916 and 1917.

State.	Coal washed (net tons).	Cleaned coal (net tons).	Refuse (net tons).	Percentage of cleaned coal to total State output.
1916.				
Alabama	10,695,700	9,742,467	953,233	53.9
Colorado	323,064	273,645	49,419	2.6
Georgia	114,571	87,178	27,393	50.2
Illinois	3,480,849	3,017,876	462,973	4.6
Indiana	97,326	84,008	13,318	.4
Kansas	323	217	106	......
Kentucky	400,243	350,853	49,390	1.4
Michigan	195,159	169,495	25,664	14.4
Missouri	144,252	109,689	34,563	2.3
Montana	464,057	401,157	62,900	11.0
New Mexico	1,009,338	844,083	165,255	22.3
Ohio	172,015	151,761	20,254	.4
Oklahoma	10,083	6,875	3,208	.2
Oregon	17,373	15,333	2,040	36.0
Pennsylvania	4,335,661	3,941,355	394,306	2.3
Tennessee	597,481	546,034	51,447	8.9
Texas	21,742	17,742	4,000	.9
Virginia	62,445	57,120	5,325	.6
Washington	1,275,925	1,099,453	176,472	36.2
West Virginia	2,215,367	2,005,877	209,490	2.3
	25,632,974	22,922,218	2,710,756	4.8
1917.				
Alabama	12,714,868	11,408,051	1,306,817	56.8
Colorado	322,277	267,096	55,181	2.1
Georgia	91,076	73,793	17,283	62.0
Illinois	5,159,079	4,651,154	507,925	5.4
Indiana	52,442	48,065	4,377	.2
Kentucky	237,975	211,689	26,286	.8
Maryland	35,712	34,693	1,019	.7
Michigan	204,998	174,642	30,356	12.7
Missouri	45,759	37,617	8,142	.7
Montana	263,798	243,475	20,323	5.8
New Mexico	531,881	478,834	53,047	12.0
Ohio	74,689	66,785	7,904	.2
Oregon	10,612	9,551	1,061	33.7
Pennsylvania	3,786,135	3,400,075	386,060	2.0
Tennessee	697,953	630,621	67,332	10.2
Texas	34,282	23,817	10,465	1.0
Virginia	398,457	361,489	36,968	3.6
Washington	1,853,818	1,475,529	378,289	36.8
West Virginia	2,071,326	1,886,720	184,606	2.2
	28,587,137	25,483,696	3,103,441	4.9

THICKNESS OF COAL MINED.

Thickness of coal bears an interesting relation to the average daily output per man employed in the production and also, as the higher the average output per man the lower the labor cost, to the relative importance of fields under competitive market conditions. It is generally accepted that a coal bed 6 feet thick presents the most favorable conditions for mining, and the statistics in the following table show that a larger percentage of the total output of bituminous coal and lignite comes from beds between 5 and 6 feet thick than from any other thickness and that the average daily production per man from beds between 5 and 6 feet thick is nearly as great as from those thicker beds from which an appreciable percentage of the total coal is mined.

Although presenting striking exceptions to the general rule, these statistics, collected for the first time for 1917, show a direct relation

Bituminous coal and lignite produced from beds of different thickness and output per man per day, 1917.

[Net tons of 2,000 pounds.]

State.	0 to 2 feet.	2 to 3 feet.	3 to 4 feet.	4 to 5 feet.	5 to 6 feet.	6 to 7 feet.	7 to 8 feet.	8 to 9 feet.	9 to 10 feet.
Alabama:									
Tons produced	166,343	3,470,167	5,073,384	4,463,576	1,818,163	2,292,496	379,658	883,199	485,520
Percentage of State total	0.8	17.3	25.3	22.3	9.0	11.4	1.0	4.4	2.4
Average output per man per day	1.94	2.36	2.46	2.43	3.09	3.00	2.07	2.10	3.31
Arkansas:									
Tons produced	12,189	170,469	572,606	495,172	29,756	394,558	12,351		
Percentage of State total	0.6	8.0	26.9	23.3	1.4	18.6	0.6		
Average output per man per day	1.97	1.62	2.52	3.05	3.5	3.6	2.33		
Colorado:									
Tons produced		75,593	1,135,216	1,324,997	2,730,848	2,817,065	1,209,233	415,578	1,245,100
Percentage of State total		0.6	9.1	10.7	22.0	22.7	9.7	3.3	10.0
Average output per man per day		1.65	2.71	2.54	3.05	3.53	3.14	5.77	4.68
Georgia:									
Tons produced		117,403							
Percentage of State total		98.6							
Average output per man per day		1.57							
Idaho:									
Tons produced					2,912				
Percentage of State total					100.0				
Average output per man per day					1.94				
Illinois:									
Tons produced	6,039	532,609	3,293,954	7,160,188	9,223,900	18,779,430	22,197,766	10,981,655	6,658,758
Percentage of State total		0.6	3.8	8.3	10.7	21.8	25.8	12.8	7.8
Average output per man per day	0.71	1.75	2.17	3.31	3.83	4.40	4.91	4.89	4.99
Indiana:									
Tons produced		105,379	478,734	11,302,277	[illegible]	4,158,623	1,753,169	10,982	
Percentage of State total		0.4	1.8	42.7	[illegible]	15.8	6.6	0.1	
Average output per man per day		2.23	3.81	4.31	4.73	5.02	5.05	4.58	
Iowa:									
Tons produced	26,962	1,530,306	2,541,187	2,041,035	1,117,989	1,037,066	74,253		
Percentage of State total	0.3	17.1	28.5	22.9	12.5	11.6	0.8		
Average output per man per day	1.36	1.90	2.48	2.74	2.11	2.86	3.50		
Kansas:									
Tons produced	331,794	2,356,534	3,350,135						
Percentage of State total	4.7	32.8	46.7						
Average output per man per day	1.43	3.01	3.17						
Kentucky:									
Tons produced	77,258	590,909	4,230,148	9,168,447	6,788,625	2,319,418	2,119,350	215,494	4,387
Percentage of State total	0.3	2.1	15.2	33.1	21.5	8.5	7.0	0.8	
Average output per man per day	1.75	2.19	3.22	3.85	3.96	4.12	4.48	3.99	1.88
Maryland:									
Tons produced		242,725	1,147,221	503,702	720,707	414,428	125,702	963,051	188,672
Percentage of State total		5.2	21.1	11.0	15.3	8.8	2.7	20.4	4.0
Average output per man per day		3.10	2.89	3.51	3.37	4.00	2.59	2.93	2.63
Michigan:									
Tons produced	57,401	654,171	460,634	63,983		133,389			
Percentage of State total	6.4	47.6	33.5	4.7		7.5			
Average output per man per day	1.85	2.21	2.12	1.64		2.69			
Missouri:									
Tons produced	1,599,458	867,152	1,320,257	1,507,148	97,887				
Percentage of State total	28.9	15.7	23.8	27.2	1.8				
Average output per man per day	1.64	2.89	2.77	3.02	3.18				
Montana:									
Tons produced			7,783	60,829	1,107,962	811,256	1,599,463	4,429	
Percentage of State total			0.2	1.4	26.4	19.4	38.2	0.1	
Average output per man per day			2.27	2.01	3.55	3.89	3.73	3.54	
New Mexico:									
Tons produced		52,284	230,512	103,052	2,399,413	592,555	618,478		
Percentage of State total		1.3	5.8	2.6	60.0	14.8	15.1		
Average output per man per day		0.98	2.33	4.09	3.01	3.14	3.68		
North Dakota:									
Tons produced				5,700	19,378	120,394	20,836	48,225	23,889
Percentage of State total				0.8	2.7	16.7	2.9	6.7	3.2
Average output per man per day				1.56	2.15	2.98	1.60	3.84	2.81
Ohio:									
Tons produced	12,229	619,097	4,290,169	8,211,133	19,969,655	4,019,834	238,344	89,194	199,556
Percentage of State total		1.5	10.7	20.4	49.5	10.1	0.6	0.2	0.5
Average output per man per day	2.99	2.61	2.95	4.14	4.79	4.31	4.05	4.49	5.13
Oklahoma:									
Tons produced	24,925	426,679	1,714,439	1,430,098	1,215	1,049			
Percentage of State total	0.6	9.7	40.1	32.7	0.1				
Average output per man per day	2.85	2.46	2.22	2.16	2.55	3.89			
Oregon:									
Tons produced			1,561	11,215		9,551			
Percentage of State total			5.5	39.6		33.7			
Average output per man per day			0.70	1.08		0.97			
Pennsylvania:									
Tons produced	91,053	4,024,878	33,295,978	23,892,453	27,902,660	22,911,771	10,663,806	8,836,229	19,853,900
Percentage of State total	0.1	2.3	19.4	13.9	16.2	13.1	6.2	5.1	11.5
Average output per man per day	2.35	2.58	3.28	3.54	4.07	4.30	4.12	3.69	4.10
South Dakota:									
Tons produced	1,055	300	540		1,800	2,261	421	1,435	
Percentage of State total	13.1	3.7	6.7		22.4	28.1	5.2	17.9	
Average output per man per day	1.49	1.00	0.83		1.68	1.82	1.50	2.66	
Tennessee:									
Tons produced	74,603	329,495	3,033,754	1,738,156	339,132				
Percentage of State total	1.2	5.3	49.1	28.1	5.5				
Average output per man per day	2.07	1.54	2.29	2.91	4.03				
Texas:									
Tons produced	924,121	190,417	99,870	22,617	199,187	174,235	162,588	113,011	150,808
Percentage of State total	39.2	8.1	4.2	1.0	8.5	7.4	6.9	4.8	5.6
Average output per man per day	1.67	1.45	2.12	1.96	1.67	3.48	1.78	2.85	2.25
Utah:									
Tons produced					126,601	2,000	132,921	1,056,973	
Percentage of State total					3.1		3.2	25.7	
Average output per man per day					4.84	1.78	4.90	4.81	
Virginia:									
Tons produced	22,998	128,442	1,113,432	1,093,150	1,075,176	1,859,761	82,122	698,401	317,337
Percentage of State total	0.2	1.3	11.0	10.7	10.5	18.5	0.8	6.8	3.2
Average output per man per day	2.21	2.15	2.09	2.57	3.67	3.50	2.20	7.09	5.78
Washington:									
Tons produced		3,251	162,132	1,700,621	249,455	236,138	202	20,125	55,550
Percentage of State total		0.1	4.0	12.4	6.1	5.9		0.7	1.1
Average output per man per day			2.37	3.39	4.08	1.92	0.81	1.90	2.82
West Virginia:									
Tons produced	2,404	956,145	5,807,939	20,109,641	23,773,855	11,551,173	11,850,814	3,026,139	938,682
Percentage of State total		1.1	6.7	23.4	27.5	13.1	13.5	1.2	1.1
Average output per man per day	1.88	3.53	3.24	3.89	4.67	5.14	5.25	4.21	6.70
Wyoming:									
Tons produced				350,309	793,897	751,258	1,587,651	1,124,773	627,921
Percentage of State total				4.1	9.1	8.8	18.5	13.1	7.3
Average output per man per day				3.49	5.60	4.69	4.39	4.97	4.73
Total:									
Tons produced	3,484,790	17,442,107	73,377,590	106,011,089	109,679,265	75,738,707	54,632,709	29,060,187	30,721,088
Percentage of total	0.6	3.2	13.3	17.0	19.9	13.8	9.9	5.3	5.6
Average output per man per day	1.67	2.41	2.91	3.54	4.18	4.27	4.67	4.16	4.39

State.	10 to 11 feet.	11 to 12 feet.	12 to 13 feet.	13 to 14 feet.	14 to 15 feet.	15 to 16 feet.	16 to 17 feet.	17 to 18 feet.	18 to 19 feet.
Alabama:									
Tons produced	70,163		364,178						
Percentage of State total	0.3		1.0						
Average output per man per day	1.63		5.64						
Arkansas:									
Tons produced									
Percentage of State total									
Average output per man per day									
Colorado:									
Tons produced	117,156	247,963	11,614	409,863	2,615	22,929	139,185		
Percentage of State total	0.9	2.0	0.1	3.3		0.2	1.1		
Average output per man per day	3.69	5.08	3.55	5.38	5.73	3.66	3.75		
Georgia:									
Tons produced									
Percentage of State total									
Average output per man per day									
Idaho:									
Tons produced									
Percentage of State total									
Average output per man per day									
Illinois:									
Tons produced	2,314,975								
Percentage of State total	2.7								
Average output per man per day	4.51								
Indiana:									
Tons produced									
Percentage of State total									
Average output per man per day									
Iowa:									
Tons produced									
Percentage of State total									
Average output per man per day									
Kansas:									
Tons produced									
Percentage of State total									
Average output per man per day									
Kentucky:									
Tons produced	3,954								
Percentage of State total									
Average output per man per day	3.04								
Maryland:									
Tons produced	98,329	82,656							
Percentage of State total	2.1	1.8							
Average output per man per day	4.37	3.14							
Michigan:									
Tons produced									
Percentage of State total									
Average output per man per day									
Missouri:									
Tons produced									
Percentage of State total									
Average output per man per day									
Montana:									
Tons produced		2,262							
Percentage of State total		0.1							
Average output per man per day		5.11							
New Mexico:									
Tons produced									
Percentage of State total									
Average output per man per day									
North Dakota:									
Tons produced	90,925	269,763	26,000			21,247			4,796
Percentage of State total	12.6	37.4	3.6			2.0			0.7
Average output per man per day	5.01	4.05	3.25			4.28			5.21
Ohio:									
Tons produced			541,131						
Percentage of State total			1.3						
Average output per man per day			4.44						
Oklahoma:									
Tons produced									
Percentage of State total									
Average output per man per day									
Oregon:									
Tons produced									
Percentage of State total									
Average output per man per day									
Pennsylvania:									
Tons produced									
Percentage of State total									
Average output per man per day									
South Dakota:									
Tons produced	231								
Percentage of State total	2.9								
Average output per man per day	3.85								
Tennessee:									
Tons produced									
Percentage of State total									
Average output per man per day									
Texas:									
Tons produced	61,940								
Percentage of State total	2.6								
Average output per man per day	2.07								
Utah:									
Tons produced	14,011	521,837	419,980				1,404,102	330,442	
Percentage of State total	0.1	12.7	10.9				34.1	8.0	
Average output per man per day	2.38	6.18	7.24				6.04	4.10	
Virginia:									
Tons produced		281,442							
Percentage of State total		2.8							
Average output per man per day		4.72							
Washington:									
Tons produced					2,570	69,874	5,372	204,425	
Percentage of State total					0.1	1.7	0.1	5.1	
Average output per man per day					1.62	3.70	2.50	6.79	
West Virginia:									
Tons produced	588,946		27,486	43,933					
Percentage of State total	0.7			0.1					
Average output per man per day	5.06		2.77	4.31					
Wyoming:									
Tons produced		199,338	598,318		250	90,270	484,612		390,603
Percentage of State total		2.3	7.0			1.0	5.7		4.6
Average output per man per day		4.91	4.65			4.82	6.29		5.61
Total:									
Tons produced	3,341,238	1,605,291	2,018,907	153,706	5,744	204,320	2,033,271	534,867	395,399
Percentage of total	0.6	0.3	0.4	0.1			0.4	0.1	0.1
Average output per man per day	1.35	4.01	5.10	5.25	2.57	4.18	5.83	4.88	5.01

State.	22 to 23 feet.	23 to 24 feet.	25 to 26 feet.	26 to 27 feet.	28 to 29 feet.	30 to 31 feet.	31 to 32 feet.	40 to 41 feet.	50 to 51 feet.	Not reported.	Total production.
Alabama:											
Tons produced										592,731	20,059,148
Percentage of State total										3.0	100.0
Average output per man per day										2.34	2.59
Arkansas:											
Tons produced										437,849	2,124,949
Percentage of State total										20.6	100.0
Average output per man per day										3.51	2.81
Colorado:											
Tons produced				60,156		28,609	1,015	1,129		446,678	12,410,671
Percentage of State total				0.5		0.2				3.6	100.0
Average output per man per day				0.94		6.50	1.19	4.03		3.22	3.32
Georgia:											
Tons produced										1,625	119,028
Percentage of State total										1.4	100.0
Average output per man per day										1.93	1.57
Idaho:											
Tons produced											2,912
Percentage of State total											100.0
Average output per man per day											1.94
Illinois:											
Tons produced										4,916,273	86,064,567
Percentage of State total										5.7	100.0
Average output per man per day										4.31	4.22
Indiana:											
Tons produced										2,163,698	26,460,654
Percentage of State total										8.2	100.0
Average output per man per day										3.94	4.52
Iowa:											
Tons produced										509,482	8,926,090
Percentage of State total										5.7	100.0
Average output per man per day										2.22	2.49
Kansas:											
Tons produced										1,132,732	7,171,195
Percentage of State total										15.8	100.0
Average output per man per day										3.47	3.11
Kentucky:											
Tons produced										2,153,506	27,721,528
Percentage of State total										7.8	100.0
Average output per man per day										3.37	3.71
Maryland:											
Tons produced										176,563	4,720,476
Percentage of State total										3.7	100.0
Average output per man per day										2.55	3.14
Michigan:											
Tons produced										4,000	1,373,577
Percentage of State total										0.3	100.0
Average output per man per day											2.27
Missouri:											
Tons produced								570		110,643	5,539,145
Percentage of State total										2.0	100.0
Average output per man per day								1.42		4.00	2.39
Montana:											
Tons produced										594,830	4,188,825
Percentage of State total										11.2	100.0
Average output per man per day										4.74	3.77
New Mexico:											
Tons produced										2,675	3,999,960
Percentage of State total										0.1	100.0
Average output per man per day										1.45	3.12
North Dakota:											
Tons produced	8,112	31,600								31,020	722,175
Percentage of State total	1.1	4.4								4.3	100.0
Average output per man per day	2.23	2.76								3.05	3.44
Ohio:											
Tons produced										2,116,330	41,323,681
Percentage of State total										5.2	100.0
Average output per man per day										3.71	4.21
Oklahoma:											
Tons produced										735,919	4,378,523
Percentage of State total										16.8	100.0
Average output per man per day										3.08	2.44
Oregon:											
Tons produced										6,000	28,327
Percentage of State total										21.2	100.0
Average output per man per day										1.67	1.00
Pennsylvania:											
Tons produced										20,667,804	172,051,132
Percentage of State total										12.0	100.0
Average output per man per day										3.93	3.78
South Dakota:											
Tons produced											8,042
Percentage of State total											100.0
Average output per man per day											1.51
Tennessee:											
Tons produced										665,003	6,180,203
Percentage of State total										10.8	100.0
Average output per man per day										2.40	2.40
Texas:											
Tons produced										277,009	2,355,615
Percentage of State total										11.7	100.0
Average output per man per day										3.00	2.03
Utah:											
Tons produced		1,602								69,780	4,119,758
Percentage of State total										1.7	100.0
Average output per man per day		3.11								2.76	5.19
Virginia:											
Tons produced										422,351	10,072,916
Percentage of State total										4.2	100.0
Average output per man per day										3.08	3.31
Washington:											
Tons produced			31,695							1,268,185	4,009,902
Percentage of State total			0.8							31.6	100.0
Average output per man per day			1.76							2.17	2.78
West Virginia:											
Tons produced										7,212,239	80,356,670
Percentage of State total										8.3	100.0
Average output per man per day										3.92	4.34
Wyoming:											
Tons produced		294,942		787,767	261,198				211,609	16,525	8,571,499
Percentage of State total		3.4		9.2	3.0				2.5	0.2	100.0
Average output per man per day		5.03		4.21	5.28				8.07	2.17	4.71
Total:											
Tons produced	8,112	323,244	31,695	847,913	261,198	28,609	1,015	1,699	211,609	46,815,310	550,434,148
Percentage of total		0.1		0.2						8.5	100.0
Average output per man per day	2.23	1.59	1.76	4.21	5.28	6.50	1.49	2.50	8.07	3.60	3.78

between the thickness of the bed and the average daily production per man, with the lowest average from the thinnest beds and increasingly higher averages from beds increasing in thickness up to 10 feet, above which the results are extremely variable. These figures are given in the accompanying table by States.

Among the Eastern States Pennsylvania, Maryland, Tennessee, and Alabama each show the largest percentage of coal mined from beds 3 to 4 feet thick; Kentucky, including western Kentucky, the largest percentage from beds between 4 and 5 feet thick, and Ohio, West Virginia, and Virginia the largest percentage from beds between 5 and 6 feet thick. The maximum thickness of coal reported mined in Pennsylvania was 10 feet; in Ohio and Alabama, 13 feet; Maryland and Virginia, 12 feet; Kentucky, 11 feet; West Virginia, 14 feet; and Tennessee, 6 feet. With the exception of Maryland, all the Eastern States reported operation in beds less than 2 feet thick.

Nearly 50 per cent of the coal mined in Michigan is from beds between 2 and 3 feet thick, and more than 80 per cent is from beds between 2 and 4 feet thick.

About 50 per cent of the coal mined in Illinois is from beds between 6 and 8 feet thick, with the greater quantity from the thicker beds. In Indiana the larger quantity is from beds between 4 and 5 feet thick.

In the Mississippi Valley States the coal is not so thick as in the Eastern States or in the Rocky Mountain States. With the exception of Texas, no production was reported in these States from beds more than 8 feet thick. In Iowa, Kansas, Oklahoma, and Arkansas the largest percentage was from beds between 3 and 4 feet thick, and in Missouri and Texas from beds less than 2 feet thick.

Lignite beds mined in North Dakota range from 4 to 23 feet in thickness, with the largest percentage of output from beds 11 to 12 feet thick. In South Dakota the largest percentage of production is from beds between 6 and 7 feet thick.

Colorado presents a wide range in thickness of coal mined, from 2 to 41 feet. The largest percentage is from beds 4 to 7 feet thick. Coal beds mined in New Mexico range from 2 to 8 feet in thickness, 60 per cent of the total output being from beds 5 to 6 feet thick. Coal is mined in Wyoming from beds ranging from 4 to 51 feet thick; nearly 20 per cent of the total production is from beds 7 to 8 feet thick, and nearly 10 per cent from beds between 26 and 27 feet thick.

In Montana no coal is reported as mined from beds less than 3 feet thick, the largest percentage being from beds 7 to 8 feet thick.

In Utah the beds mined range from 5 to 23 feet thick; about 25 per cent of the production is from beds 8 to 9 feet thick, and 35 per cent from beds 16 to 17 feet thick.

In Washington more than 40 per cent of the coal mined is from beds 4 to 5 feet thick, although small quantities are reported from beds as much as 26 feet thick.

PRODUCTION BY CLASSES OF MINES.

Reports of production were collected in 1917 from 10,634 mines, of which 3,695, with an aggregate output of 1,625,006 tons, were "small mines" without even such railroad facilities as are available to the so-called "wagon mines." These small mines are for the most part country "banks" worked only in the winter to supply purely local needs.

Coal produced at small mines in 1917, by States.

State.	Number of mines.	Quantity (net tons).	State.	Number of mines.	Quantity (net tons).
Alabama	20	8,752	New Mexico	3	2,092
Arkansas	29	19,660	North Dakota	139	73,663
Colorado	52	42,662	Ohio	708	393,858
Illinois	266	137,646	Oklahoma	33	8,321
Indiana	178	81,559	Pennsylvania	572	398,166
Iowa	54	39,740	Tennessee	26	14,018
Kansas	56	10,782	Utah	11	5,474
Kentucky	614	86,549	Virginia	26	14,180
Maryland	51	25,208	West Virginia	455	84,995
Michigan	2	1,228	Wyoming	20	4,120
Missouri	331	134,499			
Montana	49	37,834		3,695	1,625,006

The commercial mines, 6,939 in number, are so classified either because their product enters the market or because of their size and the fact that shipments are originated by rail or water.

More than 51 per cent of the total bituminous coal produced in 1917 came from 792 mines, or 7.5 per cent of the total number, in what has been designated the first class—those producing 200,000 tons or more a year. These 792 mines produced 285,366,000 tons, an average of 360,310 tons each. The highest average was reached in Virginia, in which 14 mines had an average output of nearly 500,000 tons each. In the number of large mines Pennsylvania, of course, excels, with 268 mines having an average output of 375,354 tons, representing 58 per cent of the total production in the State. Among the leading coal-producing States Illinois was first in the largest percentage of large mines, with 154, or 20 per cent of the total, from which came nearly 80 per cent of the State's output.

Mines of the second class—those producing between 100,000 and 200,000 tons—numbered 914, or 8.6 per cent of the total, and produced an average of 141,700 tons each, representing in the aggregate 23.5 per cent of the total production of the country.

There were 1,044 mines of the third class, producing from 50,000 to 100,000 tons, with an aggregate output of nearly 75,000,000 tons, or 13.5 per cent of the total, and 1,966 mines of the fourth class, from 10,000 tons to 50,000 tons, with an average production each of 25,850 tons and an aggregate production of 51,596,000 tons, or 9.4 per cent of the total.

Mines producing less than 10,000 tons numbered 5,888, or 55.3 per cent of the total. Production of this, the fifth class, was 10,500,000 tons, or less than 2 per cent of the total for the country. These smaller mines had an average output in 1917 of 1,775 tons.

Bituminous coal produced in the United States in 1917 according to classes of mines, in net tons.

State.	First class (mines producing more than 200,000 tons).					Second class (mines producing from 100,000 to 200,000 tons).					Third class (mines producing from 50,000 to 100,000 tons).				
	Mines.		Quantity.			Mines.		Quantity.			Mines.		Quantity.		
	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Per centage.	Total.	Average per mine.	Percentage.
Alabama	28	9.7	11,040,920	394,319	55.0	27	9.4	3,458,017	128,075	17.2	43	14.9	3,206,216	74,563	16.0
Arkansas						4	3.5	551,336	137,834	25.7	11	9.7	757,587	68,872	35.3
California, Idaho, and Alaska															
Colorado	16	6.3	4,629,349	289,334	37.1	24	9.5	3,574,623	148,943	28.6	33	13.0	2,417,657	73,262	19.4
Georgia						1	50.0	117,403	117,403	98.6					
Illinois	154	20.2	68,709,245	446,164	79.7	77	10.1	11,654,782	151,031	13.5	45	5.9	3,114,477	69,211	3.6
Indiana	52	12.6	16,708,099	321,310	62.9	41	9.9	6,364,068	155,221	24.0	30	7.3	2,031,943	67,731	7.7
Iowa	6	2.8	2,017,602	336,267	22.5	26	11.9	3,553,759	136,683	39.6	31	14.2	2,077,590	67,019	23.1
Kansas	4	2.2	864,189	216,047	12.1	22	11.8	2,839,657	129,075	39.6	28	15.1	2,105,612	75,200	29.3
Kentucky	20	1.8	5,421,394	271,070	19.5	81	7.2	11,249,865	138,887	40.5	88	7.8	6,290,786	71,486	22.6
Maryland	2	1.4	541,994	270,997	11.5	13	9.4	1,889,229	145,325	39.8	18	12.9	1,351,406	75,078	28.5
Michigan						7	31.8	898,061	128,294	65.3	6	27.3	425,463	70,911	30.9
Missouri	6	1.2	1,490,270	248,378	26.3	5	.9	631,495	126,299	11.1	25	4.9	1,817,149	72,686	32.0
Montana	7	7.4	2,801,245	400,178	66.3	4	4.3	604,741	151,185	14.3	9	9.6	560,024	62,225	13.3
New Mexico	9	20.0	2,782,089	309,121	69.5	5	11.1	648,321	129,664	16.2	5	11.1	385,953	77,191	9.6
North Dakota						2	1.1	260,263	130,132	32.9	1	.5	73,276	73,276	9.3
Ohio	61	4.3	17,686,225	289,938	43.4	86	6.1	12,288,999	142,895	30.2	72	5.1	5,106,454	70,923	12.5
Oklahoma	2	1.3	412,448	206,224	9.4	8	5.4	986,002	123,250	22.5	18	12.1	1,367,261	75,959	31.2
Oregon															
Pennsylvania	268	10.4	100,594,862	375,354	58.3	243	9.5	33,489,396	137,816	19.5	267	10.4	19,294,682	72,265	11.2
South Dakota															
Tennessee	7	4.5	1,781,717	254,531	28.7	10	6.5	1,445,445	144,545	23.4	22	14.2	1,555,855	70,721	25.1
Texas	1	2.1	204,625	204,625	8.7	5	10.4	747,971	149,596	31.8	9	18.7	575,951	63,995	24.4
Utah	10	27.8	3,544,808	354,481	85.9	3	8.3	402,662	134,221	9.8	1	2.8	60,579	60,579	1.5
Virginia	14	10.1	6,926,711	494,765	68.7	8	5.7	1,055,490	131,936	10.5	21	15.1	1,450,682	69,080	14.4
Washington	8	14.3	2,141,180	267,648	53.3	6	10.7	808,157	134,693	20.2	7	12.5	458,800	65,543	11.4
West Virginia	94	5.8	28,545,525	303,676	33.0	197	12.2	28,492,230	144,631	33.0	248	15.3	17,987,484	72,530	20.8
Wyoming	23	31.1	6,521,244	283,532	76.0	9	12.2	1,473,549	163,728	17.2	6	8.1	421,382	70,230	4.9
Grand total	792	7.5	285,365,741	360,310	51.7	914	8.6	129,485,524	141,669	23.5	1,044	9.3	74,894,269	71,738	13.5

Bituminous coal produced in the United States in 1917, according to classes of mines, in net tons—Continued.

State.	Fourth class (mines producing from 10,000 to 50,000 tons).					Fifth class (mines producing less than 10,000 tons).					Total.		
	Mines.		Quantity.			Mines.		Quantity.					
	Number.	Percentage.	Total.	Average per mine.	Percentage.	Number.	Percentage.	Total.	Average per mine.	Percentage.	Mines.	Quantity.	Average per mine.
Alabama	77	26.9	2,023,857	26,284	10.1	112	39.1	339,068	3,027	1.7	287	20,068,078	69,924
Arkansas	34	29.8	682,868	20,084	31.9	65	57.0	151,790	2,335	7.1	114	2,143,581	18,803
California, Idaho, and Alaska	......	......	......	......	......	7	100.0	60,401	8,629	100.0	7	60,401	8,629
Colorado	60	23.7	1,601,767	26,696	12.8	120	47.5	259,941	2,166	2.1	253	12,483,337	49,341
Georgia	......	......	......	......	......	1	50.0	1,625	1,625	1.4	2	119,028	59,514
Illinois	75	9.9	1,994,809	26,598	2.3	410	53.9	726,064	1,771	.9	761	86,199,377	113,271
Indiana	46	11.1	1,085,123	23,590	4.1	245	59.1	350,096	1,429	1.3	414	26,539,329	64,105
Iowa	39	17.9	1,047,879	26,869	11.7	116	53.2	269,000	2,319	3.1	218	8,965,830	41,128
Kansas	42	22.6	1,205,403	28,700	16.7	90	48.3	170,114	1,890	2.3	186	7,184,975	38,629
Kentucky	150	13.3	4,093,432	27,290	14.7	789	69.9	752,475	954	2.7	1,128	27,807,952	24,652
Maryland	29	20.9	857,764	29,578	18.0	77	55.4	105,531	1,371	2.2	139	4,745,924	34,143
Michigan	2	9.1	23,595	11,798	1.7	7	31.8	27,686	3,955	2.1	22	1,374,805	62,491
Missouri	50	9.9	1,264,850	25,297	22.3	422	83.1	466,785	1,106	8.3	508	5,670,549	11,163
Montana	7	7.4	161,773	23,110	3.8	67	71.3	98,906	1,476	2.3	94	4,226,689	44,965
New Mexico	7	15.6	128,454	18,351	3.3	19	42.2	55,710	2,932	1.4	45	4,000,527	88,901
North Dakota	14	7.4	253,443	18,103	32.1	171	91.0	203,566	1,190	25.7	188	790,548	4,205
Ohio	178	12.7	4,034,381	22,665	9.9	1,010	71.8	1,632,674	1,617	4.0	1,407	40,748,733	28,961
Oklahoma	59	39.6	1,505,475	25,517	34.3	62	41.6	115,658	1,865	2.6	149	4,386,844	29,442
Oregon	1	16.7	10,055	10,055	35.5	5	83.3	18,272	3,654	64.5	6	28,327	4,721
Pennsylvania	626	24.4	16,038,564	25,621	9.3	1,162	45.3	3,030,638	2,608	1.7	2,566	172,448,142	67,205
South Dakota	......	......	......	......	......	12	100.0	8,042	670	100.0	12	8,042	670
Tennessee	53	34.2	1,288,228	24,306	20.8	63	40.6	122,976	1,952	2.0	155	6,194,221	39,963
Texas	26	54.2	792,063	30,464	33.6	7	14.6	35,202	5,029	1.5	48	2,355,815	49,079
Utah	3	8.3	89,226	29,742	2.1	19	52.8	27,955	1,471	.7	36	4,125,230	114,590
Virginia	24	17.3	486,330	20,264	4.8	72	51.8	167,878	2,332	1.6	139	10,087,091	72,569
Washington	22	39.3	555,494	25,250	13.9	13	23.2	46,271	3,559	1.2	56	4,009,902	71,605
West Virginia	366	22.6	10,246,766	27,997	11.8	715	44.1	1,169,662	1,636	1.4	1,620	86,441,667	53,359
Wyoming	6	8.1	124,401	20,734	1.5	30	40.5	35,043	1,168	.4	74	8,575,619	115,887
Grand total	1,996	18.8	51,596,000	25,850	9.4	5,888	55.3	10,449,029	1,775	1.9	10,634	551,790,563	51,884

PRODUCTION OF COAL SUITABLE FOR THE MANUFACTURE OF BY-PRODUCT COKE.

The following table presents the results of tabulating the production in 1917 of mines listed by the United States Fuel Administration as producing coal suitable for the manufacture of by-product coke. This list of mines was determined by a committee of the Fuel Administration staff familiar with by-product coke-oven practice, after correspondence with all the operators of by-product ovens and many producers of coal. The classification as between first and second grade was not made in accordance with exact standards or hard and fast rules, but was largely determined by the experience of users verified by the analyses of the coals. The following notes describe briefly the standards used in the classification: [1]

Answering your inquiry [of November 21, 1918], we have no exact standard by which coal is arbitrarily classified in the three different grades.

In order to be classed in the first grade the ash should not exceed 8 per cent as a maximum and the sulphur should not exceed 1 per cent in the coke. This allows for a considerable variation of sulphur in coal, as a much larger percentage will burn off in coking in some coals than in others.

Medium grade should analyze not more than 10 per cent in ash and coke made from this coal should not exceed 1.20 [per cent] in sulphur.

Any coals that are higher in sulphur or ash than second grade we have classed in the third grade and these coals we consider unsuitable for by-product use.

In addition to the analysis there is also a physical structure of the coke to be considered, and even though the analysis would class a coal as first grade, if it did not make coke of good structure, we would place this coal in a lower grade.

Bituminous coal suitable for use in the manufacture of by-product coke produced in 1917, in net tons.

Producing district.	Production of all kinds of bituminous coal.	Production of mines listed by the Fuel Administration as producing bituminous coal suitable for the manufacture of by-product coke.					
		High volatile.			Low volatile.		
		First grade.	Second grade.	Total.	First grade.	Second grade.	Total.
Central Pennsylvania	59,044,092	1,715,722	3,613,062	5,328,784	7,356,720	3,360,815	10,717,535
Northern Pennsylvania	7,381,328	670,738	919,988	1,590,726	371,716	74,131	445,847
Western Pennsylvania [a]	102,063,891	58,957,980	8,775,461	67,733,441			
Somerset, Md	13,843,238	92,612	33,618	126,230	2,941,750	2,951,381	5,893,131
Fairmont, W. Va	17,567,575	6,644,914	1,884,211	8,529,125			
Northeastern Kentucky	6,453,679	5,389,454	196,713	5,586,167			
Hazard	1,853,353	878,009	92,902	970,911			
Logan	8,784,270	3,553,774	1,427,952	4,981,726			
Coal and coke—K. & M.	5,091,152	2,084,645	389,886	2,474,531			
Kanawha	7,656,440	3,409,895	773,277	4,183,172	116,999		116,999
Kenova-Thacker	6,332,261	2,119,580	1,238,985	3,358,565			
New River	15,096,036	283,994	599,776	883,770	9,360,542	4,401,930	13,762,472
Pocahontas and Tug River	24,947,362				22,055,212	1,689,788	23,745,000
Southwestern Virginia	8,604,318	3,730,468	2,097,900	5,828,368	316,826		316,826
Southeastern Kentucky	6,381,144	3,747,724 (Southeastern Kentucky and Tennessee and Georgia)	544,286	4,292,010			
Tennessee and Georgia	6,313,249						
Alabama	20,068,074	5,234,937	599,130	5,834,067			
Western Kentucky	10,249,480	293,539		293,539			
	327,730,942	98,807,985	23,187,147	121,995,132	42,519,765	12,478,045	54,997,810

[a] Western Pennsylvania includes the Pittsburgh, Westmoreland, Latrobe, Ligonier, Greensburg, and Connellsville districts of Pennsylvania and the Panhandle district of West Virginia.

[1] Informal communication from C. C. Marvel, manager, section on by-product coke and artificial gas plants, United States Fuel Administration, Nov. 22, 1918.

BOX-CAR LOADERS AT BITUMINOUS COAL MINES.

At the request of the Committee on Coal Production the number and capacity of mechanical box-car and stock-car loaders were determined in June and July, 1917, by inquiries addressed to the operators of bituminous coal and lignite mines. The results of this inquiry are summarized in the following table. A total of 343 mechanical loaders was reported (of which 23 were on the date of inquiry reported as out of repair), which had a capacity of 9,622 cars, or somewhat less than 300,000 tons a day. Illinois and Colorado led in the number of mechanical loaders, Illinois having 68 loaders, or 20 per cent of the total, and Colorado 61 loaders, or 18 per cent. Of the total number 73 per cent, or 246 loaders, were in the coal fields of the Central and Western States, and only 97 loaders were in the Appalachian regions.

Number and capacity of mechanical box-car loaders at bituminous coal mines in the United States, July 1, 1917.

State.	Railroad.	Number of loaders.	Daily capacity of cars of 30 tons each.	Remarks.
Arkansas	Denver & Rio Grande	1	7	
Colorado	Colorado & Southern	15	225	
	Chicago, Burlington & Quincy	2	38	
	Atchinson, Topeka & Santa Fe	4	60	
	Colorado & Southeastern	3	113	
	Denver & Rio Grande	25	420	14 of these also on Colorado & Southern.
	Rio Grande Southern	1	10	
	Denver & Intermountain	1	23	
	Denver & Salt Lake	5	165	
	Union Pacific	5	114	
		61	1,168	
Illinois	Chicago, Burlington & Quincy	2	56	
	Illinois Southern	4	144	
	St. Louis, Iron Mountain & Southern	3	172	
	Peoria Railway & Terminal	1	20	
	St. Louis & O'Fallon	1	17	
	Toledo & Western	1	10	
	St. Louis & Eastern	1	27	
	Chicago & Alton	1	40	
	Litchfield & Madison	1	27	
	Cleveland, Cincinnati, Chicago & St. Louis	7	288	
	Chicago, Milwaukee & St. Paul	4	165	
	Chicago & Illinois Midland	2	73	
	Chicago & Northwestern	3	107	
	Peoria, Pekin Union	1	14	
	Illinois Central	4	153	
	Wabash	1	20	
	Elgin, Joliet & Eastern	1	8	
	Illinois Central and other roads, jointly [a]	22	670	
	Wabash and Louisville & Nashville	1	83	
	Wabash and Chicago & Alton	1	20	
	Chicago & Eastern Illinois, Iron Mountain, and Chicago, Burlington & Quincy, jointly.	1	17	
	Minneapolis & St. Louis	3	73	
	Vandalia	1	27	
	Toledo, Peoria & Western	1	17	
		68	2,248	
Indiana	Chicago & Eastern Illinois	2	70	
	Chicago, Terre Haute & Southeastern	2	15	
		4	85	

[a] The mines on the Illinois Central and also on one or more of the following roads: Baltimore & Ohio; Baltimore & Ohio Southwestern; Cleveland, Cincinnati, Chicago & St. Louis; Chicago & Eastern Illinois; Chicago, Burlington & Quincy; Chicago & Alton; Chicago, Milwaukee & St. Paul; Cincinnati, Hamilton & Dayton; St. Louis, Iron Mountain & Southern; Illinois Traction; Vandalia; Chicago, Peoria & St. Louis; Wabash.

Number and capacity of mechanical box-car loaders at bituminous coal mines in the United States, July 1, 1917—Continued.

State.	Railroad.	Number of loaders.	Daily capacity of cars of 30 tons each.	Remarks.
Iowa	Chicago, Rock Island & Pacific	4	120	
	Chicago, Milwaukee & St. Paul	6	141	
	Chicago, Burlington & Quincy	1	2	
	Minneapolis & St. Louis	2	74	
		13	337	
Kansas	St. Louis & Santa Fe	1	10	
Kentucky	Chesapeake & Ohio	2	8	
	Louisville & Nashville	11	180	1 on Illinois Central also.
	Cumberland	1	13	
	Illinois Central	2	45	
		a16	246	
Maryland	Cumberland & Pennsylvania	1	13	
Michigan	Pere Marquette	2	28	
	Michigan Central	2	34	
		4	62	
Missouri	Chicago, Burlington & Quincy	3	57	
Montana	Chicago, Minneapolis & St. Paul	3	82	
	Great Northern	3	202	
	Northern Pacific	3	58	
	Montana, Wyoming & Southern	4	116	
		13	458	
New Mexico	Atchison, Topeka & Santa Fe	9	263	
	El Paso & Southwestern	3	68	
		12	331	
North Dakota	Great Northern	1	23	
	Northern Pacific	2	17	
	Chicago, Milwaukee & St. Paul	1	1	
	Minneapolis, St. Paul & Saulte Sainte Marie	2	110	
		6	151	
Ohio	Wheeling & Lake Erie	1	....	
	Hocking Valley	1	....	
	Cincinnati, Hamilton & Dayton	1	17	
	Erie	1	8	
	Baltimore & Ohio	9	2,097	Also on Pittsburgh, Lisbon & Western; 1 also on Wheeling and Lake Erie.
	Kanawha & Michigan	1	4	
		14	2,126	
Oklahoma	Missouri, Kansas & Texas	5	83	
	Chicago, Rock Island & Pacific	7	151	
	Fort Smith & Western	2	15	
		14	249	
Pennsylvania	Baltimore & Ohio	11	111	
	Pennsylvania	12	343	
	Pittsburgh, Cincinnati, Chicago & St. Louis	2	60	
	Pittsburgh & Lake Erie	2	50	
	West Side Belt	1	33	
		28	597	
Texas	Missouri, Kansas & Texas	1	8	

a Three in western Kentucky.

Number and capacity of mechanical box-car loaders at bituminous coal mines in the United States, July 1, 1917—Continued.

States.	Railroad.	Number of loaders.	Daily capacity of cars of 30 tons each.	Remarks.
Utah	Denver & Rio Grande	20	368	
Washington	Northern Pacific	1	17	
	Oregon-Washington Railroad & Navigation Co.	1	17	
		2	34	
West Virginia	Baltimore & Ohio	25	271	
	Chesapeake & Ohio	6	100	
	Western Maryland	2	6	
	Norfolk & Western	1	7	
	Wabash, Pittsburgh Terminal	2	37	
		36	421	
Wyoming	Chicago, Burlington & Quincy	11	390	
	Northern Pacific	7	159	
	Chicago & Northwestern	1	....	
	Oregon Short Line	6	104	
		25	653	
	Grand total	343	9,629	

VALUE.

The value of coal given in this report is the realization value at the mine f. o. b. cars, and the average value per ton is the average realization price obtained by dividing the total value by the number of tons sold or produced. The coal used at the mine, the coal coked by the producing company, and the coal used in some other industry by the company operating the mine—an appreciable proportion of the whole—is never sold, and the value placed upon it is either an estimate or the figure at which it is carried on the books, either of which is supposedly based on what the coal would have brought if sold or what other fuel for the respective purpose would have cost if its purchase had been necessary. In other words, the values given represent returns to the operators for coal sold, plus estimated exchange value of that not sold. These figures do not necessarily show prices or even an average of the prices of coal at the mine.[1]

[1] For a study of prices and of Government control of prices, see the report on Prices of coal and coke in Mineral Resources of the United States, 1918.

Average value per net ton of coal at the mines since 1908.

State.	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	Advance in 1917.
Alabama	$1.26	$1.19	$1.26	$1.27	$1.29	$1.31	$1.34	$1.28	$1.37	$2.27	+$0.90
Alaska	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	4.00	4.92	+ .92
Arkansas	1.68	1.48	1.56	1.61	1.71	1.76	1.72	1.79	1.92	2.56	+ .64
California	b 3.19	2.21	b 2.74	b 2.00	b 2.33	b 3.54	c 2.85	bc 2.54	c 2.12	c 2.30	+ .18
Colorado	1.41	1.33	1.42	1.45	1.49	1.52	1.66	1.58	1.62	2.22	+ .60
Georgia	1.38	1.41	1.46	d 1.49	d 1.49	1.41	e 1.44	1.72	1.79	2.53	+ .74
Idaho	4.02	4.27	3.92	f 2.68	f 3.14	2.43	(c)	(c)	(c)	(c)	(c)
Illinois	1.05	1.05	1.14	1.11	1.17	1.14	1.12	1.10	1.25	1.88	+ .63
Indiana	1.06	1.02	1.13	1.08	1.14	1.11	1.10	1.10	1.27	1.99	+ .72
Iowa	1.63	1.65	1.75	1.73	1.80	1.79	1.79	1.78	1.86	2.35	+ .49
Kansas	1.49	1.44	1.61	1.53	1.62	1.67	1.64	1.66	1.78	2.31	+ .53
Kentucky	1.01	.94	.99	.99	1.02	1.05	1.02	1.01	1.19	2.17	+ .98
Maryland	1.17	1.11	1.12	1.11	1.18	1.24	1.27	1.28	1.56	2.46	+ .90
Michigan	1.81	1.79	1.91	1.78	1.99	1.99	1.99	2.05	2.25	3.22	+ .97
Missouri	1.64	1.65	1.79	1.72	1.76	1.73	1.73	1.73	1.91	2.43	+ .52
Montana	1.96	1.97	1.82	1.79	1.82	1.74	1.75	1.62	1.73	2.11	+ .38
New Mexico	1.37	1.29	1.39	1.44	1.42	1.46	1.61	1.44	1.47	1.86	+ .39
North Dakota	1.63	1.56	1.49	1.43	1.53	1.52	1.52	1.45	1.49	1.80	+ .31
Ohio	1.06	.99	1.05	1.03	1.07	1.10	1.13	1.08	1.33	2.48	+ 1.15
Oklahoma	2.03	2.00	2.22	2.05	2.14	2.05	2.06	2.01	2.09	2.81	+ .72
Oregon	2.74	2.69	3.48	2.32	2.60	2.53	2.78	2.84	2.68	3.38	+ .70
Pennsylvania (bituminous)	1.01	.94	1.02	1.01	1.05	1.11	1.07	1.06	1.30	2.44	+ 1.14
South Dakota	......	......	......	......	......	1.96	1.73	1.55	2.03	2.90	+ .87
Tennessee	1.15	1.09	1.11	1.12	1.14	1.14	1.14	1.13	1.23	2.19	+ .96
Texas	1.80	1.72	1.67	1.66	1.67	1.77	1.69	1.65	1.56	1.77	+ .21
Utah	1.69	1.66	1.68	1.69	1.67	1.65	1.59	1.58	1.62	2.07	+ .45
Virginia	.91	.89	.90	.91	.96	1.01	1.01	.98	1.06	2.00	+ .94
Washington	2.21	2.54	2.50	2.29	2.39	2.38	2.20	2.17	2.27	2.68	+ .41
West Virginia	.95	.86	.92	.90	.94	1.01	.99	.97	1.18	2.32	+ 1.14
Wyoming	1.62	1.55	1.55	1.56	1.58	1.56	1.55	1.46	1.55	1.93	+ .38
Total bituminous	1.12	1.07	1.12	1.11	1.15	1.18	1.17	1.13	1.32	2.26	+ .94
Pennsylvania anthracite	1.90	1.84	1.90	1.94	2.11	2.13	2.07	2.07	2.30	2.85	+ .55

a Included with California.
b Includes Alaska.
c California includes Idaho and Nevada in 1914 and 1915; Idaho in 1916 and 1917.
d Includes North Carolina.
e Average for total output, including refuse from washery. The average, excluding refuse, was $1.71
f Includes Nevada.

Average value per net ton of coal at the mines in the United States for 38 years.

Year.	Anthracite.	Bituminous.	Year.	Anthracite.	Bituminous.
1880	$1.47	$1.25	1899	$1.46	$0.87
1881	2.01	1.12	1900	1.49	1.04
1882	2.01	1.12	1901	1.67	1.05
1883	2.01	1.07	1902	1.84	1.12
1884	1.79	.94	1903	2.04	1.24
1885	2.00	1.13	1904	1.90	1.10
1886	1.95	1.05	1905	1.83	1.06
1887	2.01	1.11	1906	1.85	1.11
1888	1.91	1.00	1907	1.91	1.14
1889	1.44	.99	1908	1.90	1.12
1890	1.43	.99	1909	1.84	1.07
1891	1.46	.99	1910	1.90	1.12
1892	1.57	.99	1911	1.94	1.11
1893	1.59	.96	1912	2.11	1.15
1894	1.51	.91	1913	2.13	1.18
1895	1.41	.86	1914	2.07	1.17
1896	1.50	.83	1915	2.07	1.13
1897	1.51	.81	1916	2.30	1.32
1898	1.41	.80	1917	2.85	2.26

On August 21, 1917, prices of bituminous coal were fixed by the President under the Food and Fuel Control Act (Lever Act).

The schedule of prices and subsequent modifications by the Fuel Administrator in 1917 are given in the following table:

Prices for bituminous coal at the mines established by the President Aug. 21, 1917, with subsequent modifications authorized by the United States Fuel Administration to Dec. 31, 1917.

[These prices do not include the 45-cent allowance for wage increase under the President's order of Oct. 27, 1917.]

State.	President's prices.			Modifications by the United States Fuel Administrator.			Date when effective.
	Run of mine.	Prepared sizes.	Screenings.	Run of mine.	Prepared sizes.	Screenings.	
Alabama:							
Big Seam district	$1.90	$2.15	$1.65				Aug. 21, 1917
Pratt, Jaeger & Corona district	2.15	2.40	1.90				Do.
Cahaba and Black Creek district	2.40	2.65	2.15				Do.
New classifications.							
Big Seam district				$2.15	$2.45	$1.85	Oct. 1, 1917
Cahaba, Black Creek, Brookwood, and Blue Creek districts				2.85	3.10	2.45	Do.
Pratt, Jaeger, Jefferson, Nickle Plate, and Coal City districts				2.35	2.65	2.05	Do.
Corona districts				2.40	2.75	2.05	Do.
Montevallo district				2.40	4.00	2.15	Do.
Sunlight Mining Co. in Walker County				2.85	3.10	2.45	Dec. 1, 1917
Benoit Coal Mining Co. and Cordova Fuel Co. in the county of Walker				2.85	3.10	2.45	Dec. 6, 1917
Gilbert Coal Mining Co., at Dora, and the Mount Carmel Seam				2.85	3.10	2.45	Dec. 20, 1917
Arkansas	2.65	2.90	2.40				Aug. 21, 1917
Hartford, Greenwood, Midland, Hackett, and Denning thin vein				3.05	3.40	2.40	Oct. 1, 1917
Paris field					4.50	2.00	Oct. 27, 1917
Colorado	2.45	2.70	2.20				Aug. 21, 1917
Bituminous domestic coal in Walsenburg, Canon City, Rout, Garfield, Gunnison, Durange, Mesa, Pitkin, Montezuma, Delta, Montrose, and Rio Blanca districts				3.00	4.00	1.50	Oct. 1, 1917
Bituminous steam coal in Trinidad district				2.75	3.25	2.00	Do.
Lignite coal, northern field and El Paso districts				2.45	3.50	1.00	Do.
				2.45	3.50	1.25	Nov. 22, 1917
Illinois	1.95	2.20	1.70				Aug. 21, 1917
McLean County Coal Co. (when sold at retail only)					4.00	1.70	Oct. 27, 1917
Counties of Peoria, Fulton, and Tazewell				2.30	2.55	2.05	Dec. 8, 1917
Illinois (third vein)	2.40	2.65	2.15				Aug. 21, 1917
Mercer County and northern field				2.65	2.90	2.40	Dec. 8, 1917
Indiana	1.95	2.20	1.70				Aug. 21, 1917
Brazil Block					2.95	1.70	Oct. 1, 1917
Iowa	2.70	2.95	2.45				Aug. 21, 1917
Appanoose, Wayne, Boone, and Webster counties				3.15	3.40	2.90	Oct. 1, 1917
Kansas	2.55	2.80	2.30				Aug. 21, 1917
Mines at Leavenworth	2.70	2.95	2.45				Do.
				3.15	3.40	2.90	Oct. 1, 1917
Osage County				2.55	4.00	2.30	Do.
				3.05	4.50	2.80	Dec. 1, 1917
Kentucky	1.95	2.20	1.70				Aug. 21, 1917
Counties of McCreary, Pulaski, Rockcastle, Jackson, Lee, Wolfe, Morgan, Lawrence, Johnson, Martin, Laurel, Whitley, Clay, Owsley, Knox, Bell, Breathitt, Perry, Leslie, Harlan, Magoffin, Boyd, Carter, Pike, and all of Floyd, Knott, and Letcher counties excepting coal produced from the thick vein in Elkhorn districts in these three counties				2.40	2.65	2.15	Oct. 11, 1917

Prices for bituminous coal at the mines established by the President Aug. 21, 1917, with subsequent modifications authorized by the United States Fuel Administration to Dec. 31, 1917—Continued.

State.	President's prices.			Modifications by the United States Fuel Administrator			Date when effective.
	Run of mine.	Prepared sizes.	Screenings.	Run of mine.	Prepared sizes.	Screenings.	
Kentucky—Continued.							
Counties of Whitley, Knox, Clay, and Bell, Blue Gem district in Campbell County				3.55	3.80	2.30	Nov. 6, 1917
Counties of Whitley, Knox, Bell, and McCreary other than the Blue Gem district				2.65	2.90	2.40	Dec. 3, 1917
Kentucky (Jellico)	2.40	2.65	2.15				Aug. 21, 1917
Maryland	2.00	2.25	1.75				Do.
The North Maryland Coal Mining Co. in Allegany County				2.75			Dec. 3, 1917
Michigan				3.15	3.60	2.20	Oct. 27, 1917
What Cheer Mining Co				3.40	3.95	2.25	Nov. 30, 1917
Banner Coal Co				3.40	3.95	2.25	Do.
Bliss Coal Co				3.40	3.95	2.25	Do.
Robert Gage Coal Co				3.40	3.95	2.25	Do.
Beaver Coal Co				3.40	3.95	2.25	Do.
Consolidated and Wolverine Coal Cos				3.40	3.95	2.25	Do.
Handy Bros				3.70	4.25	2.55	Do.
Caledonia Mine, operated by Robert Gage Coal Co				4.55	5.05	3.55	Do.
Flint Mine, operated by the What Cheer Mining Co					5.55	3.55	Do.
Missouri	2.70	2.96	2.45				Aug. 21, 1917
Lafayette, Ray, Clay, Platte, and Linn counties				3.15	3.40	2.90	Oct. 1, 1917
The Longwall thin vein seam in Randolph County and Putnam County				3.15	3.40	2.90	Oct. 27, 1917
Montana	2.70	2.95	2.45				Aug. 21, 1917
				2.70	3.60	1.50	Oct. 27, 1917
New Mexico	2.40	2.65	2.15				Aug. 21, 1917
Raton district				2.75	3.25	2.00	Oct. 28, 1917
Gallup field				3.05	4.50	2.00	Nov. 26, 1917
Cerillos and Carthage fields				4.05	5.05	3.55	Do.
Sugarite and Monroe fields				3.00	4.00	2.00	Do.
All other mines				2.40	2.65	2.15	Do.
Ohio (thick vein)	2.00	2.25	1.75				Aug. 21, 1917
Ohio (thin vein)	2.35	2.60	2.10				Do.
Deerfield or Palmyra field, Massilon field, and Jackson field				3.75	4.00	3.50	Nov. 6, 1917
Oklahoma	3.05	3.30	2.80				Aug. 21, 1917
Le Flore and Haskell counties				3.50	4.30	2.25	Oct. 1, 1917
Okmulgee and Tulsa counties				3.10	3.90	2.00	Do.
Coal County				3.30	4.10	2.00	Do.
Pittsburg and Latimer counties				3.50	4.30	2.25	Do.
Le Flore and Haskell counties				3.75	4.55	2.50	Nov. 30, 1917
Okmulgee and Tulsa counties				3.35	4.15	2.25	Do.
Coal County				3.55	4.35	2.25	Do.
Pittsburg and Latimer Counties				3.75	4.55	2.50	Do.
Pennsylvania	2.00	2.25	1.75				Aug. 21, 1917
O'Donnell Bros., at Morris Run, Tioga County				2.25	2.50	2.00	Dec. 8, 1917
Tennessee (eastern)	2.30	2.55	2.05				Aug. 21, 1917
Counties of Scott, Claiborne, Anderson, Morgan, Campbell				2.40	2.65	2.15	Oct. 11, 1917
County of Campbell, Blue Gem district				3.55	3.80	2.30	Nov. 6, 1917
Counties of Claiborne, Morgan, Anderson, Scott, Campbell, other than the Blue Gem district				2.65	2.90	2.40	Dec. 3, 1917
Bledsoe, Marion, Grundy, and White counties				2.40	2.65	2.15	Dec. 8, 1917
Tennessee (Jellico)	2.40	2.65	2.15				Aug. 21, 1917
Texas	2.65	2.90	2.40				Do.
Counties of Young, Erath, Palo Pinto				3.60	4.40	2.25	Nov. 16, 1917
Wise County				4.25	5.05	2.25	Do.
Utah	2.60	2.85	2.35				Aug. 21, 1917

Prices for bituminous coal at the mines established by the President Aug. 21, 1917, with subsequent modifications authorized by the United States Fuel Administration to Dec. 31, 1917—Continued.

State.	President's prices.			Modifications by the United States Fuel Administrator.			Date when effective.
	Run of mine.	Prepared sizes.	Screenings.	Run of mine.	Prepared sizes.	Screenings.	
Virginia	2.00	2.25	1.75				Aug. 21, 1917
Mines operated near St. Charles, Lee County, by the Darby Coal Mining Co., Black Mountain Mining Co., Virginia Lee Co., Old Virginia Coal Co., United Collieries Co. (Inc.), Benedict Coal Corp.				2.40	2.65	2.15	Oct. 11, 1917
Imperial Mine of the Virginia Iron, Coal & Coke Co., Roanoke				2.40	2.65	2.15	Oct. 27, 1917
Washington	3.25	3.50	3.00				Aug. 21, 1917
Pierce and King counties				3.25	4.50	3.00	Oct. 1, 1917
West Virginia	2.00	2.25	1.75				Aug. 21, 1917
Pomeroy field				2.35	2.60	2.10	Nov. 28, 1917
Davy-Pocahontas Coal Co., McDowell County				2.75			Nov. 22, 1917
Ajax Hocking Coal Co., in Mineral County (publication 2, 4E, and special order)				2.75			Nov. 13, 1917
West Virginia (New River)	2.15	2.40	1.90				Aug. 21, 1917
Wyoming	2.50	2.75	2.25				
				2.50	3.50	1.25	Oct. 1, 1917

Value of coal produced in the United States in 1916.

State.	Loaded at mines for shipment.	Average value per ton.	Sold to local trade and used by employees.	Average value per ton.	Used at mines for steam and heat.	Average value per ton.	Made into coke at mines.	Average value per ton.	Total value.	Average value per ton.
Alabama	$20,015,046	$1.39	$579,342	$1.48	$705,879	$1.20	$3,559,564	$1.33	$24,859,831	$1.37
Alaska	37,159	4.70	14,832	2.91	326	5.26			52,317	4.00
Arkansas	3,637,973	1.93	102,545	2.32	96,327	1.38			3,836,845	1.92
California and Idaho	3,234	2.03	11,133	2.40	1,000	1.00			15,367	2.12
Colorado	13,657,844	1.69	660,178	1.67	313,616	1.16	2,332,466	1.33	16,964,104	1.62
Georgia	141,840	1.84	1,773	1.06	8,640	1.20	157,840	1.80	310,093	1.79
Illinois	75,566,086	1.23	5,316,399	1.72	1,575,469	.97			82,457,954	1.25
Indiana	23,867,222	1.27	1,158,427	1.47	480,597	1.04			25,506,246	1.27
Iowa	12,062,465	1.85	1,311,111	2.22	156,807	1.06			13,530,383	1.86
Kansas	11,734,804	1.78	305,105	2.10	212,814	1.34			12,252,723	1.78
Kentucky	28,135,151	1.20	971,268	1.24	459,812	.95	626,816	.96	30,193,047	1.19
Maryland	6,730,068	1.56	112,794	1.52	104,761	1.61			6,947,623	1.56
Michigan	2,442,102	2.23	154,117	2.98	56,963	1.81			2,653,182	2.25
Missouri	7,929,340	1.88	987,207	2.26	127,958	1.47			9,044,505	1.91
Montana	5,841,429	1.74	331,327	2.33	113,441	.81			6,286,197	1.73
New Mexico	4,552,160	1.58	78,718	1.56	30,793	1.22	918,698	1.09	5,580,369	1.47
North Dakota	655,545	1.49	270,095	1.55	20,442	1.01			946,082	1.49
Ohio	42,571,318	1.33	2,905,746	1.37	673,195	1.11	648	.90	46,150,907	1.33
Oklahoma	7,164,358	2.11	83,088	2.44	277,981	1.56			7,525,427	2.09
Oregon	87,702	3.09	19,216	2.57	7,058	1.05			113,976	2.68
Pennsylvania (bituminous)	163,491,695	1.33	5,833,879	1.39	3,927,220	1.16	48,432,381	1.23	221,685,175	1.30
South Dakota	1,782	2.00	16,239	2.03					18,021	2.06
Tennessee	6,559,072	1.25	133,929	1.35	177,099	1.02	652,345	1.09	7,522,445	1.23
Texas	3,022,862	1.56	34,811	1.97	34,990	1.17			3,092,663	1.56
Utah	[a]5,650,542	1.65	107,771	1.65	37,631	.48	(a)	(a)	5,795,944	1.62
Virginia	8,348,668	1.11	175,286	1.12	122,107	1.08	1,615,363	.84	10,261,424	1.06
Washington	6,158,317	2.28	166,537	2.19	179,706	1.44	402,868	2.94	6,907,428	2.27
West Virginia	95,745,695	1.20	2,115,269	1.20	1,170,388	1.00	3,334,740	.89	102,366,092	1.18
Wyoming	11,872,979	1.57	152,414	1.59	214,314	.80			12,239,707	1.55
Total bituminous	567,684,458	1.34	24,110,556	1.52	11,287,334	1.09	62,033,729	1.18	665,116,077	1.32
Pennsylvania (anthracite)	193,336,887	2.56	4,619,356	2.08	4,053,318	.42			202,009,561	2.30
Grand total	761,021,345		28,729,912		15,340,652		62,033,729		867,125,638	

a Value of coal made into coke included in loaded at mines for shipment.

Value of coal produced in the United States in 1917.

State.	Loaded at mines for shipment.	Average value per ton.	Sold to local trade and used by employees.	Average value per ton.	Used at mines for steam and heat.	Average value per ton.	Made into coke at mines.	Average value per ton.	Total value.	Average value per ton.
Alabama	$33,391,495	$2.19	$1,021,115	$2.01	$1,331,855	$2.08	$9,872,527	$2.71	$45,616,992	$2.27
Alaska			265,317	4.92					265,317	4.92
Arkansas	5,148,786	2.56	180,844	3.06	163,147	2.17			5,492,777	2.56
California and Idaho	6,196	2.21	8,235	2.43	360	1.50			14,791	2.30
Colorado	22,665,626	2.32	1,066,267	2.37	477,579	2.55	3,459,657	1.77	27,669,129	2.22
Georgia	107,469	2.84	2,074	1.62	11,490	1.60	180,358	2.48	301,391	2.53
Illinois	150,747,394	1.88	7,706,905	2.18	3,827,523	1.61			162,281,822	1.88
Indiana	49,922,167	2.00	1,842,057	2.03	1,175,882	1.83			52,940,106	1.99
Iowa	18,523,946	2.33	2,178,836	2.78	393,626	1.74			21,096,408	2.35
Kansas	15,807,949	2.31	465,326	2.89	345,002	1.86			16,618,277	2.31
Kentucky	56,436,837	2.20	1,667,589	1.87	1,083,544	1.69	1,109,683	1.85	60,297,653	2.17
Maryland	11,315,888	2.47	210,943	2.02	141,021	2.39			11,667,852	2.46
Michigan	3,940,104	3.17	342,616	4.18	143,594	2.99			4,426,314	3.22
Missouri	11,896,660	2.41	1,524,744	2.65	334,460	2.20			13,755,864	2.43
Montana	8,225,437	2.12	460,046	2.61	233,653	1.39			8,919,136	2.11
New Mexico	5,920,518	2.02	103,192	2.31	65,975	1.81	1,365,481	1.38	7,455,166	1.86
North Dakota	1,005,897	1.80	373,296	1.90	46,557	1.37			1,425,750	1.80
Ohio	93,890,397	2.51	5,443,716	2.15	1,561,835	2.08	1,200	1.90	100,897,148	2.48
Oklahoma	11,754,785	2.83	139,520	3.07	441,108	2.33			12,335,413	2.81
Oregon	54,668	3.98	35,491	3.91	5,504	1.00			95,663	3.38
Pennsylvania (bituminous)	332,497,267	2.58	11,619,410	2.20	7,266,631	2.08	69,885,500	2.01	421,268,808	2.44
South Dakota	2,414	3.73	20,932	2.83					23,346	2.90
Tennessee	11,874,273	2.30	265,899	1.96	313,801	1.91	1,139,025	1.57	13,592,998	2.19
Texas	4,103,221	1.79	25,245	1.79	49,142	1.00			4,177,608	1.77
Utah	[a]8,304,971	2.10	150,387	1.95	76,024	.88	(a)	(a)	8,531,382	2.07
Virginia	16,333,972	2.11	350,006	2.02	257,661	1.77	3,184,074	1.56	20,125,713	2.00
Washington	9,671,252	2.68	175,970	2.46	317,610	1.91	562,530	3.57	10,727,362	2.68
West Virginia	185,729,321	2.38	5,064,260	2.03	2,174,139	1.82	7,691,648	1.62	200,659,368	2.32
Wyoming	16,033,589	1.96	286,449	2.28	273,245	1.01			16,593,283	1.93
Total bituminous	1,085,312,499	2.31	42,996,687	2.20	22,511,968	1.86	98,451,683	1.98	1,249,272,837	2.26
Pennsylvania (anthracite)	269,193,801	3.10	6,070,907	2.55	8,386,015	.80			283,650,723	2.85
Grand Total	1,354,506,300	2.43	49,067,594	2.24	30,897,983	1.37	98,451,683	1.98	1,532,923,560	2.35

a Value of coal made into coke at the mines included in loaded at mines for shipment.

PRODUCTION OF COAL, BY STATES.

ALABAMA.

The production of coal in Alabama in 1917 was 20,068,074 tons, valued at $45,616,992, an increase compared with 1916 of 1,981,877 tons, or 11 per cent, in quantity and of $20,757,161, or 83 per cent, in value. This was the record year for production of coal in this State. The increase was shared by all counties except Etowah and Tuscaloosa. Jefferson County, with a gain of 600,000 tons, and Walker County, with 900,000 tons, showed the largest increase in quantity produced.

The demand for coal from the mines of Alabama exceeded the supply throughout the year. For the manufacture of coke to supply the demand of the iron and steel industry, 7,638,000 tons of coal were furnished, an increase over 1916 of 12 per cent, and the railroads of the South used in 1917 about 5,700,000 tons of coal from Alabama, an increase of about 1,100,000 tons, or 21 per cent over 1916, the two industries taking substantially all of the increase in production in the State, with the result that other commercial industries and domestic consumers suffered a real shortage, particularly in the more than ordinarily severe winter of 1917–18.

The average number of days worked in 1917 was 273, a record for the State and equaled by one other State, Virginia, and exceeded only by New Mexico in 1917. This represents about 90 per cent full time operation, if the number of working days in a year be taken as 304. The accompanying graphic representation (fig. 24) of working conditions as compiled from weekly reports furnished by the majority of the operators from the last of July to the end of the year [1] indicates approximately the same percentage in the last half of the year. That car shortage and transportation difficulties had but little effect on production and that the most important factor limiting output was labor trouble is shown by this diagram. Strikes in August and September and again in December resulted in a decrease in production and are shown clearly in figure 24. The record of strikes for the year shows 1,835 men affected for an average of 6 days, or 10,220 men-days lost. The loss, though but 0.1 per cent of the total men-days worked was, for Alabama, a nonunion State, very large. The record for 1916 was 920 men-days lost, and for 1915, 1,290 men-days lost.

The increase in production was affected by the greater number of days worked (from 262 in 1916 to 273 in 1917); for, although the number of men employed increased from 25,308 to 28,386, the efficiency of the labor as indicated by the average output per man per day fell from 2.73 tons in 1916 to 2.6 tons in 1917 and the average annual production per employee fell from 715 to 707, notwithstanding the greater number of active days. This is partly accounted for by the fact that of the total increase in men employed (3,078, or 12 per cent), more than half (1,606) were surface men. The increase in total number of men was 12 per cent, in underground employees 7 per cent, and in surface employees 42 per cent. The men working on the surface contribute only indirectly to production.

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[1] For description of the method of compilation, see p. 926.

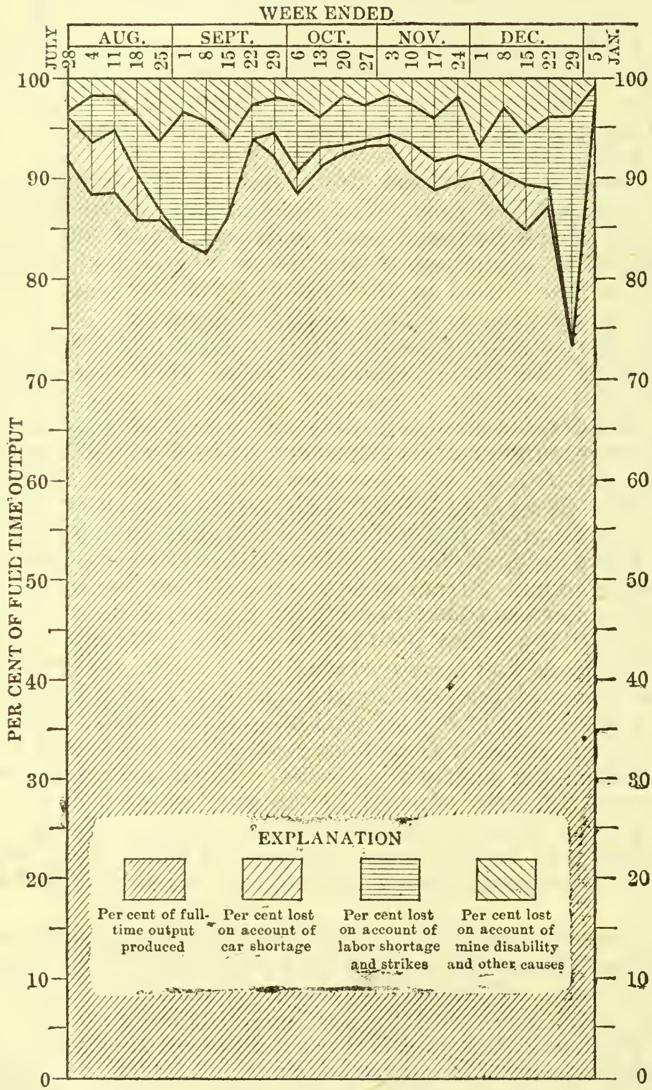


FIGURE 24.—Percentage of full time operation of coal mines and of losses by causes, in Alabama, July to December, 1917.

Coal produced in Alabama in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
						Underground.	Surface.	Total.	
Bibb	1,384,205	12,281	97,370	....	1,493,856	2,142	411	2,553	255
Blount and Jackson	207,986	2,875	1,250	....	212,111	389	36	425	240
Etowah	154,474	2,163	1,964	....	158,601	281	54	335	269
Jefferson	7,428,469	303,661	268,133	1,834,606	9,834,869	10,869	1,793	12,662	275
Marion	68,083	6,021	6 054	....	80,158	180	41	221	215
St. Clair	765,485	3,403	23,282	....	792,170	787	110	897	250
Shelby	578,551	9,705	30,382	....	618,638	938	204	1,142	270
Tuscaloosa	272,307	8,859	59,270	600,360	940,796	1,042	240	1,282	293
Walker	3,540,791	40,744	99,506	250,982	3,932,023	4,739	955	5,694	235
Winston	22,005	410	....	....	22,415	86	11	97	143
Small mines	....	560	....	....	560	....	....	....	....
	14,422,356	390,682	587,211	2,685,948	18,086,197	21,453	3,855	25,308	262

Value of coal produced in Alabama in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total value.	Average value per ton
Bibb	$2,032,201	$23,303	$101,946	....	$2,157,450	$1.44
Blount and Jackson	298,204	3,931	1,725	....	303,860	1.43
Etowah	243,471	3,598	3,222	....	250,291	1.58
Jefferson	10,447,149	443,775	362,917	$2,485,957	13,739,798	1.40
Marion	121,123	8,604	6,054	....	135,781	1.69
St. Clair	1,018,356	4,904	26,132	....	1,049,392	1.32
Shelby	1,076,722	17,555	33,707	....	1,127,984	1.82
Tuscaloosa	359,799	21,976	68,151	754,352	1,204,278	1.28
Walker	4,376,689	49,231	102,025	319,255	4,847,200	1.23
Winston	41,332	825	....	....	42,157	1.88
Small mines	....	1,640	....	....	1,640	2.93
	20,015,046	579,342	705,879	3,559,564	24,859,831	1.37
Average value per ton	1.39	1.48	1.20	1.33	1.37	....

Coal produced in Alabama in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked
						Underground.	Surface.	Total.	
Bibb	1,514,154	12,358	98,111	....	1,624,623	1,999	547	2,546	277
Blount	257,159	3,700	5,870	....	266,729	423	122	545	206
Etowah	150,153	1,918	2,194	....	154,265	197	41	238	271
Jefferson	7,089,174	229,060	300,555	2,834,304	10,453,093	11,746	2,731	14,477	291
St. Clair	813,070	3,406	20,519	....	836,995	643	91	734	290
Shelby	731,082	6,847	43,929	....	781,858	1,161	309	1,470	256
Tuscaloosa	193,800	87,528	36,642	605,765	923,735	1,227	315	1,542	240
Walker	4,364,113	151,560	123,649	205,158	4,844,480	5,170	1,193	6,363	248
Winston	43,456	444	....	....	43,900	118	20	138	176
Other counties [a]	116,555	3,111	10,264	....	129,930	241	92	333	223
Small mines	....	8,466	....	....	8,466	....	....	....	....
	15,272,716	508,398	641,733	3,645,227	20,068,074	22,925	5,461	28,386	273

[a] Includes Cullman, Jackson, and Marion counties.

Value of coal produced in Alabama in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total value.	Average value per ton.
Bibb	$3,669,103	$31,561	$224,880		$3,925,544	$2.42
Blount	659,832	9,300	16,748		685,880	2.57
Etowah	320,239	3,702	4,523		328,464	2.13
Jefferson	15,445,288	382,805	653,963	$8,167,903	24,649,959	2.36
St. Clair	1,560,721	6,764	30,320		1,597,805	1.91
Shelby	2,038,669	19,034	119,532		2,177,235	2.78
Tuscaloosa	453,778	190,742	68,182	1,234,479	1,947,181	2.11
Walker	8,786,741	347,490	198,182	470,145	9,802,558	2.02
Winston	124,307	1,100			125,407	2.86
Other counties [a]	332,817	7,851	15,525		356,193	2.74
Small mines		20,766			20,766	2.45
	33,391,495	1,021,115	1,331,855	9,872,527	45,616,992	2.27
Average value per ton	2.19	2.01	2.08	2.71	2.27	

[a] Includes Cullman, Jackson, and Marion counties.

Coal produced in Alabama, 1913-1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Bibb	1,911,026	1,674,846	1,534,534	1,493,856	1,624,623	+130,767
Blount	178,958	150,384	165,739	[a] 212,111	266,729	+ 54,618
Cullman, Jackson, and Marion	123,615	81,041	[b] 68,890	[b] 80,158	129,930	+ 49,772
Etowah	137,792	156,909	177,368	158,601	154,265	− 4,336
Jefferson	9,028,834	7,936,145	7,579,503	9,834,869	10,453,093	+618,224
St. Clair	890,379	752,588	774,058	792,170	836,995	+ 44,825
Shelby	497,569	498,914	589,412	618,638	781,858	+163,220
Tuscaloosa	917,305	858,899	787,586	940,796	923,735	− 17,061
Walker	3,967,263	3,450,185	3,221,955	3,932,023	4,844,480	+912,457
Winston	24,951	31,618	26,627	22,415	43,900	+ 21,485
Small mines	830	1,893	[a] 2,265	560	8,466	+ 7,906
	17,678,522	15,593,422	14,927,937	18,086,197	20,068,074	+1,981,877
Total value	$23,083,724	$20,849,919	$19,066,043	$24,859,831	$45,616,992	+$20,757,161

[a] Includes Jackson County. [b] Marion County only.

ALASKA.

The production of coal in Alaska in 1917 was 53,955 tons valued at about $265,317. This was by far the largest production in the history of Alaskan coal mining, and it is probably to be regarded as marking the beginning of coal mining on a moderate but permanent commercial scale. The production was derived chiefly from the Matanuska coal field, especially from the Eska Creek mines, which were opened under private auspices in 1916 but were taken over and operated by the Alaskan Engineering Commission in 1917. The Matanuska branch of the Government railroad was completed late in the fall of 1917, which rendered the coal on Chickaloon River available for exploitation. The coal on Chickaloon River has not been offered for leasing and mines in this locality are being opened by the Alaskan Engineering Commission. Much underground work must be done before mining can be attempted on a large scale, but small shipments of coal obtained in the course of development of the mines were made late in 1917. A small mine on Moose Creek was operated under a mining permit throughout the year, and work preparatory to mining was undertaken by private lessees on Moose Creek.

The lignite fields on Cook Inlet rank next to the Matanuska coal fields in point of production for 1917. A considerable quantity of lignite mined near Bluff Point was shipped to Cook Inlet towns for local consumption. A lignite mine on Cache Creek in the Yentna district was operated part of the year in order to supply fuel for a gold dredge. A small production of lignite was also reported from near Candle.

Steps preparatory to opening the Nenana coal field were taken. The Government railroad was being extended south toward this field from Nenana on Tanana River. It is said that this coal may be available for river shipment in the summer of 1918. The more accessible coal lands in the Nenana field were offered for leasing early in 1918.

There was apparently no coal mining in the Bering River field during 1917. A railroad under construction from the east shore of Controller Bay to a patented coal claim in the eastern part of the Bering River field is reported to be nearing completion. No leases had been granted in the Bering River field up to the end of 1917, but two claims have been patented and it is said that one application for patent is still pending.

The following table gives the estimated production of coal in Alaska since 1888. The production for 1888 to 1896 is estimated from the best data available but is only approximate. The figures for 1897 to 1917 are based for the most part on data supplied by operators. Most of the coal mined before 1916 was lignite. There was a small production of bituminous coal from the west end of the Bering River field in 1906. The table does not include 855 tons of coal mined in the Bering River field in 1912 and 1,100 tons mined in the Matanuska field in 1913 for test by the United States Navy.

Coal produced in Alaska, 1888–1917.

Year.	Quantity (net tons).	Value.	Year.	Quantity (net tons).	Value.
1888–1896	6,000	$84,000	1908	3,107	$14,810
1897	2,000	28,000	1909	2,800	12,300
1898	1,000	14,000	1910	1,000	15,000
1899	1,200	16,800	1911	900	9,300
1900	1,200	16,800	1912	355	2,840
1901	1,300	15,600	1913	2,300	13,800
1902	2,212	19,048	1914	....	....
1903	1,447	9,782	1915	1,400	3,300
1904	1,694	7,225	1916	13,073	52,317
1905	3,774	13,250	1917	53,955	265,317
1906	5,541	17,974			
1907	10,139	53,600		116,397	685,063

The following table shows the consumption of coal in Alaska, including both local production and imports since 1899. Most of the coal shipped to Alaska was bituminous, but a little was anthracite.

Coal consumed in Alaska, 1899-1917, in net tons.

Year.	Produced in Alaska, chiefly subbituminous and lignite.	Imported from States chiefly bituminous from Washington.	Total foreign coal chiefly bituminous from British Columbia.	Total coal consumed.
1899	1,200	10,000	[a] 50,120	61,320
1900	1,200	15,048	[a] 56,623	72,871
1901	1,300	24,000	[a] 77,674	102,974
1902	2,212	40,000	[a] 68,363	110,575
1903	1,447	64,626	[a] 60,605	126,678
1904	1,694	36,689	[a] 76,815	115,198
1905	3,774	67,713	[a] 72,567	144,054
1906	5,541	69,493	[a] 47,590	122,624
1907	10,139	46,246	[a] 88,596	144,981
1908	3,107	23,893	[a] 72,831	99,831
1909	2,800	33,112	[a] 74,316	110,228
1910	1,000	32,138	[a] 73,904	107,042
1911	900	32,255	[a] 88,573	121,728
1912	355	27,767	[a] 59,804	87,926
1913	2,300	61,666	[a] 60,600	124,566
1914	....	41,509	[a] 21,882	63,391
1915	1,400	46,329	[a] 36,878	84,607
1916	13,073	44,934	[a] 36,454	94,461
1917	53,955	58,116	56,549	168,620
	107,397	775,534	1,180,744	2,063,675

[a] By fiscal years ending June 30.

It is too early to forecast the future of coal mining in Alaska, especially in the Bering River and Matanuska fields. If future discoveries in the Matanuska field reveal any considerable extension of the known coal lands, especially the lands containing high-grade coal which are now known only in very restricted areas; if it be found that the greatly disturbed bituminous coals of the Bering River and Matanuska fields can be mined at a moderate cost; if the Matanuska or Bering River coal proves to be suitable for the manufacture of coke; or if it be found that there is a supply of coal suitable for the Navy in the Matanuska or Bering River fields and if the Navy requires coal rather than oil, then there will probably be a rapid expansion of coal mining in one or both of these fields. The facts now known indicate, however, that there may be considerable difficulty both in producing and in selling any large output of these coals at a profit and that mining in both these fields will probably proceed at a moderate rate. If the general public still retains the extravagant and entirely false impression created by sensational magazines a few years ago as to the quantity and value of Alaska coal, it should prepare itself for disappointment.

The future of the Nenana coal field is more definite. This field contains a large quantity of lignite of fair grade, which can be mined at a moderate cost. The market is reasonably certain. Although this coal is not suitable for export, it will furnish a valuable and much needed fuel in portions of interior Alaska that are now dependent on a scanty and expensive supply of wood. The uses of Nenana coal will probably be as locomotive fuel on the Government railroad, as fuel for power and thawing at the mines in the Tanana Valley, as domestic fuel in the Tanana Valley, and as river-boat fuel on local Tanana River boats and possibly on some of the Yukon steamers. It is desirable that Nenana coal should, if possible, be used on the greater part of the railroad rather than the higher-grade Matanuska coal, because the heavy freight traffic will be northbound; thus the southbound empties would be available for hauling coal. The Nenana coal field is nearer the summit of the Alaska Range than any known coal south of the divide. It seems reasonable to expect that a coal-mining industry of moderate size will begin in this field at an early date, but the growth of coal mining in this field will depend on the growth of other industries. Gold mining, coal mining, and agriculture in the Tanana Valley should be interdependent and each industry, through the stimulating effect of the others, should expand at a gradually accelerating rate.

The possibility of the growth of an important coal mining industry on Cook Inlet should not be overlooked. There is a large deposit of lignite on Cook Inlet and it is of fair quality, being of about the same grade as the Nenana lignite. Much of it is on waters that are navigable throughout the year and it lies in beds that are but slightly folded. Its mining and shipment should, therefore, be relatively cheap. The possibility of coal mining on Cook Inlet on a large scale depends, however, on the success of experiments in the treatment of lignite in order to render it available for purposes for which the higher-grade coals are now required. If lignites can, at a moderate cost, be rendered suitable for such purposes, the lignites of Cook Inlet must be regarded as one of the most important factors in the Alaska coal situation.

ARKANSAS.

The production of coal in Arkansas in 1917 was 2,143,579 tons, valued at $5,492,777, an increase of 148,664 tons, or 7.5 per cent, in quantity and of $1,655,932, or 43 per cent, in value. The production in 1917 was, with the exception of that of 1913, the highest recorded since 1909. The limitation imposed on the industry in Arkansas by the lack of sufficient reserves capable of extraction at profit under competition with coal produced in neighboring States has more than offset the advantage of higher quality, with the result that the output of the State has shown no progress in the last 14 or 15 years—the production in 1903 exceeded that of 1917 and has been since exceeded in only three years.

Except in the early part of the year, particularly in March, April, and May, the demand for coal from Arkansas was good and production was limited only by shortage of labor and cars and by breakdowns in the mines in about equal proportion. The number of days worked in 1917 was 187, compared with 184 in 1916 and 149 in 1915. The number of men employed increased from 3,772 in 1916 to 3,998 in 1917, with a relatively larger increase in surface employees. Time lost because of strikes was 27,315 men-days—2,417 men on strike for an average of 11 days each, compared with 30,847 men-days in 1916 and 20,304 men-days in 1915. The greater part of the time lost on account of strikes was after the middle of the year and in a period in which there was demand for all the coal that could be produced. The loss in men-days was more than 3.6 per cent of the total time worked and undoubtedly represents an actual loss in putput of around 60,000 tons, a quantity equivalent to nearly half the total annual gain over 1916.

Coal produced in Arkansas in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Franklin	230,458	4,131	8,529	243,118	303	46	349	225
Johnson	222,031	14,124	7,619	243,774	541	202	743	140
Logan	38,720	2,117	1,291	42,128	126	21	147	154
Sebastian	1,292,787	11,380	48,235	1,352,402	1,880	350	2,230	186
Other counties [a]	97,109	2,782	3,882	103,773	205	98	303	239
Small mines	....	9,720	....	9,720	....	....	....	....
	1,881,105	44,254	69,556	1,994,915	3,055	717	3,772	184

[a] Pope, Scott, and Washington.

Value of coal produced in Arkansas in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Franklin	$420,114	$10,659	$11,489	$442,262	$1.82
Johnson	575,476	31,091	15,079	621,646	2.55
Logan	99,616	3,735	1,541	104,892	2.49
Sebastian	2,220,929	23,972	61,424	2,306,325	1.71
Other counties [a]	321,838	10,781	6,794	339,413	3.27
Small mines	....	22,307	....	22,307	2.29
	3,637,973	102,545	96,327	3,836,845	1.92
Average value per ton	1.93	2.32	1.38	1.92	....

[a] Pope, Scott, and Washington.

Coal produced in Arkansas in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Franklin	196,919	3,567	9,666	210,152	308	47	355	162
Johnson	283,690	10,564	12,694	306,948	541	221	762	167
Logan	40,622	4,554	1,774	46,950	119	19	138	179
Sebastian	1,371,956	14,321	47,078	1,433,355	1,843	435	2,278	194
Other counties [a]	116,221	7,468	3,855	127,544	324	141	465	207
Small mines	....	18,630	....	18,630	....	....	....	....
	2,009,408	59,104	75,067	2,143,579	3,135	863	3,998	187

[a] Includes Ouachita, Pope, Scott, and Washington.

Value of coal produced in Arkansas in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Franklin	$538,154	$9,346	$24,654	$572,154	$2.72
Johnson	984,473	40,262	33,795	1,058,530	3.45
Logan	139,413	11,887	4,977	156,277	3.33
Sebastian	3,034,870	34,921	91,746	3,161,537	2.21
Other counties [a]	451,876	39,657	7,975	499,508	3.92
Small mines	....	44,771	....	44,771	2.40
	5,148,786	180,844	163,147	5,492,777	2.56
Average value per ton	2.56	3.06	2.17	2.56	....

[a] Includes Ouachita, Pope, Scott, and Washington.

Coal produced in Arkansas, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Franklin	346,682	168,746	190,237	243,118	210,152	− 32,966
Johnson	166,208	148,845	176,457	243,774	306,948	+ 63,174
Logan	(a)	7,172	29,505	42,128	46,950	+ 4,822
Pope, Scott, and Washington	[b] [c] 85,136	[d] 88,047	93,517	103,773	[d] 127,544	+ 23,771
Sebastian	1,635,379	1,423,202	1,153,494	1,352,402	1,433,355	+ 80,953
Small mines	702	528	8,896	9,720	18,630	+ 8,910
	2,234,107	1,836,540	1,652,106	1,994,915	2,143,579	+148,664
Total value	$3,923,701	$3,158,168	$2,950,456	$3,836,845	$5,492,777	+$1,655,932

[a] Included with Pope and other counties.
[b] No production in Scott County.
[c] Includes Logan County.
[d] Includes Ouachita County.

CALIFORNIA, IDAHO, AND NEVADA.

The production of coal in California, Idaho, and Nevada is limited to a few small and, in part, infrequently operated mines and prospects. No production of coal was reported from Nevada in 1916 or 1917 and only a small quantity was reported from Idaho. The Teton Basin field in eastern Idaho has a reserve sufficient only for local use, and the deposits of California, though of greater value, will not be seriously exploited while fuel oil is sufficient for industrial needs on the Pacific coast.

Coal produced in California, 1911–1913, in California, Idaho, and Nevada in 1914 and 1915, and in California and Idaho in 1916 and 1917.

Year.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
1911	4,981	5,266	500	10,747	$16,097	$1.50	45	254
1912	3,748	3,630	3,600	10,978	23,601	2.15	52	184
1913	14,864	1,808	8,167	24,839	84,073	3.38	35	332
1914	4,200	9,174	600	13,974	39,821	2.85	43	291
1915	2,488	9,715	300	12,503	32,054	2.56	36	285
1916	1,593	4,647	1,000	7,240	15,367	2.12	18	188
1917	2,800	3,383	240	6,423	14,791	2.30	17	173

COLORADO.

All records for the production of coal in Colorado were broken in 1917 by a production of 12,483,336 net tons, a production greater than in 1916 by nearly 2,000,000 tons, or 19 per cent, and greater by 500,000 tons than the output in 1910, the highest previous record. This increase, brought forth by the unprecedented demand for coal in the western territory served by the fields in Colorado and by the needs of the local iron and steel industry and of the base metal smelters for coke, was accomplished by an increase in labor from 13,104 men in 1916 to 14,231 men in 1917, who worked an average of 263 days, compared with 233 days in 1916. The number of days worked in 1917 was greater than in any preceding year since 1906 and well above the average for the last 10 years.

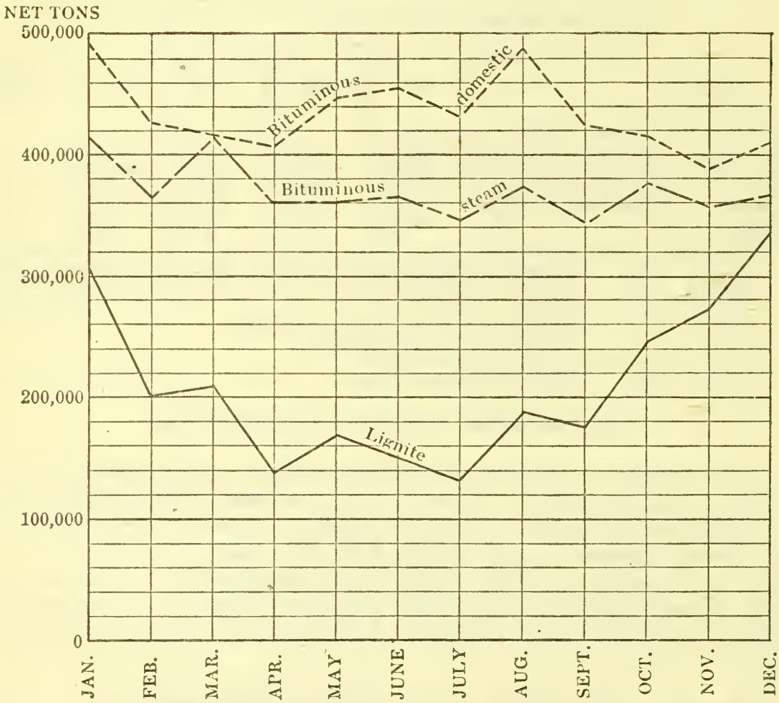


FIGURE 25.—Production of lignite, bituminous coal for domestic trade, and bituminous coal for steam trade in Colorado, by months, 1917.

The coal produced in Colorado may be roughly classified, according to quality and use, between the subbituminous, or "lignite" as it is termed in the trade, bituminous domestic, and bituminous steam. The lignite is produced in the northern part of the State, in North Park and near Colorado Springs. It is used mainly for domestic fuel and to a limited extent for steam purposes by beet-sugar plants and other local industrials. As it does not stock well, the demand is seasonal. The domestic trade requires lump and the screenings produced as a by-product have always presented a marketing problem. The seasonal demand for this grade of fuel is illustrated in the accompanying diagram (fig. 25), which shows by months the output of coal produced in 1917. Even in a year with so strong a demand for coal as 1917, the production of "lignite" was very low in the summer months.

Coal produced in the Trinidad field (Las Animas County) is largely used for the manufacture of coke, for railroad fuel, and for the steam trade in the market territory along the east front of the Rocky Mountains. The demand for this coal is usually steady and during 1917 is reflected in the production by months shown in fig. 25.

Bituminous coal for domestic use finds a market throughout the year. The shippers, by summer reduction in price, induce the storage of this coal during the summer months in such distant market territory as western Kansas, Nebraska, and northern Texas and thereby maintain production at a fairly uniform rate throughout the year. The success of this policy in 1917 is illustrated in figure 25, which shows a production during the summer about equal to that of the winter months as contrasted with the low output of "lignite" in the same season.

The average daily output per man decreased slightly and there was only a slight increase in the percentage of coal mined by machines. As a result of the greater number of days worked, however, the average annual output per man increased from 800 to 877 tons, the highest recorded since 1906. There was a notable increase in the time lost because of strikes in 1917—7,292 days, compared with 82 days in 1916.

The value of the coal produced in Colorado in 1917 was $27,699,129, an increase over 1916 of $10,705,025, or 63 per cent. The average value per ton at the mines was $2.22 in 1917, compared with $1.62 in 1916. The highest average realization was for the high-grade domestic coal produced in Huerfano and Fremont counties.

Coal produced in Colorado in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked
						Underground.	Surface.	Total.	
Boulder	1,002,304	24,903	30,332	....	1,057,539	906	179	1,085	204
Delta	60,239	10,157	300	....	70,696	55	20	75	159
El Paso	195,497	110,205	6,968	....	312,670	298	39	337	223
Fremont	543,997	48,588	12,523	....	605,108	1,060	155	1,215	166
Garfield	121,404	5,892	6,475	....	133,771	102	64	166	176
Gunnison	454,241	5,121	21,803	31,100	512,265	449	138	587	223
Huerfano	1,790,145	49,846	44,952	....	1,884,943	2,277	646	2,923	218
Jackson and Jefferson	174,513	2,969	8,222	....	185,704	163	38	201	218
La Plata	78,516	15,323	1,206	13,558	108,603	115	23	138	208
Las Animas	2,196,844	45,364	86,830	1,713,899	4,042,937	3,650	898	4,548	283
Mesa	116,397	15,714	....	....	132,111	119	35	154	195
Pitkin and Rio Blanco	28,083	9,684	5,094	....	42,861	58	18	76	177
Routt	881,568	6,957	26,503	....	915,028	697	258	955	219
Weld	414,072	30,611	20,276	....	464,959	505	137	642	204
Small mines [a]	....	15,042	....	....	15,042	2	......	2	200
	8,057,820	396,376	271,484	1,758,557	10,484,237	10,456	2,648	13,104	233

[a] Includes Montezuma County.

Value of coal produced in Colorado in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total value.	Average value per ton.
Boulder	$1,632,729	$53,839	$32,875	....	$1,719,443	$1.63
Delta	110,000	18,527	....	....	128,527	1.82
El Paso	284,053	166,969	8,131	....	459,153	1.47
Fremont	1,206,868	91,021	18,393	....	1,316,282	2.18
Garfield	188,388	11,262	5,828	....	205,478	1.54
Gunnison	733,030	8,681	27,146	$44,566	813,423	1.59
Huerfano	3,291,122	58,157	47,015	....	3,396,294	1.80
Jackson and Jefferson	257,823	7,770	6,102	....	271,695	1.46
La Plata	127,924	38,134	2,034	33,895	201,987	1.86
Las Animas	3,254,065	69,095	115,955	2,254,005	5,693,120	1.41
Mesa	170,620	34,888	....	....	205,508	1.56
Pitkin and Rio Blanco	42,640	14,222	8,717	....	65,579	1.53
Routt	1,771,302	13,641	21,086	....	1,806,029	1.97
Weld	587,280	47,018	20,334	....	654,632	1.41
Small mines [a]	....	26,954	....	....	26,954	1.79
	13,657,844	660,178	313,616	2,332,466	16,964,104	1.62
Average value per ton	1.69	1.67	1.16	1.33	1.62	....

[a] Includes Montezuma County.

Coal produced in Colorado in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
						Underground.	Surface.	Total.	
Boulder	1,218,852	28,087	30,724	....	1,277,663	1,033	156	1,189	241
Delta	82,581	11,969	19	....	94,569	71	18	89	216
El Paso	314,694	48,041	8,431	....	371,166	302	45	347	273
Tremont	788,078	63,526	20,242	....	871,846	1,032	174	1,206	277
Garfield	93,915	6,278	4,270	....	104,463	76	28	104	291
Gunnison	586,912	5,904	25,898	36,870	655,584	460	146	606	275
Huerfano	2,316,712	42,799	51,929	....	2,411,140	2,352	879	3,231	265
Jackson and Jefferson	201,059	4,564	11,863	....	217,486	321	83	404	248
La Plata	112,311	9,890	1,267	16,010	139,478	135	43	178	249
Las Animas	2,217,101	144,960	92,740	1,905,043	4,359,844	4,053	964	5,017	282
Mesa	169,924	9,298	....	....	179,222	175	18	193	233
Pitkin and Rio Blanco	22,964	3,729	....	....	26,693	30	13	43	170
Routt	1,033,015	5,835	35,253	....	1,074,103	768	282	1,050	205
Weld	612,411	20,871	21,695	....	654,977	471	97	568	223
Small mines [a]	....	44,641	161	....	44,802	6	......	6	174
	9,770,529	450,392	304,492	1,957,923	12,483,336	11,285	2,946	14,231	263

[a] Includes Montrose and Ouray counties.

Value of coal produced in Colorado in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total value.	Average value per ton.
Boulder	$2,695,445	$95,632	$55,374	....	$2,846,451	$2.23
Delta	199,687	28,687	38	....	228,412	2.42
El Paso	591,500	96,175	9,719	....	697,394	1.88
Tremont	2,217,906	175,953	26,401	....	2,420,260	2.78
Garfield	179,347	13,680	5,934	....	198,961	1.90
Gunnison	1,236,441	11,948	33,763	$53,097	1,335,249	2.04
Huerfano	5,904,855	72,340	103,630	....	6,080,825	2.52
Jackson and Jefferson	386,084	13,339	17,408	....	416,831	1.92
La Plata	246,055	22,465	2,348	44,828	315,696	2.26
Las Animas	4,628,570	326,862	132,936	3,361,732	8,450,100	1.94
Mesa	366,048	28,838	....	....	394,886	2.20
Pitkin and Rio Blanco	62,921	10,218	....	....	73,139	2.74
Routt	2,699,432	15,309	51,726	....	2,766,467	2.58
Weld	1,251,335	52,334	38,141	....	1,341,810	2.05
Small mines [a]	....	102,487	161	....	102,648	2.29
	22,665,626	1,066,267	477,579	3,459,657	27,669,129	2.22
Average value per ton	2.32	2.37	2.55	1.77	2.22	....

[a] Includes Montrose and Ouray counties.

Coal produced in Colorado, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Archuleta and Montezuma	(a)	3,775	2,375	(b)	....	....
Boulder	902,918	1,000,590	946,888	1,057,539	1,277,663	+ 220,124
Delta	86,464	86,861	69,053	70,696	94,569	+ 23,873
El Paso	326,899	280,577	299,883	312,670	371,166	+ 58,496
Fremont	535,778	169,271	473,284	605,108	871,846	+ 266,738
Garfield	158,662	112,842	139,393	133,771	104,463	− 29,308
Gunnison	472,753	402,045	439,403	512,265	655,584	+ 143,319
Huerfano	1,705,240	1,724,265	1,682,335	1,884,943	2,411,440	+ 526,497
Jackson and Jefferson	219,569	188,080	152,498	185,704	217,486	+ 31,782
La Plata	140,055	132,317	117,502	108,603	139,478	+ 30,875
Las Animas	3,739,357	2,693,288	2,853,847	4,042,937	4,359,844	+ 316,907
Mesa	134,438	163,894	101,327	132,111	179,222	+ 47,111
Pitkin and Rio Blanco	54,517	65,104	52,143	42,861	26,693	− 16,168
Routt	334,961	666,384	852,315	915,028	1,074,103	+ 159,075
Weld	409,131	475,734	432,501	464,959	654,977	+ 190,018
Small mines	[c] 11,768	5,532	10,233	[b] 15,042	[c] 44,802	+ 29,760
	9,232,510	8,170,559	8,624,980	10,484,237	12,483,336	+ 1,999,099
Total value	$14,035,090	$13,601,718	$13,599,264	$16,964,104	$27,669,129	+$10,705,025

[a] Archuleta County included with small mines; no production in Montezuma County.
[b] Small mines include Montezuma County.
[c] Includes Montrose and Ouray counties.

GEORGIA.

The coal produced in Georgia in 1917 was 119,028 tons, valued at $301,391, a decrease compared with 1916 of 54,526 tons, or 31 per cent, in quantity and of $8,702, or 3 per cent, in value.

Coal produced in Georgia, 1914, 1915, 1916, and 1917.

Year.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
1914	85,645	1,400	7,900	45,298	140,243	$239,462	$1.71	355	207
1915	90,523	1,396	7,200	35,377	134,496	231,861	1.72	368	197
1916	76,954	1,672	7,200	87,728	173,554	310,093	1.79	411	280
1917	37,855	1,284	7,200	72,689	119,028	301,391	2.53	281	269

ILLINOIS.

The coal industry in Illinois in 1917 exceeded all records. The production, 86,199,387 tons, was 20,004,051 tons, or 30 per cent greater than in 1916 and more than twice the output in 1906. The value of the output was $162,281,822, an increase of $79,823,868, or nearly 97 per cent over 1916, and the average value per ton at the mine rose from $1.25 in 1916 to $1.88 in 1917, an increase of 50 per cent. The number of days worked increased 23 per cent, from 198 to 243, a new high record not approached in any year since 1903. The number of men employed increased from 75,538 in 1916 to 84,090 in 1917, a gain of 11 per cent, and the average annual output per employee rose from 876 tons in 1916 to 1,025 in 1917. There was a decrease, however, in the average daily output per man from 4.42 tons in 1916 to 4.22 in 1917, and this indicates less efficient operation. The percentage of coal mined by hand and by machine decreased and the percentage of coal shot off the solid increased. The time lost because of strikes increased notably; labor troubles in the summer and fall months affected operations more or less generally throughout the State. The number of days reported lost on this account was 464,511 in 1917, as against 55,416 in 1916. The importance of the strikes in Illinois in 1917 is apparent from the fact that the theóretical time lost was equivalent to more than 2 per cent of the total time worked in the year and to the output of nearly 2,000,000 tons of coal.

Coal produced in Illinois in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Bond and White	113,882	14,042	4,995	132,919	162	31	193	173
Bureau	1,258,151	43,613	38,254	1,340,018	2,470	197	2,667	230
Christian	2,348,261	123,618	44,457	2,516,336	2,774	225	2,999	187
Clinton	1,184,476	79,799	43,437	1,307,712	1,426	128	1,554	168
Franklin	9,095,314	58,813	234,165	9,388,292	7,739	987	8,726	198
Fulton	2,023,749	107,294	59,907	2,190,950	2,755	266	3,021	198
Gallatin and Johnson	61,962	6,331	2,005	70,298	56	8	64	134
Greene		2,953	10	2,963	14	5	19	119
Grundy	289,914	17,062	17,818	324,794	663	64	727	205
Hancock, Scott, and Warren		8,036	110	8,146	22	5	27	177
Henry		42,157	2,345	44,502	73	15	88	242
Jackson	654,142	95,764	22,882	772,788	871	90	961	221
Knox	16	9,556	325	9,897	23	3	26	236
La Salle	676,474	332,236	42,190	1,050,900	1,716	236	1,952	201
Livingston	27,174	80,215	3,320	110,709	130	44	174	243
Logan	354,280	87,728	23,151	465,159	577	64	641	262
McDonough	350	13,277	300	13,927	19	3	22	173
McLean, Marshall, Putnam, Will, and Woodford	1,176,576	202,144	69,153	1,447,873	2,707	250	2,957	247
Macon and Moultrie	236,004	148,401	12,168	396,573	493	77	570	231
Macoupin	5,296,014	70,629	125,573	5,492,216	5,218	440	5,658	194
Madison	3,999,467	97,660	76,460	4,173,587	3,576	322	3,898	195
Marion	954,473	15,871	28,765	999,109	947	103	1,050	220
Menard	122,494	32,610	4,232	159,336	185	24	209	201
Mercer	241,307	19,814	13,571	274,692	312	53	365	232
Montgomery	3,013,211	22,471	40,030	3,075,712	2,888	383	3,271	185
Peoria	1,189,229	104,854	13,817	1,307,900	1,359	171	1,530	224
Perry	2,319,811	95,933	58,829	2,474,573	2,267	219	2,486	193
Randolph	915,117	31,018	18,954	965,089	1,077	106	1,183	186
Rock Island		32,629	951	33,580	66	12	78	158
St. Clair	3,765,653	273,396	133,648	4,172,697	4,467	467	4,934	169
Saline	4,023,759	46,883	82,874	4,153,516	3,708	322	4,030	192
Sangamon	4,740,471	263,498	125,001	5,128,970	5,803	466	6,269	179
Schuyler		8,115		8,115	23	4	27	189
Shelby	61,815	13,523	2,935	78,273	104	23	127	172
Stark	150	7,613	250	8,013	23	7	30	132
Tazewell	322,332	58,544	4,735	385,611	425	42	467	240
Vermilion	2,601,830	186,465	45,614	2,833,909	2,751	467	3,218	213
Washington	617,660	60,135	16,673	694,468	583	43	626	232
Williamson	7,800,824	67,870	208,933	8,077,627	7,655	1,039	8,694	198
Small mines		103,587		103,587				
	61,486,342	3,086,157	1,622,837	66,195,336	68,127	7,411	75,538	198

Coal produced in Illinois in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Bond and White	263,085	17,624	11,194	291,903	227	26	253	233
Bureau	1,237,589	75,004	50,769	1,363,362	2,425	204	2,629	285
Christian	2,939,888	128,035	65,437	3,133,360	2,573	279	2,852	242
Clinton	1,315,869	87,209	61,644	1,464,722	1,435	133	1,568	203
Franklin	11,055,327	93,112	306,799	11,455,238	9,144	1,339	10,483	217
Fulton	2,607,467	114,893	98,135	2,820,495	2,879	320	3,199	202
Gallatin and Johnson	64,828	7,225	2,684	74,737	84	16	100	227
Greene, McDonough, Moultrie, and Stark	237,737	19,768	10,501	268,006	231	21	252	243
Grundy	382,042	18,230	17,761	418,033	656	65	721	267
Hancock, Scott, and Warren		9,410		9,410	29		29	207
Henry		47,911	2,121	50,032	82	10	92	259
Jackson	693,341	86,445	27,374	807,160	835	166	1,001	205
Knox	75	13,125	850	14,050	21	4	25	212
La Salle	768,300	174,494	208,362	1,151,156	1,275	240	1,515	273
Livingston	40,557	79,772	5,034	125,363	141	28	169	263
Logan	470,395	99,430	29,919	599,744	660	78	738	257
McLean, Putnam, Will, and Woodford	915,653	121,075	52,689	1,089,417	1,654	177	1,831	282
Macon	103,745	186,136	18,172	308,053	496	45	541	252
Macoupin	6,768,331	142,243	159,572	7,070,146	5,607	528	6,135	248
Madison	5,080,675	163,982	119,594	5,364,251	4,038	386	4,424	248
Marion	1,078,087	20,415	21,924	1,120,426	1,013	113	1,126	227
Marshall	315,889	95,978	25,220	437,087	728	81	809	297
Menard	163,066	44,731	5,681	213,478	220	26	246	257
Mercer	231,119	21,496	16,176	268,791	316	48	364	235
Montgomery	4,098,210	43,106	63,406	4,204,722	3,216	448	3,664	238
Peoria	1,392,783	132,120	23,013	1,547,916	1,499	168	1,667	283
Perry	2,567,623	104,232	68,059	2,739,914	2,574	283	2,857	205
Randolph	1,335,249	25,771	36,609	1,397,629	1,216	118	1,334	224
Rock Island		53,593	1,489	55,082	52	9	61	205
St. Clair	6,399,749	330,588	225,429	6,955,766	5,549	729	6,278	225
Saline	5,027,201	48,330	113,246	5,188,777	4,967	493	5,460	238
Sangamon	7,555,314	346,029	161,392	8,062,735	6,708	608	7,316	264
Schuyler		8,060		8,060	18	1	19	167
Shelby	101,873	22,018	8,700	132,591	203	32	235	177
Tazewell	414,906	85,071	8,238	508,215	499	67	566	273
Vermilion	3,631,877	207,241	47,362	3,886,480	3,077	477	3,554	277
Washington	736,874	51,664	24,025	812,563	653	54	707	277
Williamson	10,288,621	81,406	275,670	10,645,697	8,085	1,185	9,270	231
Small mines		134,820		134,820				
	80,283,345	3,541,792	2,374,250	86,199,387	75,085	9,005	84,090	243

Value of coal produced in Illinois in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Bond and White	$164,053	$23,832	$5,485	$193,370	$1.45
Bureau	2,248,042	77,689	46,054	2,371,785	1.77
Christian	2,598,340	195,259	42,207	2,835,806	1.13
Clinton	1,233,943	103,656	41,856	1,379,455	1.05
Franklin	12,283,591	106,363	201,033	12,590,987	1.34
Fulton	2,928,287	201,667	66,904	3,196,858	1.46
Gallatin and Johnson	123,924	10,987	3,000	137,911	1.96
Greene		6,066	20	6,086	2.05
Grundy	586,579	45,118	26,720	658,417	2.03
Hancock, Scott, and Warren		19,574	40	19,614	2.41
Henry		82,916	2,451	85,367	1.92
Jackson	803,993	130,833	18,348	953,174	1.23
Knox	32	18,168	325	18,525	1.87
La Salle	1,230,604	671,553	53,057	1,955,214	1.86
Livingston	32,608	137,245	3,619	173,472	1.57
Logan	492,986	159,669	23,159	675,814	1.45
McDonough	613	29,309		29,922	2.15
McLean, Marshall, Putnam, Will, and Woodford	2,063,486	468,891	86,771	2,619,148	1.81
Macon and Moultrie	328,323	305,142	11,424	644,889	1.63
Macoupin	5,539,922	127,427	97,440	5,764,789	1.05
Madison	4,264,913	151,043	71,789	4,487,745	1.08
Marion	1,011,306	24,256	26,386	1,061,948	1.06
Menard	188,231	60,525	5,494	254,250	1.60
Mercer	379,543	41,390	20,678	441,611	1.61
Montgomery	3,504,781	48,456	35,484	3,588,721	1.17
Peoria	1,538,420	182,071	17,097	1,737,588	1.33
Perry	2,546,402	147,575	50,221	2,744,198	1.11
Randolph	1,030,403	39,981	18,427	1,088,811	1.13
Rock Island		60,173	1,596	61,769	1.84
St. Clair	4,078,605	361,940	121,043	4,561,588	1.09
Saline	4,816,602	74,501	74,667	4,965,770	1.20
Sangamon	5,794,781	433,358	113,082	6,341,221	1.24
Schuyler		17,230		17,230	2.12
Shelby	82,139	31,250	2,935	116,324	1.49
Stark	75	15,986	125	16,186	2.02
Tazewell	447,718	88,316	4,632	540,666	1.40
Vermilion	3,210,195	242,261	51,474	3,503,930	1.24
Washington	713,537	76,112	18,966	808,615	1.16
Williamson	9,299,109	111,175	211,460	9,621,744	1.19
Small mines		187,436		187,436	1.81
	75,566,086	5,316,399	1,575,469	82,457,954	1.25
Average value per ton	1.23	1.72	0.97	1.25	

Value of coal produced in Illinois in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Bond and White	$517,204	$37,270	$16,303	$570,777	$1.96
Bureau	2,993,660	193,563	77,539	3,264,762	2.39
Christian	4,671,560	265,175	97,174	5,033,909	1.61
Clinton	2,234,360	150,390	93,392	2,478,142	1.69
Franklin	24,129,079	205,434	491,696	24,826,209	2.17
Fulton	5,454,541	228,543	159,382	5,842,466	2.07
Gallatin and Johnson	143,312	14,298	5,092	162,702	2.18
Greene, McDonough, Moultrie, and Stark	456,091	55,025	14,725	525,841	1.96
Grundy	1,047,478	55,971	33,423	1,136,872	2.72
Hancock, Scott, and Warren	....	27,316	....	27,316	2.90
Henry		119,015	3,025	122,040	2.44
Jackson	1,436,030	196,815	44,546	1,677,391	2.08
Knox	131	31,482	1,850	33,463	2.38
La Salle	1,877,336	460,822	486,159	2,824,317	2.45
Livingston	94,613	198,209	9,336	302,158	2.41
Logan	986,361	207,114	51,885	1,245,360	2.08
McLean, Putnam, Will, and Woodford	1,821,185	396,318	107,042	2,324,545	2.13
Macon	267,294	499,972	41,079	808,345	2.62
Macoupin	10,821,414	279,370	167,679	11,268,463	1.59
Madison	8,376,251	311,381	179,895	8,867,527	1.65
Marion	2,287,061	38,242	34,396	2,359,699	2.11
Marshall	818,692	264,993	50,583	1,134,268	2.60
Menard	296,164	115,790	11,247	423,201	1.98
Mercer	480,812	49,606	28,982	559,400	2.08
Montgomery	7,775,173	98,509	100,349	7,974,031	1.90
Peoria	2,722,379	267,744	36,843	3,026,966	1.96
Perry	4,858,542	238,911	111,553	5,209,006	1.90
Randolph	2,271,521	41,476	48,477	2,361,474	1.69
Rock Island		112,082	2,170	114,252	2.07
St. Clair	10,990,799	619,214	341,300	11,951,313	1.72
Saline	9,079,035	91,662	166,944	9,337,641	1.80
Sangamon	12,842,535	694,079	232,091	13,768,705	1.71
Schuyler	....	16,610	....	16,610	2.06
Shelby	228,020	68,151	17,619	313,790	2.37
Tazewell	834,247	172,578	17,456	1,024,281	2.02
Vermilion	6,683,983	311,259	74,635	7,069,877	1.82
Washington	1,355,072	109,584	35,956	1,500,612	1.85
Williamson	19,895,459	161,865	435,700	20,493,024	1.93
Small mines	....	301,067	....	301,067	2.23
	150,747,394	7,706,905	3,827,523	162,281,822	1.88
Average value per ton	1.88	2.18	1.61	1.88	....

Every important coal-producing county in Illinois recorded an increase in 1917. The largest increase in quantity, nearly 3,000,000 tons, was in Sangamon County, and other counties in the central and southern fields and in the Belleville district recorded an increase from 1,000,000 to over 2,000,000 tons each. In southern Illinois the increase in Franklin County was 2,066,946 tons, in Williamson County 2,568,070 tons, in Saline County 1,035,261 tons. In central Illinois Macoupin County had an increase of 1,577,930 tons; Madison County, 1,190,664 tons; Montgomery County, 1,129,010 tons; and Sangamon County, 2,933,765 tons. St. Clair County, in the Belleville district, increased 2,783,069 tons and Vermilion County, in the Danville district, 1,052,571 tons.

Coal produced in Illinois, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Bond, Jefferson, Washington, and White	600,460	661,892	513,705	[a] 827,387	[a] 1,104,466	+277,079
Bureau	1,639,208	1,284,311	1,202,698	1,340,018	1,363,362	+23,344
Christian	1,504,716	1,486,053	2,135,052	2,516,336	3,133,360	+617,024
Clinton	1,049,575	1,090,787	1,315,648	1,307,712	1,464,722	+157,010
Franklin	6,072,102	7,311,209	8,027,773	9,388,292	11,455,238	+2,066,946
Fulton	2,388,775	2,052,170	1,849,906	2,190,950	2,820,495	+629,545
Gallatin	46,105	81,735	77,380	[b] 70,298	[b] 74,737	+4,439
Greene	([c])	6,665	5,764	2,963	4,234	+1,271
Grundy	401,527	388,368	293,660	324,794	418,033	+93,239
Hancock, Morgan, Schuyler, Scott, and Warren	[c] 12,069	7,169	9,788	[e] 16,261	17,470	+1,209
Henry	43,383	47,010	46,219	44,502	50,032	+5,530
Jackson	723,863	601,697	682,042	772,788	807,160	+34,372
Knox	18,280	14,150	11,985	9,897	14,050	+4,153
La Salle	1,564,459	1,279,592	1,192,794	1,050,900	1,151,156	+100,256
Livingston	63,877	64,461	63,341	110,709	125,363	+14,654
Logan	351,666	352,181	311,346	465,159	599,744	+134,585
McDonough	12,603	5,251	5,132	13,927	1,587	−12,340
McLean, Putnam, and Woodford	994,997	853,941	[f] 1,296,237	[f] 1,447,873	[f] 1,089,417	−358,456
Macon and Moultrie	326,274	363,987	329,490	396,573	563,762	+167,189
Macoupin	5,097,619	4,555,834	4,832,540	5,492,216	7,070,146	+1,577,930
Madison	3,732,153	3,546,256	3,419,955	4,173,587	5,364,251	+1,190,664
Marion	988,964	906,837	925,365	999,109	1,120,426	+121,317
Marshall	426,490	383,331	([f])	([f])	[f] 437,087	[f] +437,087
Menard	120,174	76,603	78,893	159,336	213,478	+54,142
Mercer	408,875	372,528	340,840	274,692	268,791	−5,901
Montgomery	2,689,702	2,597,677	2,877,459	3,075,712	4,204,722	+1,129,010
Peoria	1,163,073	1,055,323	1,193,351	1,307,900	1,547,916	+240,016
Perry	2,013,128	2,236,480	2,383,658	2,474,573	2,739,914	+265,341
Randolph	763,472	956,582	892,948	965,089	1,397,629	+432,540
Rock Island	35,672	36,022	24,747	33,580	55,082	+21,502
St. Clair	4,383,459	3,246,322	2,908,129	4,172,697	6,955,766	+2,783,069
Saline	4,189,003	3,746,656	4,166,249	4,153,516	5,188,777	+1,035,261
Sangamon	5,875,853	5,679,595	5,075,823	5,128,970	8,062,735	+2,933,765
Shelby	193,632	196,339	88,672	78,273	132,591	+54,318
Stark	14,610	12,703	11,919	8,013	6,476	−1,537
Tazewell	341,626	335,566	263,247	385,611	508,215	+122,604
Vermillion	3,501,880	2,394,081	2,469,263	2,833,909	3,886,480	+1,052,571
Will	149,926	136,758	[f] 141,416	([f])	([f])	([f])
Williamson	7,644,397	7,066,029	7,264,395	8,077,627	10,645,697	+2,568,070
Small mines	71,097	99,046	100,747	103,587	134,820	+31,233
	61,618,744	57,589,197	58,829,576	66,195,336	86,199,387	+ 20,004,051
Total value	$70,313,605	$64,693,529	$64,622,471	$82,457,954	$162,281,822	+$79,823,868

[a] No production in Jefferson County.
[b] Gallatin includes Johnson County.
[c] Hancock, etc., includes Greene County.
[d] No production in Hancock County.
[e] No production in Morgan County, 1916; in Morgan and Schuyler County, 1917.
[f] McLean, etc., includes Marshall County, 1915; Marshall and Will Counties in 1916; Will County, 1917

For the period beginning with the week ended June 9, 1917, to the end of the year data were collected on the hours of operation of mines in Illinois and causes of lost time.[1] This information is shown graphically in the accompanying diagrams. Except in August and in October, when labor trouble closed many mines, lack of cars was the controlling factor limiting production. The general tendency was toward higher average working time—about 70 per cent in the first week of period shown, compared with 82 per cent in the first week of 1918.

The comparatively large percentage of time lost from "other causes" in Saline County in December was due to failure of electrical power from outside central stations.

The diagrams show for these three local districts in Illinois the variations in car supply and in the effects of the strikes.

[1] For description of these statistics see page 924.

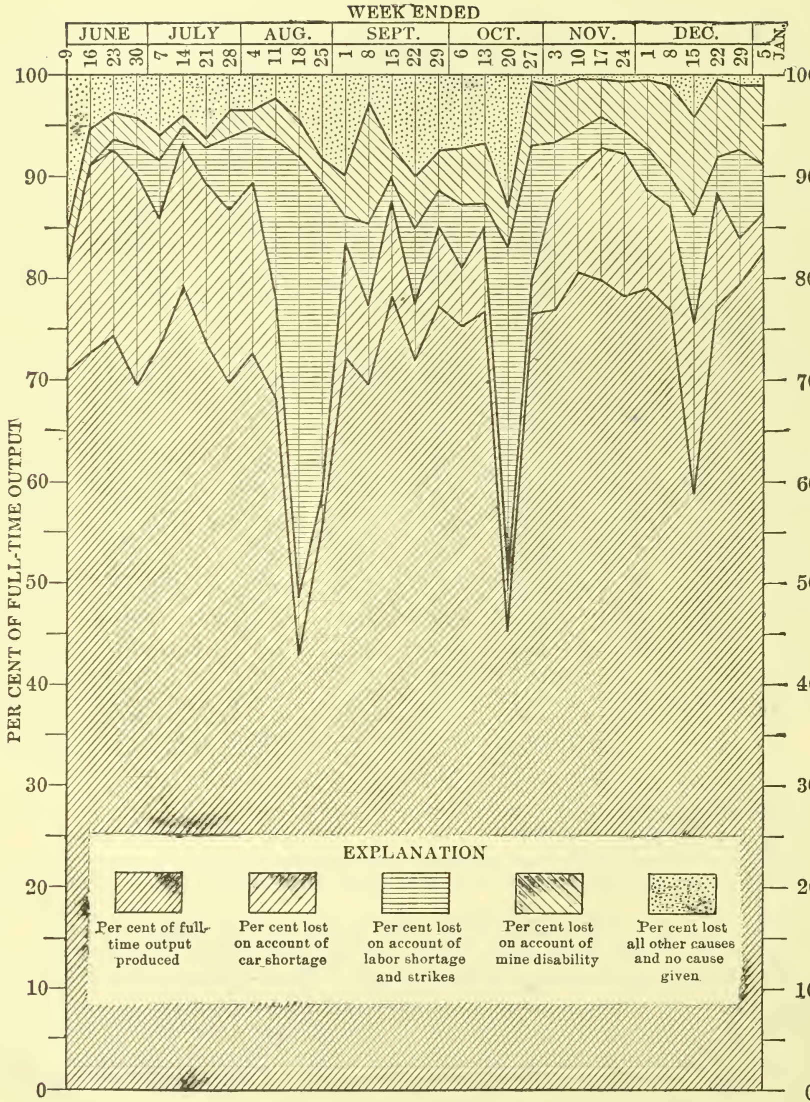


FIGURE 26.—Percentage of full time operation of coal mines and of losses by causes, in Illinois, June to December, 1917.

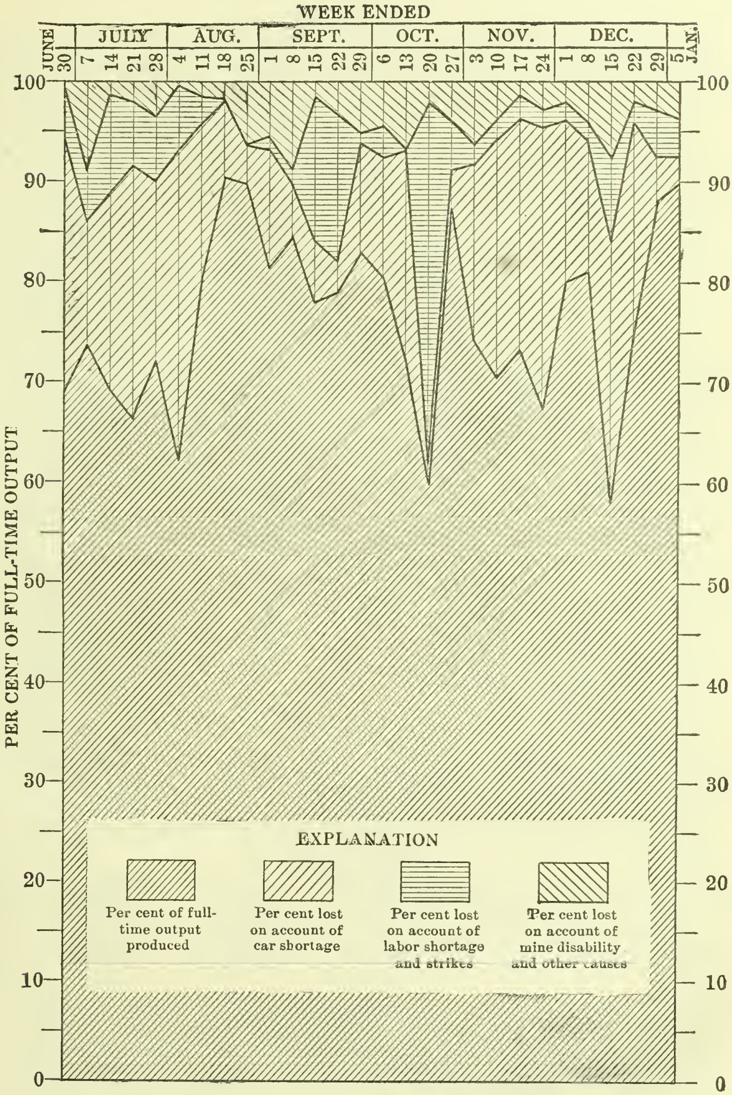


FIGURE 27.—Percentage of full time operation of coal mines and of losses by causes, in Williamson County, Ill., July to December, 1917.

FIGURE 28.—Percentage of full time operation of coal mines and of losses by causes, in Belleville district, Ill., June to December, 1917.

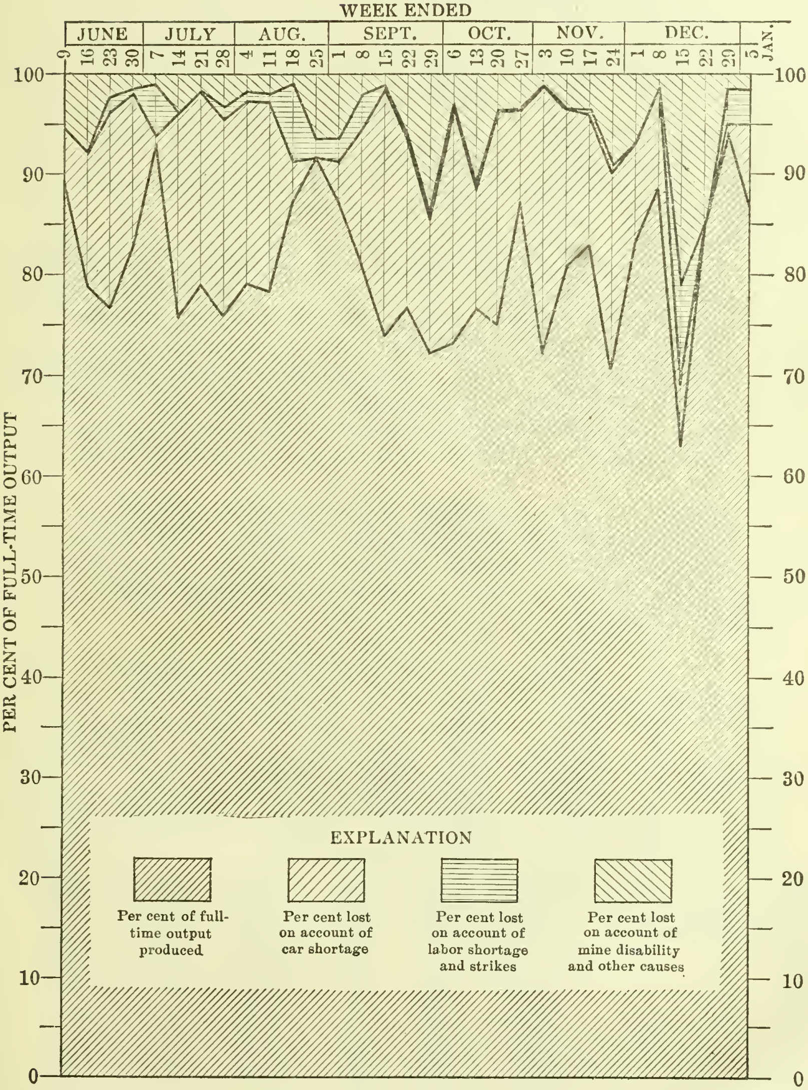


FIGURE 29.—Percentage of full time operation of coal mines and of losses by causes, in Saline County, Ill., June to December, 1917.

INDIANA.

With the production of 26,539,329 tons of coal in 1917 a new high record was reached for Indiana. The production in 1917 exceeded that in 1916 by 6,445,801 tons, or 32 per cent, and was more than double the output in 1906. Every section of the producing fields shared in the increase in output, which was accompanied by a large increase in value, the total value of the product at the mine in 1917 exceeding that of 1916 by $27,433,860, or 107 per cent, and the average realization price per ton in 1916 by 57 per cent. The increase was largely due to demand for use by industrials and domestic users, the increased consumption of Indiana coal by railroads accounting for only 10 per cent of the total increase.

The demand for coal from the mines in Indiana was steady throughout the year. The average number of days worked increased from 187 in 1916 to 221 in 1917. In former years consumers have not taken their coal for storage in the summer months and during this period the mines in this State have been idle because of no market. Except at a few isolated mines, particularly in the Brazil Block field, which supplies coal mainly for domestic trade, the output in 1917 was insufficient to supply demand, and production was limited only by the ability of the mines to produce and the railroads to haul the coal to market.

The number of men employed increased from 23,965 in 1916 to 26,527 in 1917, a gain of more than 10 per cent. Inside labor, however, increased only 8 per cent and outside labor 30 per cent. The average output per man per day (4.52 tons) increased slightly and was the highest recorded in the last 18 years.

Coal produced in Indiana in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Clay	565,797	41,545	22,180	629,522	750	409	1,159	152
Daviess	62,379	12,469	3,689	78,537	100	35	135	186
Dubois, Owen, and Perry	70,688	16,413	7,500	94,601	26	56	82	142
Fountain and Warren	10,000	2,911	1,000	13,911	27	5	32	270
Gibson	315,846	15,071	3,063	333,980	450	37	487	192
Greene	2,311,016	54,612	74,683	2,440,311	2,430	378	2,808	185
Knox	2,637,389	53,410	61,414	2,752,213	2,173	253	2,426	202
Parke	267,157	11,024	3,516	281,697	380	67	447	200
Pike	774,924	28,175	12,205	815,304	1,020	97	1,117	182
Spencer	1,610	5,121	15	6,746	18	2	20	189
Sullivan	2,663,094	35,124	65,215	2,763,433	3,089	530	3,619	172
Vanderburg	80,671	238,259	11,205	330,135	390	41	431	224
Vermilion	3,347,987	8,780	63,321	3,420,088	3,253	340	3,593	198
Vigo	5,047,227	124,347	113,968	5,285,542	6,255	514	6,769	185
Warrick	683,783	69,692	20,641	774,116	631	209	840	202
Small mines		73,392		73,392				
	18,839,568	790,345	463,615	20,093,528	20,992	2,973	23,965	187

Value of coal produced in Indiana in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Clay	$805,970	$80,143	$23,348	$909,461	$1.44
Daviess	93,671	21,748	4,408	119,827	1.53
Dubois, Owen, and Perry	98,028	25,297	10,125	133,450	1.41
Fountain and Warren	15,000	6,460	1,500	22,960	1.65
Gibson	423,032	23,360	3,559	449,951	1.35
Greene	2,999,949	82,066	83,398	3,165,413	1.30
Knox	3,072,076	82,552	57,432	3,212,060	1.17
Parke	641,157	19,430	1,758	662,345	2.35
Pike	919,098	38,797	8,831	966,726	1.19
Spencer	2,818	7,456	22	10,296	1.53
Sullivan	3,299,582	48,551	59,900	3,408,033	1.23
Vanderburg	114,396	333,305	15,681	463,382	1.40
Vermilion	4,069,373	13,778	74,249	4,157,400	1.22
Vigo	6,571,615	182,328	118,892	6,872,835	1.30
Warrick	741,457	82,102	17,494	841,053	1.09
Small mines	....	111,054	....	111,054	1.51
	23,867,222	1,158,427	480,597	25,506,246	1.27
Average value per ton	1.27	1.47	1.04	1.27	....

Coal produced in Indiana in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Clay	1,055,757	48,180	37,092	1,141,029	969	406	1,375	207
Daviess	110,371	30,970	5,883	147,224	150	49	199	227
Fountain and Warren	15,510	5,400	....	20,910	29	7	36	221
Gibson	456,739	9,688	5,148	471,575	724	112	836	210
Greene	3,326,494	61,047	110,497	3,498,038	2,748	427	3,175	223
Knox	2,988,945	55,843	75,134	3,119,922	2,313	409	2,722	196
Owen and Perry	53,689	25,426	8,263	87,378	38	64	102	203
Parke	350,690	12,810	23,555	387,055	425	34	459	277
Pike	940,913	22,923	20,138	983,974	1,177	210	1,387	209
Spencer	....	5,081	....	5,081	9	......	9	213
Sullivan	3,367,367	77,908	83,627	3,528,902	2,952	533	3,485	201
Vanderburg	145,495	228,541	10,163	384,199	366	45	411	267
Vermilion	4,112,039	11,903	88,696	4,212,638	3,455	516	3,971	234
Vigo	6,999,545	155,705	148,093	7,303,343	6,502	707	7,209	233
Warrick	1,067,623	75,501	26,262	1,169,386	807	345	1,152	214
Small mines	....	78,675	....	78,675	....	......	......	....
	24,991,177	905,601	642,551	26,539,329	22,664	3,864	26,528	221

Value of coal produced in Indiana in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Clay	$2,381,846	$126,592	$71,739	$2,580,177	$2.26
Daviess	269,080	60,787	10,822	340,689	2.31
Fountain and Warren	39,553	14,875	....	54,428	2.60
Gibson	1,002,714	22,470	10,138	1,035,322	2.20
Greene	6,665,438	125,444	219,433	7,010,315	2.00
Knox	5,662,032	113,590	112,989	5,888,611	1.89
Owen and Perry	127,648	51,438	19,264	198,350	2.27
Parke	723,221	24,375	42,018	789,614	2.04
Pike	1,687,270	45,888	35,984	1,769,142	1.80
Spencer	....	8,106	....	8,106	1.60
Sullivan	6,174,933	168,307	156,753	6,499,993	1.84
Vanderburg	291,592	444,094	18,700	754,386	1.96
Vermilion	7,975,701	27,133	163,658	8,166,492	1.94
Vigo	14,724,821	319,480	266,651	15,310,952	2.10
Warrick	2,196,318	138,160	47,733	2,382,211	2.04
Small mines	....	151,318	....	151,318	1.92
	49,922,167	1,842,057	1,175,882	52,940,106	1.99
Average value per ton	2.00	2.03	1.83	1.99	....

Coal produced in Indiana, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Clay	564,957	454,009	295,451	629,522	1,141,029	+ 511,507
Daviess	84,030	91,608	79,061	78,537	147,224	+ 68,687
Dubois	[a] 7,948	[a] 5,400	[a] 3,000	[a] 94,601	....	....
Fountain and Warren	64,902	40,764	23,800	13,911	20,910	+ 6,999
Gibson	227,100	280,636	271,177	333,980	471,575	+ 137,595
Greene	2,780,708	2,230,085	2,324,634	2,440,311	3,498,038	+ 1,057,727
Knox	1,760,748	1,619,083	2,212,315	2,752,213	3,119,922	+ 367,709
Owen	127,283	111,355	91,318	([a])	62,869	− [b] 7,223
Parke	507,508	331,845	166,648	281,697	387,055	+ 105,358
Perry	14,910	13,800	11,075	([a])	24,509	([b])
Pike	583,637	578,693	646,166	815,304	983,974	+ 168,670
Spencer	8,479	8,510	6,695	6,746	5,081	− 1,665
Sullivan	3,084,419	2,999,148	2,587,108	2,763,433	3,528,902	+ 765,469
Vanderburg	280,522	288,191	227,331	330,135	384,199	+ 54,064
Vermilion	2,085,311	2,135,836	2,734,546	3,420,088	4,212,638	+ 792,550
Vigo	4,237,274	4,767,828	4,688,838	5,285,542	7,303,343	+ 2,017,801
Warrick	685,020	624,770	577,473	774,116	1,169,386	+ 395,270
Small mines	60,915	59,571	59,516	73,392	78,675	+ 5,283
	17,165,671	16,641,132	17,006,152	20,093,528	26,539,329	+ 6,445,801
Total value	$19,001,881	$18,290,928	$18,637,476	$25,506,246	$52,940,106	+$27,433,860

[a] Dubois includes Martin County in 1915; Owen and Perry in 1916.
[b] Owen includes Perry County.

The percentage of full-time operation, and causes of lost time for the period June 2, 1917, to January 5, 1918, are shown in figure 30. Lack of cars is shown to have been the principal limiting factor until November and was important throughout the period. If 304 days be considered full time for the year the operation of the mines in Indiana 221 days indicates 72.7 per cent full-time operation, which is approximately the average for the last half of the year shown in figure 30. The effect of the strikes in August and October is shown also, and compared with the diagram for Illinois (fig. 26) it indicates that the mines in Indiana were not affected to so great an extent as those in Illinois.

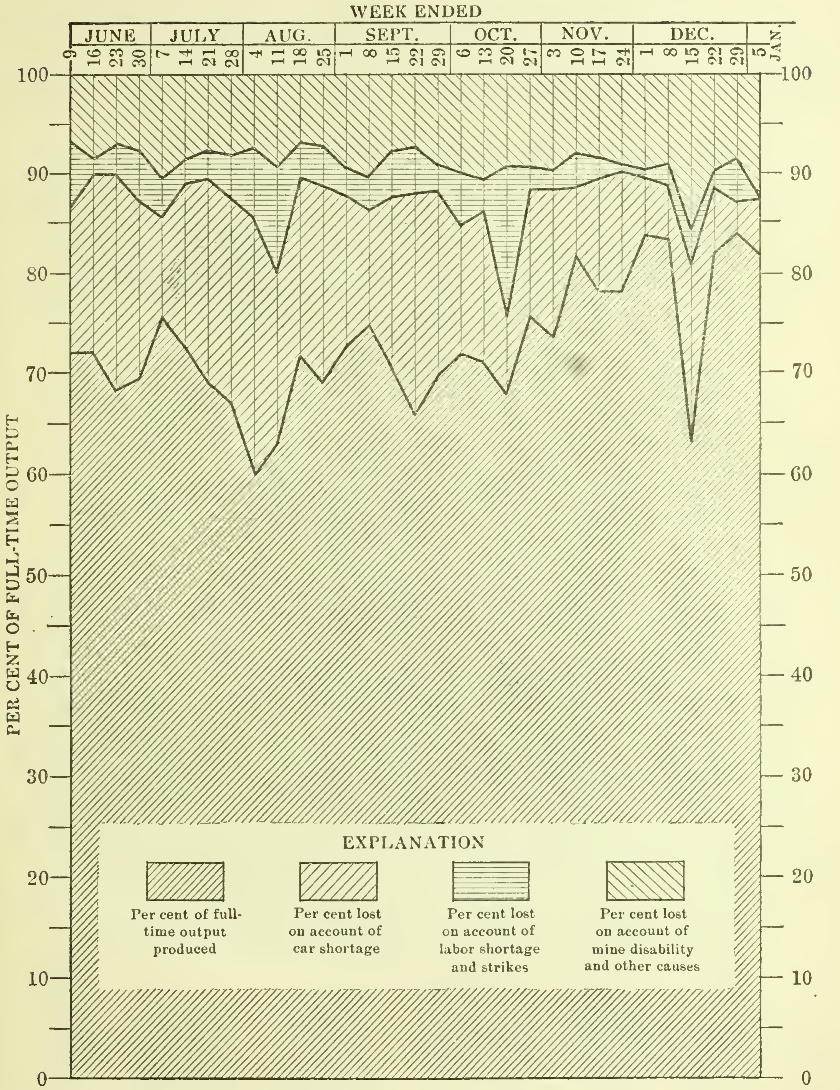


FIGURE 30.—Percentage of full-time operation of coal mines and of losses by causes, in Indiana, June to December, 1917.

IOWA.

The production of coal in Iowa in 1917 was 8,965,830 tons, a gain compared with 1916 of 1,705,030 tons, or 23.5 per cent. The production in 1917 was the greatest recorded, the nearest approach to this record having been in 1910 by a production of 7,900,000. Iowa, because of the competition offered by fields in adjacent States producing better grades of fuel, has not shown the expansion in coal production of the neighboring States. The production of coal in Iowa was nearly 4,000,000 tons in 1882 and it was not until 1903 that the 6,000,000-ton record was reached and not until 1917 that the production exceeded 8,000,000 tons.

In normal times the demand for coal from the Iowa mines is seasonal; only a few local industries and public utilities and railroads depend on this coal in the summer. In 1917 demand was good throughout the year, the number of days worked, 251, indicating

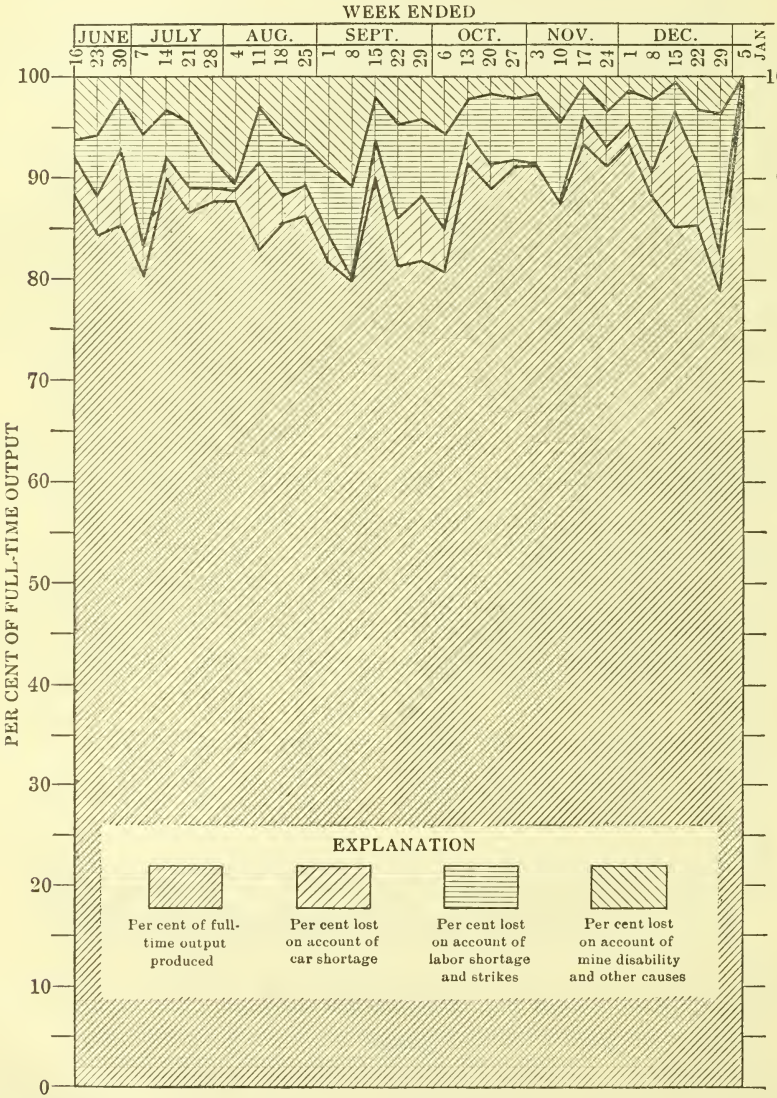


FIGURE 31.—Percentage of full-time operation of coal mines and of losses by causes, in Iowa, June to December, 1917.

about 80 per cent of full-time operation on the basis of 304 working days a year. The accompanying diagram (fig. 31) for the last seven months of the year indicates an average of about 86 per cent of full-time operation, from which it is inferred that in the first five months the mines were operated about 70 per cent of the time.

The average number of days worked in 1917 exceeded all previous records for the State, as the average annual output per man, 628 tons, did also. There was little change in the average daily output per man, the figure for 1917, 2.50 tons, exceeding that in 1916 by only 0.1 ton. The use of machines in the mining of coal in Iowa has shown considerable progress in the last four years, the proportion of machine-mined product having increased from less than 2 per cent in 1913 to over 11 per cent in 1917. Iowa was one of the few States reporting a decrease in the number of men engaged in the production of coal in 1917, though the decrease was small, from 14,443 men in 1916 to 14,266 in 1917. The number of underground employees decreased from 12,960 in 1916 to 12,672 in 1917, but the number of surface men increased from 1,483 to 1,594.

Coal produced in Iowa in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Adams	240	10,663	800	11,703	43	7	50	204
Appanoose	1,140,041	68,184	18,902	1,227,127	3,366	353	3,719	182
Boone	116,775	48,607	5,200	170,582	362	51	413	180
Dallas	445,039	26,432	2,500	473,971	702	68	770	232
Greene, Lucas, Warren, and Wayne	706,837	22,407	13,060	742,304	1,057	113	1,170	....
Guthrie and Webster	8,500	10,000	300	18,800	55	8	63	....
Jasper	220,864	11,961	....	232,825	391	45	436	214
Jefferson, Keokuk, and Van Buren	475	6,906	....	7,381	26	8	34	....
Mahaska	145,143	12,990	1,262	159,395	255	47	302	201
Marion	320,087	25,169	16,544	361,800	612	81	693	202
Monroe	1,689,158	36,160	47,296	1,772,614	3,147	385	3,532	183
Page and Taylor	5,360	4,801	....	10,161	38	5	43	....
Polk	1,431,595	249,645	38,604	1,719,844	2,420	247	2,667	238
Wapello	291,656	21,831	2,845	316,332	486	65	551	210
Small mines	....	35,961	....	35,961	......	......	......	....
	6,521,770	591,717	147,313	7,260,800	12,960	1,483	14,443	202

Value of coal produced in Iowa in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Adams	$670	$29,717	$1,400	$31,787	$2.72
Appanoose	2,256,668	146,548	12,817	2,416,033	1.97
Boone	286,777	119,085	5,200	411,062	2.41
Dallas	833,985	53,251	2,775	890,011	1.88
Greene, Lucas, Warren, and Wayne	1,257,917	60,508	14,941	1,333,366	1.80
Guthrie and Webster	16,575	23,866	438	40,879	2.17
Jasper	430,685	34,764	....	465,449	2.00
Jefferson, Keokuk, and Van Buren	950	15,875	....	16,825	2.28
Mahaska	275,708	24,124	862	300,694	1.89
Marion	517,044	49,229	17,094	583,367	1.61
Monroe	2,828,288	73,985	41,097	2,943,370	1.66
Page and Taylor	12,328	13,553	....	25,881	2.55
Polk	2,791,444	545,386	56,551	3,393,381	1.97
Wapello	553,426	40,579	3,632	597,637	1.89
Small mines	....	80,641	....	80,641	2.24
	12,062,465	1,311,111	156,807	13,530,383	1.86
Average value per ton	1.85	2.22	1.06	1.86	....

Coal produced in Iowa in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Adams	....	4,016	....	4,016	26	7	33	141
Appanoose	1,529,622	85,776	48,056	1,663,454	3,325	401	3,726	243
Boone	181,761	56,103	6,857	244,721	465	57	522	206
Dallas	567,338	8,510	12,629	588,477	832	109	941	258
Greene, Lucas, Warren, and Wayne	734,649	23,027	18,644	776,320	1,063	94	1,157	255
Guthrie and Webster	25,876	3,803	....	29,679	63	7	70	276
Jasper	280,532	22,715	965	304,212	397	47	444	255
Mahaska	128,478	14,107	3,235	145,820	216	24	240	234
Marion	459,177	21,187	24,635	504,999	748	130	878	211
Monroe	2,331,400	44,365	70,905	2,446,670	2,662	404	3,066	266
Page and Taylor	7,500	10,443	....	17,943	48	6	54	212
Polk	1,409,684	403,992	32,163	1,845,839	2,363	246	2,609	267
Van Buren	2,207	4,224	....	6,431	14	2	16	223
Wapello	296,242	41,962	8,305	346,509	450	60	510	248
Small mines [a]	....	40,740	....	40,740	....	......	....	....
	7,954,466	784,970	226,394	8,965,830	12,672	1,594	14,266	251

[a] Includes Jefferson County.

Value of coal produced in Iowa in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Adams	....	$13,285	....	$13,285	$3.31
Appanoose	$4,035,430	200,336	$82,477	4,318,243	2.60
Boone	580,997	169,669	12,320	762,986	3.12
Dallas	1,381,139	25,062	24,307	1,430,508	2.43
Greene, Lucas, Warren, and Wayne	1,557,482	68,988	34,099	1,660,569	2.14
Guthrie and Webster	68,996	12,330	....	81,326	2.74
Jasper	549,162	67,728	2,150	619,040	2.03
Mahaska	344,522	31,213	4,743	380,478	2.61
Marion	1,051,980	49,828	46,587	1,148,395	2.27
Monroe	4,872,267	108,634	101,921	5,082,822	2.08
Page and Taylor	26,250	42,200	....	68,450	3.81
Polk	3,340,616	1,158,759	62,547	4,561,922	2.47
Van Buren	6,860	12,695	....	19,555	3.04
Wapello	708,245	113,921	22,475	844,641	2.44
Small mines [a]	....	104,188	....	104,188	2.56
	18,523,946	2,178,836	393,626	21,096,408	2.35
Average value per ton	2.33	2.78	1.74	2.35	....

[a] Includes Jefferson County.

Coal produced in Iowa in 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Adams	6,971	6,660	8,340	11,703	4,016	−7,687
Appanoose	1,207,387	1,272,276	1,225,100	1,227,127	1,663,454	+436,327
Boone	256,212	181,952	156,260	170,582	244,721	+74,139
Dallas	574,186	466,697	470,881	473,971	588,477	+114,506
Greene, Lucas, and Warren	40,934	302,132	[a] 597,784	[a] 742,304	[a] 776,320	+34,016
Guthrie	4,492	3,925	3,968	[b] 18,800	[b] 29,679	+10,879
Jasper	267,567	241,991	268,167	232,825	304,212	+71,387
Jefferson and Keokuk	[c] 21,785	[c] 13,149	[c] 6,710	[c] 7,381	([d])	([d])
Mahaska	355,737	272,868	245,786	159,395	145,820	−13,575
Marion	298,552	311,183	360,155	361,800	504,999	+143,199
Monroe	2,571,277	2,273,066	2,157,349	1,772,614	2,446,670	+674,056
Page and Taylor	7,473	9,902	8,617	10,161	17,943	+7,782
Polk	1,601,015	1,706,779	1,744,304	1,719,844	1,845,839	+125,995
Van Buren	([c])	([c])	([c])	([c])	6,431	([d])
Wapello	153,705	237,176	313,993	316,332	346,509	+30,177
Wayne	85,775	76,524	([a])	([a])	([a])	([a])
Webster	45,676	33,692	18,905	([b])	([b])	([b])
Small mines	27,192	41,050	27,824	35,961	[d] 40,740	+[d] 3,829
	7,525,936	7,451,022	7,614,143	7,260,800	8,965,830	+ 1,705,030
Total value	$13,496,710	$13,364,070	$13,577,608	$13,530,383	$21,096,408	+$7,566,025

[a] Greene, etc., includes Wayne County.
[b] Guthrie includes Webster County in 1916 and 1917.
[c] Jefferson, etc., includes Van Buren County.
[d] Small mines include Jefferson County. No production in Keokuk County. (See Van Buren County, 1907.)

KANSAS.

The production of coal in Kansas in 1917 was 7,184,975 tons, valued at $16,618,277, an increase compared with 1916 of 303,520 tons, or 4.4 per cent, in quantity and of $4,365,554, or 35 per cent, in value. Although exceeding the output in 1916, the production in 1917 was exceeded by the high records of 1907 and 1913. Crawford County, with a production of more than 5,500,000 tons, a gain of 460,000 tons over 1916, exceeded all previous records and was the only section of the State with a substantial increase over 1916. The small field in Osage County had a decrease of 32,178 tons, or 26 per cent, and Cherokee County a decrease of 133,058 tons, or 9 per cent. The number of men employed decreased from 12,132 to 10,680, and the days worked increased from 204 to 216. Time lost because of strikes was 128,514 men-days, equivalent to 5.5 per cent of the time worked. The average daily output per man, the index of efficiency, increased from 2.78 tons in 1916 to 3.12 in 1917, a new high record for the State.

The use of steam shovels in the mining of bituminous coal, which has been well developed in Kansas, decreased somewhat in 1917, 26 steam shovels being used in mining coal in Kansas in 1917, 2 less than in 1916. The total tons produced from steam-shovel pits in 1917 was 806,985 tons, or 11 per cent of the total output, against 858,370 tons, or 12 per cent, in 1916. Although the number of mining machines in use increased from 6 in 1916 to 9 in 1917, the quantity of coal so mined decreased.

Coal produced in Kansas in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Cherokee	1,477,636	10,881	40,936	1,529,453	1,641	523	2,164	211
Crawford	4,874,331	65,632	113,276	5,053,239	7,658	1,191	8,849	198
Leavenworth	110,338	34,325	4,959	149,622	476	59	535	276
Linn	4,087	4,219		8,306	27	3	30	231
Osage	110,672	14,382	167	125,221	523	31	554	194
Small mines		15,614		15,614				
	6,577,064	145,053	159,338	6,881,455	10,325	1,807	12,132	204

Value of coal produced in Kansas in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Cherokee	$2,750,017	$16,152	$59,716	$2,825,885	$1.85
Crawford	8,403,436	117,318	142,944	8,663,698	1.71
Leavenworth	273,942	83,906	9,799	367,647	2.46
Linn	8,174	8,960		17,134	2.06
Osage	299,235	41,104	355	340,694	2.72
Small mines		37,665		37,665	2.41
	11,734,804	305,105	212,814	12,252,723	1.78
Average value per ton	1.78	2.10	1.34	1.78	

Coal produced in Kansas in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Cherokee	1,349,607	10,978	35,810	1,396,395	1,236	378	1,614	223
Crawford	5,295,453	74,148	143,955	5,513,556	6,592	1,396	7,988	215
Leavenworth	107,878	45,516	5,315	158,709	457	58	515	278
Linn and Osage	85,569	19,582	384	105,535	531	32	563	157
Small mines		10,780		10,780				
	6,838,507	161,004	185,464	7,184,975	8,816	1,864	10,680	216

Value of coal produced in Kansas in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam	Total value.	Average value per ton.
Cherokee	$3,071,624	$39,110	$74,641	$3,185,375	$2.28
Crawford	12,116,085	195,649	254,861	12,566,595	2.28
Leavenworth	311,654	136,394	14,763	462,811	2.92
Linn and Osage	308,586	61,112	737	370,435	3.56
Small mines		33,061		33,061	3.07
	15,807,949	465,326	345,002	16,618,277	2.31
Average value per ton	2.31	2.89	1.86	2.31	

Coal produced in Kansas, 1913–1917, in net tons.

	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Cherokee	2,259,019	1,882,810	1,707,456	1,529,453	1,396,395	−133,058
Crawford	4,614,257	4,752,114	4,843,232	5,053,239	5,513,556	+460,317
Leavenworth	161,209	110,791	153,055	149,622	158,709	+ 9,087
Linn	25,212	10,480	10,541	8,306	12,492	+ 4,186
Osage	115,810	88,371	100,779	125,221	93,043	− 32,178
Small mines	a 26,703	a 16,422	9,411	15,614	10,780	− 4,834
	7,202,210	6,860,988	6,824,474	6,881,455	7,184,975	+303,520
Total value	$12,036,292	$11,238,253	$11,360,630	$12,252,723	$16,618,277	+$4,365,554

a Includes Franklin County.

KENTUCKY.

Although the production of coal in Kentucky increased from 25,393,997 tons in 1916 to 27,807,971 tons in 1917, or 9.5 per cent, the fields in the east and west shared differently in the increase. Eastern Kentucky as a whole made no progress in the production of coal in 1917. The Hazard field (Perry County) continued to develop and had a production of 1,660,000 tons, a gain of 668,000, or 67 per cent. The development of this field has been rapid and steady. In 1913 the output of Perry County was only 25,000 tons, in 1914 the output was nearly 10 times greater, and each succeeding year has nearly doubled the output for the preceding year.

Western Kentucky established a new high record in 1917 with a production of 10,214,480 tons, a gain of 2,427,924 tons, or 31 per cent. Except Webster and Christian counties, all sections shared in the increase, with the largest gain, 1,375,000 tons, in Muhlenberg County. The coal field of western Kentucky is a part of the eastern interior basin, of which the fields in Illinois and Indiana constitute the greater part, and the increase in production in western Kentucky in 1917 was comparable with that in those States. The fields in eastern Kentucky are a part of the Appalachian coal belt and, like West Virginia, the nearest fields on the east, had little or no increase in output in 1917.

Labor trouble was responsible in large degree for a loss in production in the eastern Kentucky districts. In the State as a whole the loss of time because of labor trouble was 425,725 men-days, of which 416,370 days were lost in the eastern part of the State. This loss was equivalent to 17 days' operation for the total men employed and is to be compared with 209 days worked in the year and represented a loss, making due allowance for normal time losses, of not less than 1,000,000 tons. No time was reported lost because of strikes in Perry County (Hazard field) and the loss in western Kentucky was slight.

The percentage of total output mined by machine decreased from 84.4 in 1916 to 83.6 in 1917. Ninety per cent of the product in western Kentucky was machine mined in 1917, compared with 80 per cent in eastern Kentucky. The average daily output per employee in western Kentucky, though higher than in the eastern fields, was lower than in 1916 or in 1915, when the maximu record of nearly 5 tons was obtained.

Coal produced in Kentucky in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
						Underground.	Surface.	Total.	
Eastern district:									
Bell	2,182,454	27,859	34,229	....	2,244,542	3,308	621	3,929	208
Boyd	74,179	9,229	2,173	....	85,581	139	49	188	232
Breathitt, Greenup, Knott, Lawrence, and Lee	32,912	3,700	600	....	37,212	63	20	83	144
Carter	119,258	3,983	336	....	123,577	145	31	176	238
Floyd	851,158	8,149	14,146	....	873,453	772	157	929	197
Harlan	1,879,589	18,155	15,673	300,811	2,214,228	1,651	435	2,086	219
Jackson and Pulaski	4,985	5,023	156	....	10,164	16	7	23	200
Johnson	932,808	12,210	30,468	....	975,486	974	255	1,229	240
Knox	775,426	13,437	14,661	....	803,524	1,110	261	1,371	214
Laurel	86,803	120	715	....	87,638	200	18	218	165
Letcher	3,627,815	16,555	27,066	....	3,671,436	3,002	304	3,306	274
McCreary	654,340	9,950	1,000	....	665,290	898	93	991	256
Morgan	47,573	1,092	62	....	48,727	149	36	185	258
Perry	973,760	4,753	13,749	....	992,262	846	261	1,107	224
Pike	3,285,961	128,891	52,850	289,225	3,756,927	2,705	608	3,313	252
Whitley	869,108	13,650	22,670	....	905,428	1,519	269	1,788	197
	16,398,129	276,756	230,554	590.036	17,495,475	17,497	3,425	20,922	231
Western district:									
Christian	103,875	1,100	3,000	....	107,975	170	24	194	235
Daviess	....	59,335	520	....	59,855	63	12	75	240
Henderson	111,334	65,771	8,643	....	185,748	277	45	322	192
Hopkins	2,356,617	104,260	99,117	62,531	2,622,525	2,260	415	2,675	179
McLean	54,160	4,020	200	....	58,380	63	11	74	190
Muhlenberg	1,962,127	28,814	45,878	....	2,036,819	3,219	359	3,578	140
Ohio	428,339	33,966	22,635	....	484,940	1,073	105	1,178	112
Union	542,538	74,878	42,660	....	660,076	697	141	838	163
Webster	1,515,302	23,402	31,534	....	1,570,238	1,182	184	1,366	209
	7,074,292	395,546	254,187	62,531	7,786,556	9,004	1,296	10,300	162
Small mines [a]	1,000	110,966	....	....	111,966	....	......	......	....
Grand total	23,473,421	783,268	484,741	652,567	25,393,997	26,501	4,721	31,222	208

[a] Includes Hancock County.

Value of coal produced in Kentucky in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines	Total value.	Average value per ton.
Eastern district:						
Bell	$2,907,611	$39,442	$34,253	....	$2,981,306	$1.33
Boyd	88,282	10,792	2,850	....	101,924	1.19
Breathitt, Greenup, Knott, Lawrence and Lee	46,590	4,875	875	....	52,340	1.41
Carter	171,229	5,175	361	....	176,765	1.48
Floyd	1,148,198	9,763	13,610	....	1,171,571	1.34
Harlan	2,495,767	31,995	18,991	$300,814	2,847,567	1.29
Jackson and Pulaski	7,929	5,525	140	....	13,594	1.34
Johnson	1,471,493	17,409	40,077	....	1,528,979	1.57
Knox	984,408	17,053	14,080	....	1,015,541	1.26
Laurel	93,122	130	745	....	93,997	1.07
Letcher	4,651,497	22,927	33,604	....	4,708,028	1.28
McCreary	660,470	13,978	2,000	....	676,448	1.02
Morgan	100,393	2,585	91	....	103,069	2.12
Perry	1,358,730	5,819	16,247	....	1,380,796	1.39
Pike	3,573,653	126,934	47,284	267,223	4,015,094	1.07
Whitley	1,349,174	25,624	29,184	....	1,403,982	1.55
	21,108,546	340,026	254,392	568,037	22,271,001	1.27
Average value per ton	1.29	1.23	1.10	.96	1.27	....
Western district:						
Christian	137,432	1,165	1,500	....	140,097	1.30
Daviess	....	76,638	568	....	77,206	1.29
Henderson	119,889	96,026	8,909	....	224,824	1.21
Hopkins	2,228,838	89,999	88,574	58,779	2,466,190	.94
McLean	70,584	4,040	200	....	74,824	1.28
Muhlenberg	2,083,637	33,665	36,172	....	2,153,474	1.06
Ohio	382,916	41,925	7,303	....	432,144	.89
Union	566,434	98,925	33,262	....	698,621	1.06
Webster	1,435,125	23,298	28,932	....	1,487,355	.95
	7,024,855	465,681	205,420	58,779	7,754,735	1.00
Average value per ton	.99	1.18	.81	.94	1.00	....
Small mines [a]	1,750	165,561	....	....	167,311	1.49
Grand total	28,135,151	971,268	459,812	626,816	30,193,047	1.19
Average value per ton	1.20	1.24	.95	.96	1.19	....

[a] Includes Hancock County.

Coal produced in Kentucky in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
						Underground.	Surface.	Total.	
Eastern district:									
Bell	1,986,968	46,502	45,652	....	2,079,122	2,960	1,023	3,983	196
Boyd	95,983	3,395	2,336	....	101,714	150	62	212	239
Breathitt	54,117	1,497	267	....	55,881	104	41	145	106
Carter	119,031	5,857	25,666	....	150,554	179	66	245	225
Floyd	819,886	7,900	18,077	....	845,863	943	223	1,166	171
Harlan	1,838,694	31,795	17,629	279,623	2,167,741	2,039	669	2,708	203
Jackson and Pulaski	12,415	6,450	156	....	19,021	33	22	55	163
Johnson	829,341	9,567	30,894	....	869,802	1,012	191	1,203	210
Knott, Martin, and Morgan	68,561	938	181	....	69,680	172	59	231	207
Knox	536,564	7,281	17,190	....	561,035	873	219	1,092	201
Laurel	79,285	169	749	....	80,203	188	51	239	144
Lawrence	36,981	1,353	297	....	38,631	63	52	115	138
Lee	29,519	1,100	378	....	30,997	65	18	83	176
Letcher	3,398,131	41,415	31,233	....	3,470,779	2,904	437	3,341	231
McCreary	684,926	3,565	4,442	....	692,933	1,004	213	1,217	238
Perry	1,627,923	23,327	9,545	....	1,660,795	1,428	585	2,013	205
Pike	3,477,332	107,231	63,154	198,934	3,846,651	2,878	1,008	3,886	237
Whitney	724,490	10,141	27,515	....	762,146	1,322	247	1,569	168
	16,420,147	309,483	295,361	478,557	17,503,548	18,317	5,186	23,503	209
Western district:									
Christian	55,071	750	2,100	....	57,921	122	21	143	240
Daviess	12,337	61,186	1,140	....	74,663	92	11	103	199
Henderson	205,422	74,536	12,489	....	292,447	404	63	467	218
Hopkins	2,662,948	147,101	120,893	121,059	3,052,001	2,403	467	2,870	260
McLean	103,978	8,190	1,300	....	113,468	109	17	126	245
Muhlenberg	3,266,498	67,237	78,081	....	3,411,816	3,566	452	4,018	204
Ohio	829,019	33,804	32,996	....	895,819	1,117	168	1,285	190
Union	787,472	75,365	52,521	....	915,358	873	176	1,049	210
Webster	1,328,406	29,485	43,096	....	1,400,987	1,159	203	1,362	258
	9,251,151	497,654	344,616	121,059	10,214,480	9,845	1,578	11,423	225
Small mines [a]	3,500	86,443	....	....	89,943	....	......	......	....
Grand total	25,674,798	893,580	639,977	599,616	27,807,971	28,162	6,764	34,926	214

[a] Includes Hancock County.

Value of coal produced in Kentucky in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total value.	Average value per ton.
Eastern district:						
Bele	$5,183,507	$117,306	$105,552		$5,406,365	$2.60
Boyd	228,163	6,388	4,530		239,081	2.35
Breathitt	137,042	3,435	646		141,123	2.53
Carter	248,980	8,870	51,516		309,366	2.05
Floyd	2,244,517	17,437	36,178		2,298,132	2.72
Harlan	4,704,506	58,863	42,569	$810,907	5,616,845	2.59
Jackson and Pulaski	33,070	10,076	273		43,419	2.28
Johnson	2,820,871	28,685	90,823		2,940,379	3.38
Knott, Martin, and Morgan	213,588	2,283	363		216,234	3.10
Knox	1,264,091	16,556	35,144		1,315,791	2.35
Laurel	182,529	399	1,719		184,647	2.30
Lawrence	94,662	1,896	400		96,958	2.51
Lee	78,713	2,752	742		82,207	2.65
Letcher	7,523,226	82,560	60,472		7,666,258	2.21
McCreary	1,790,884	7,661	10,791		1,809,336	2.61
Perry	4,553,987	47,849	18,482		4,620,318	2.78
Pike	7,920,194	215,163	99,392	231,212	8,465,961	2.20
Whitney	1,867,507	17,917	49,146		1,934,570	2.54
	41,090,037	646,096	608,738	1,042,119	43,386,990	2.48
Average value per ton	2.50	2.09	2.06	2.18	2.48	
Western district:						
Christian	123,537	1,590	4,000		129,127	2.23
Daviess	21,590	125,036	2,133		148,759	1.99
Henderson	377,868	161,871	18,531		558,270	1.91
Hopkins	3,937,236	215,340	126,897	67,564	4,347,037	1.42
McLean	196,897	16,122	2,454		215,473	1.90
Muhlenberg	5,928,045	113,587	136,342		6,177,974	1.81
Ohio	1,268,756	46,799	32,498		1,348,053	1.50
Union	1,370,316	129,621	90,796		1,590,733	1.74
Webster	2,113,595	47,223	61,155		2,221,973	1.59
	15,337,840	857,189	474,806	67,564	16,737,399	1.64
Average value per ton	1.66	1.72	1.38	.56	1.64	
Small mines [a]	8,960	164,304			173,264	1.93
Grand total	56,436,837	1,667,589	1,083,544	1,109,683	60,297,653	2.17
Average value per ton	2.20	1.87	1.69	1.85	2.17	

[a] Includes Hancock County.

Coal produced in Kentucky, 1913–1917, in net tons.

County.	1914	1915	1916	1917	Increase or decrease, 1917.
Eastern district:					
Bell	2,579,011	2,306,831	2,244,542	2,079,122	− 165,420
Boyd	92,882	78,000	85,581	101,714	+ 16,133
Breathitt	[a] 113,242	[a] 74,592	[a] 37,212	55,881	+ 18,669
Carter	84,475	83,413	123,577	150,554	+ 26,977
Floyd	524,923	545,074	873,453	845,863	− 27,590
Greenup	....	(a)	(a)	....	....
Harlan	1,264,066	1,726,798	2,214,228	2,167,741	− 46,487
Johnson	935,630	975,464	975,486	869,802	− 105,684
Knox	904,684	767,713	803,524	561,035	− 242,489
Laurel	101,205	85,136	87,638	80,203	− 7,435
Lawrence	(a)	(a)	(a)	38,631	+ 38,631
Lee	(a)	(a)	(a)	30,997	+ 30,997
Letcher	1,427,626	2,229,334	3,671,436	3,470,779	− 200,657
McCreary	586,541	569,535	665,290	692,933	+ 27,643
Morgan	76,028	58,815	48,727	[b] 69,680	+ 20,953
Perry	221,012	547,962	992,262	1,660,795	+ 668,533
Pike	2,653,315	2,830,239	3,756,927	3,846,651	+ 89,724
Whitney	854,019	805,446	905,428	762,146	− 143,282
Other counties [c]	3,100	5,418	[c] 10,164	[c] 19,021	+ 8,857
	12,421,759	13,689,770	17,495,475	17,503,548	+ 8,073
Western district:					
Christian	[d] 83,905	[d] 93,256	[d] 107,975	57,921	− 50,054
Daviess	47,538	42,778	59,855	74,663	+ 14,808
Hancock	7,000	4,000	(e)	(e)	(e)
Henderson	161,066	166,704	185,748	292,447	+ 106,699
Hopkins	2,551,720	2,332,143	2,622,525	3,052,001	+ 429,476
McLean	(d)	(d)	58,380	113,468	+ 55,088
Muhlenberg	2,265,153	2,232,045	2,036,819	3,411,816	+ 1,374,997
Ohio	660,273	519,820	484,940	895,819	+ 410,879
Union	585,743	742,110	660,076	915,358	+ 255,282
Webster	1,475,790	1,409,000	1,570,238	1,400,987	− 169,251
	7,838,188	7,541,856	7,786,556	10,214,480	+ 2,427,924
Small mines	122,816	130,048	[e] 111,966	89,943	− 22,023
Grand total	20,382,763	21,361,674	25,393,997	27,807,971	+ 2,413,974
Total value	$20,852,463	$21,494,008	$30,193,047	$60,297,653	+$30,104,606

[a] Breathitt County included Knott, Lawrence, and Lee in 1914; Greenup, Knott, Lawrence, and Lee in 1915 and 1916.
[b] Includes Knott and Martin counties.
[c] Other counties include Clay, Letcher, and Pulaski in 1913; Clay, Pulaski, and Rockcastle, in 1914; Jackson and Pulaski in 1915, 1916, and 1917.
[d] Christian and McLean counties combined.
[e] Hancock County included in small mines.

MARYLAND.

The production of coal in Maryland in 1917 was 4,745,924 net tons, valued at $11,667,852, an increase compared with 1916 of 285,878 tons, or 6 per cent, in quantity and of $4,720,229, or 68 per cent, in value. The commercial mines in Allegany County and the small "county banks" had increased output, and the mines in Garrett County had a decrease. The number of employees increased in 1917 to 5,919, against 5,633 in 1916, but the average number of days decreased from 256 to 254.

Coal produced in Maryland in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Allegany	3,342,332	55,067	57,055	3,454,454	3,900	700	4,600	260
Garrett	978,388	8,148	8,158	994,694	819	214	1,033	234
Small mines	....	10,898	....	10,898	....	....	....	....
	4,320,720	74,113	65,213	4,460,046	4,719	914	5,633	256

Value of coal produced in Maryland in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Allegany	$5,511,695	$89,632	$93,747	$5,695,074	$1.65
Garrett	1,218,373	9,289	11,014	1,238,676	1.25
Small mines	....	13,873	....	13,873	1.27
	6,730,068	112,794	104,761	6,947,623	1.56
Average value per ton	1.56	1.52	1.61	1.56	....

Coal produced in Maryland in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Allegany	3,602,013	70,200	55,396	3,727,609	3,807	987	4,794	260
Garrett	980,423	8,930	3,514	992,867	889	236	1,125	227
Small mines	....	25,448	....	25,448	....	....	....	....
	4,582,436	104,578	58,910	4,745,924	4,696	1,223	5,919	254

Value of coal produced in Maryland in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton
Allegany	$8,999,653	$152,803	$134,353	$9,286,809	$2.49
Garrett	2,316,235	10,356	6,668	2,333,259	2.35
Small mines	....	47,784	....	47,784	1.88
	11,315,888	210,943	141,021	11,667,852	2.46
Average value per ton	2.47	2.02	2.39	2.46	....

Coal produced in Maryland, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Allegany	4,038,261	3,449,365	3,388,365	3,454,454	3,727,609	+ $273,155
Garrett	731,089	671,621	782,976	994,694	992,867	− 1,827
Small mines	10,489	12,561	9,136	10,898	25,448	+ 14,550
	4,779,839	4,133,547	4,180,477	4,460,046	4,745,924	+ 285,878
Total value	$5,927,046	$5,234,796	$5,330,845	$6,947,623	$11,667,852	+$4,720,229

MICHIGAN.

The output of coal in Michigan increased from 1,180,360 tons in 1916 to 1,374,805 in 1917, a gain of 16.5 per cent. The value of the coal produced in 1917 was $4,426,314, an increase over 1916 of $1,773,132, or 67 per cent. The increase was general, Bay County, with the largest output, having the largest increase. There was a decrease in the number of men employed from 2,535 in 1916 to 2,406 in 1917, but an increase in the average number of days worked from 216 to 254. The decrease in the number of men was in those employed on the surface, the number of underground employees recording a slight increase. Time lost because of strikes in 1917 was only about 10 per cent of that in 1916.

Coal produced in Michigan in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Bay	540,114	2,104	7,089	549,307	972	187	1,159	210
Ingham and Tuscola	55,769	5,210	9,200	70,179	164	21	185	230
Saginaw	501,224	44,141	15,194	560,559	988	203	1,191	219
Small mines		315		315				
	1,097,107	51,770	31,483	1,180,360	2,124	411	2,535	216

Value of coal produced in Michigan in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Bay	$1,178,380	$6,727	$12,596	$1,197,703	$2.18
Ingham and Tuscola	127,711	14,358	15,640	157,709	2.25
Saginaw	1,136,011	132,037	28,727	1,296,775	2.31
Small mines		995		995	3.16
	2,442,102	154,117	56,963	2,653,182	2.25
Average value per ton	2.23	2.98	1.81	2.25	

Coal produced in Michigan in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Bay	666,306	12,956	8,775	688,037	993	85	1,078	277
Saginaw	517,427	58,403	22,650	598,480	936	107	1,043	248
Other counties [a]	61,062	9,458	16,540	87,060	225	60	285	189
Small mines		1,228		1,228				
	1,244,795	82,045	47,965	1,374,805	2,154	252	2,406	254

[a] Includes Calhoun, Genesee, Shiawassee, and Tuscola counties.

Value of coal produced in Michigan in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Bay	$2,052,883	$51,659	$26,325	$2,130,867	$3.10
Saginaw	1,689,364	235,644	64,528	1,989,536	3.32
Other counties	197,857	48,600	52,741	299,198	3.44
Small mines		6,713		6,713	5.47
	3,940,104	342,616	143,594	4,426,314	3.22
Average value per ton	3.17	4.18	2.99	3.22	

Coal produced in Michigan, 1913–1916, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Bay	591,718	617,415	551,772	549,307	688,037	+ 138,730
Saginaw	596,193	584,648	539,036	560,559	598,480	+ 37,921
Tuscola	[a] 42,715	[a] 80,866	[a] 64,650	[a] 70,179	[a] 87,060	+ 16,881
Small mines	1,160	101	680	315	1,228	+ 913
	1,231,786	1,283,030	1,156,138	1,180,360	1,374,805	+ 194,445
Total value	$2,455,227	$2,559,786	$2,372,797	$2,653,182	$4,426,314	+$1,773,132

[a] Tuscola County includes Clinton, Ingham, and Shiawasse 1913; Genesee and Ingham 1914; Ingham 1915 and 1916; Calhoun, Genesee, and Shiawassee in 1917.

MISSOURI.

The production of coal in Missouri in 1917 exceeded all previous records for the State. The output, 5,670,549 tons, exceeded the record established in 1916 by 928,403 tons, or nearly 20 per cent. The value of the coal produced in 1917 was $13,755,864, a gain of $4,711,359, or 52 per cent. All the larger producing counties shared in the increase. The increase in production was accomplished by the greater number of days worked, 240 in 1917 against 207 in 1916, a gain of 16 per cent, and the slightly greater output per man per day, from 2.37 tons in 1916 to 2.44 tons in 1917, a gain of about 3 per cent. The total number of men employed was practically the same in both years, but the number of underground employees decreased 2.5 per cent and the surface employees increased 12 per cent in 1917.

Coal produced in Missouri in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity. (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Adair	419,016	11,816	5,581	436,413	917	59	976	185
Audrain	161	6,824	....	6,985	30	3	33	217
Barton	898,911	13,391	23,322	935,624	163	834	997	189
Bates	66,799	14,600	2,135	83,534	103	102	205	135
Boone	650	17,806	100	18,556	58	10	68	178
Callaway	35,210	24,447	2,157	61,814	99	46	145	250
Clay, Dade, Johnson, and Platte	94,749	6,648	1,033	102,430	246	44	290	222
Grundy, Harrison, and Sullivan	64,112	17,683	7,716	89,511	163	21	184	200
Henry	130,540	39,271	2,122	171,933	338	78	416	203
Lafayette	838,614	43,116	25,386	907,116	2,215	218	2,433	214
Linn	85,985	21,969	384	108,338	291	36	327	242
Macon	765,538	21,797	8,296	795,631	1,233	150	1,383	211
Putnam	5,631	2,728	160	8,519	58	10	68	83
Randolph	347,602	17,779	3,182	368,563	787	46	833	219
Ray	374,033	33,652	5,290	412,975	1,082	64	1,146	213
Vernon	77,872	3,972	....	81,844	55	51	106	244
Other counties [a]	13,991	1,522	....	15,513	39	5	44	246
Small mines	....	136,847	....	136,847	....	......	....	....
	4,219,414	435,868	86,864	4,742,146	7,877	1,777	9,654	207

[a] Cooper, Livingston, Montgomery, and Ralls.

Value of coal produced in Missouri in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Adair	$693,396	$32,255	$5,240	$730,891	$1.67
Audrain	320	15,404	....	15,724	2.25
Barton	1,726,775	19,999	37,438	1,784,212	1.91
Bates	129,210	30,840	3,235	163,285	1.95
Boone	1,300	48,579	200	50,079	2.70
Callaway	66,977	67,976	3,801	138,754	2.24
Clay, Dade, Johnson, and Platte	224,870	14,234	1,588	240,692	2.35
Grundy, Harrison, and Sullivan	108,545	42,206	8,016	158,767	1.77
Henry	234,235	84,083	3,697	322,015	1.87
Lafayette	1,707,017	112,976	41,129	1,861,122	2.05
Linn	202,124	63,094	768	265,986	2.46
Macon	1,243,211	48,755	10,443	1,302,409	1.64
Putnam	12,274	5,545	171	17,990	2.11
Randolph	661,189	31,989	1,815	694,993	1.89
Ray	748,377	77,827	10,417	836,621	2.03
Vernon	143,334	4,254	....	147,588	1.80
Other counties [a]	26,186	3,305	....	29,491	1.90
Small mines	....	283,886	....	283,886	2.07
	7,929,340	987,207	127,958	9,044,505	1.91
Average value per ton	1.88	2.26	1.47	1.91	....

[a] Cooper, Livingston, Montgomery, and Ralls.

Coal produced in Missouri in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity. (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Adair	674,785	9,999	8,300	693,084	1,056	66	1,122	239
Audrain	1,039	10,673	23	11,735	54	4	58	222
Barton	976,086	13,118	67,087	1,056,291	86	1,018	1,104	188
Bates	73,545	13,160	3,127	89,832	143	74	217	167
Boone	4,172	12,138	100	16,410	52	7	59	241
Callaway	41,031	17,502	2,348	60,881	99	44	143	217
Clay, Dade, Johnson, and Platte	161,993	30,025	3,203	195,221	350	56	406	265
Cooper and Moniteau	4,125	450	....	4,575	12	2	14	171
Grundy, Harrison, and Sullivan	63,279	19,217	9,589	92,085	128	29	157	277
Henry	83,090	24,164	3,303	110,557	176	82	258	167
Lafayette	895,342	39,356	27,041	961,739	2,027	243	2,270	243
Linn	97,638	28,144	2,730	128,512	326	42	368	258
Macon	894,376	20,598	9,693	924,667	1,123	110	1,233	269
Putnam	18,433	2,756	462	21,651	110	24	134	113
Randolph	435,806	157,149	5,290	598,245	736	56	792	275
Ray	465,368	44,449	6,468	516,285	1,171	78	1,249	257
Other counties [a]	52,581	1,777	3,017	57,375	31	53	84	217
Small mines	....	131,404	....	131,404	......	......	......	......
	4,942,689	576,079	151,781	5,670,549	7,680	1,988	9,668	240

[a] Includes Ralls and Vernon counties.

Value of coal produced in Missouri in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Adair	$1,487,639	$33,287	$14,150	$1,535,076	$2.21
Audrain	2,877	30,801	69	33,747	2.88
Barton	2,465,477	26,089	161,495	2,653,061	2.51
Bates	173,442	34,245	8,391	216,078	2.41
Boone	13,727	34,423	350	48,500	2.96
Callaway	112,203	57,281	5,989	175,473	2.88
Clay, Dade, Johnson, and Platte	439,209	89,284	7,197	535,690	2.74
Cooper and Moniteau	18,066	2,250	....	20,316	4.44
Grundy, Harrison, and Sullivan	154,015	56,965	17,508	228,488	2.48
Henry	223,831	68,020	9,330	301,181	2.72
Lafayette	2,347,258	120,725	54,949	2,522,932	2.62
Linn	264,083	80,266	5,277	349,626	2.72
Macon	1,861,680	52,445	15,663	1,929,788	2.09
Putnam	41,774	6,833	597	49,204	2.27
Randolph	920,864	360,511	9,421	1,290,796	2.16
Ray	1,241,905	119,994	16,964	1,378,863	2.64
Other counties [a]	128,610	4,163	7,110	139,883	2.44
Small mines	....	347,162	....	347,162	2.64
	11,896,660	1,524,744	334,460	13,755,864	2.43
Average value per ton	2.41	2.65	2.20	2.43	....

[a] Includes Ralls and Vernon counties.

Coal produced in Missouri, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Adair	439,991	256,397	280,187	436,413	693,084	+ 256,671
Audrain	10,606	10,360	13,803	6,985	11,735	+ 4,750
Barton	495,328	505,282	657,069	935,624	1,056,291	+ 120,667
Bates	168,469	145,031	71,312	83,534	89,832	+ 6,298
Boone	15,791	12,514	17,450	18,556	16,410	− 2,146
Caldwell, Clay, Dade, Johnson, and Platte	101,158	110,559	88,964	a 102,430	a 195,221	+ 92,791
Callaway	32,889	39,555	64,136	61,814	60,881	− 933
Cole, Cooper, and Moniteau	3,931	b 3,032	b 3,350	(b d g)	b 4,575	(g)
Grundy, Harrison, Schuyler, and Sullivan	192,932	114,949	c 103,881	c 89,511	c 92,085	+ 2,574
Henry	261,196	224,894	183,311	171,933	110,557	− 61,376
Howard, Montgomery, and Ralls	26,287	e 23,900	(f g)	(g h)	(f g)	(f g)
Lafayette	729,606	703,029	799,297	907,116	961,739	+ 54,623
Linn	117,625	108,626	97,242	108,338	128,512	+ 20,174
Macon	778,264	765,365	666,245	795,631	924,667	+ 129,036
Putnam	21,835	10,367	(g)	8,519	21,651	+ 13,132
Randolph	481,882	424,245	379,262	368,563	598,245	+ 229,682
Ray	343,285	324,080	205,184	412,975	516,285	+ 103,310
Vernon	10,073	43,165	75,377	81,844	(g)	(g)
Other counties	....	....	g 15,103	g 15,513	g 57,375	− 35,407
Small mines	86,977	110,630	90,420	136,847	131,404	− 5,443
	4,318,125	3,935,980	3,811,593	4,742,146	5,670,549	+ 928,403
Total value	$7,468,308	$6,802,325	$6,595,918	$9,044,505	$13,755,864	+$4,711,359

a No production in Caldwell County.
b No production in Cole County.
c No production in Schuyler County.
d No production in Moniteau County.
e No production in Montgomery County.
f No production in Howard and Montgomery counties.
g Other counties include Livingston, Putnam, and Ralls in 1915; Cooper, Livingston, Montgomery, and Ralls in 1916; Ralls and Vernon, and increase in Cooper and Moniteau in 1917.
h No production in Howard County.

MONTANA.

The production of coal in Montana was 4,226,689 tons, exceeding the record of 1916 by 594,162 tons, or 16 per cent, and for the first time in excess of 4,000,000 tons. The increase was general, but greatest in Carbon and Cascade counties, each of which recorded gains of more than 250,000 tons. There was a notable gain in number of men employed, both underground and surface, and in days worked. The increase in men was from 3,781 in 1916 to 4,149 in 1917, and in days from 244 to 268. Because of the greater number of days worked, the average annual output increased from 961 tons to 1,019 tons. The daily average output per man decreased, however, from 3.93 tons to 3.80 tons, probably because the percentage of total output mined by machine decreased from 56 to 49, although the quantity so mined was nearly the same in the two years. There was little change in the percentage mined by hand, but an increase from 9.5 per cent to 14 per cent in the coal shot from the solid.

Coal produced in Montana in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Carbon	1,398,223	47,482	88,562	1,534,267	1,424	299	1,723	243
Cascade	727,933	36,831	8,349	773,113	714	125	839	238
Fergus	223,696	2,635	6,350	232,681	190	70	260	278
Hill	2,500	11,950	150	14,600	18	4	22	247
Musselshell	992,226	14,145	35,636	1,042,007	664	207	871	245
Sheridan	3,600	2,473	....	6,073	8	1	9	80
Other counties [a]	2,487	12,388	685	15,560	47	10	57	204
Small mines	....	14,226	....	14,226	....	....	....	....
	3,350,665	142,130	139,732	3,632,527	3,065	716	3,781	244

[a] Blaine, Chouteau, Missoula, Park, and Valley.

Value of coal produced in Montana in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Carbon	$2,785,935	$102,671	$64,082	$2,952,688	$1.92
Cascade	1,130,724	81,409	7,200	1,219,333	1.58
Fergus	328,371	6,857	3,175	338,403	1.45
Hill	6,250	29,875	150	36,275	2.48
Musselshell	1,576,731	30,523	37,372	1,644,626	1.58
Sheridan	7,200	4,945	....	12,145	2.00
Other counties [a]	6,218	36,969	1,462	44,649	2.87
Small mines	....	38,078	....	38,078	2.68
	5,841,429	331,327	113,441	6,286,197	1.73
Average value per ton	1.74	2.33	.81	1.73	....

[a] Blaine, Chouteau, Missoula, Park, and Valley.

Coal produced in Montana in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Carbon	1,637,203	55,945	97,122	1,790,270	1,511	350	1,861	282
Cascade	987,781	22,994	14,132	1,024,907	852	173	1,025	275
Musselshell	988,180	18,441	47,400	1,054,021	744	206	950	229
Sheridan	5,368	7,586	....	12,954	12	....	12	237
Other counties [a]	264,387	33,236	9,050	306,673	219	82	301	274
Small mines	....	37,864	....	37,864	....	....	....	....
	3,882,919	176,066	167,704	4,226,689	3,338	811	4,149	268

[a] Blaine, Chouteau, Fergus, Hill, Missoula, Richland, and Valley counties.

Value of coal produced in Montana in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Carbon	$3,788,360	$138,685	$116,478	$4,043,523	$2.26
Cascade	1,969,370	52,543	27,362	2,049,275	2.00
Musselshell	1,960,163	63,870	72,889	2,096,922	1.99
Sheridan	11,166	15,356	....	26,522	2.05
Other counties[a]	496,378	88,744	16,924	602,046	1.96
Small mines	....	100,848	....	100,848	2.66
	8,225,437	460,046	233,653	8,919,136	2.11
Average value per ton	2.12	2.61	1.39	2.11	....

[a] Blaine, Chouteau, Fergus Hill, Missoula, Richland, and Valley counties.

Coal produced in Montana, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Carbon	1,304,524	1,212,941	1,172,721	1,534,267	1,790,270	+256,003
Cascade	912,634	664,423	619,745	773,113	1,024,907	+251,794
Chouteau	....	....	(a)	(a)	(a)	(a)
Fergus	5,348	23,104	68,362	232,681	265,705	+ 33,024
Hill	9,405	16,256	14,117	14,600	6,574	− 8,026
Musselshell	963,968	850,040	887,021	1,042,007	1,054,021	+ 12,014
Sheridan	....	(a)	6,556	6,073	12,954	+ 6,881
Other counties	a 37,896	a 30,183	a 3,626	a 15,560	34,394	+ 18,834
Small mines	7,198	8,226	17,607	14,226	a 37,864	+ 23,638
	3,240,973	2,805,173	2,789,755	3,632,527	4,226,689	+594,162
Total value	$5,653,539	$4,913,191	$4,526,509	$6,286,197	$8,919,136	+$2,632,939

[a] Other counties include Blaine, Custer, Missoula, Park, Rosebud, and Valley in 1913; Blaine, Missoula, Park, and Sheridan in 1914; Chouteau, Missoula, and Valley in 1915; Blaine, Chouteau, Missoula, Park, and Valley in 1916; and Blaine, Chouteau, Missoula, Richland, and Valley in 1917.

NEW MEXICO.

The production of coal in New Mexico in 1917 was 4,000,527 tons, valued at $7,455,166, an increase of 207,516 tons, or 5.5 per cent, in quantity and of $1,874,797, or 33.6 per cent, in value. The output in 1917 was the largest recorded and was more than double that of 1906, 11 years before. The increase in Colfax County, the Raton field, was greater than that of the State, as the output in the Gallup field (McKinley County) decreased 70,302 tons, or 9.5 per cent. The increase was about equally divided between shipments of coal and coke. The number of men employed decreased slightly, from 4,522 to 4,126, but the average days worked increased from 292 to 321, a very high record, Colfax County showing 336 days worked.

Coal produced in New Mexico in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at the mines (net tons).	Total quantity (net tons).	Employees.			Average number of days worked.
						Underground.	Surface.	Total.	
Colfax	1,975,027	17,963	540	844,083	2,837,613	2,201	927	3,128	300
Lincoln, Santa Fe, and Socorro	187,584	11,863	9,170	....	208,617	367	94	461	301
McKinley	706,062	14,379	15,159	....	735,600	717	194	911	261
Rio Arriba and San Juan	4,640	4,320	325	....	9,285	19	3	22	286
Small mines	....	1,896	....	....	1,896	......	......	......	....
	2,873,313	50,421	25,194	844,083	3,793,011	3,304	1,218	4,522	292

Value of coal produced in New Mexico in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total value.	Average value per ton.
Colfax	$2,862,804	$27,116	$587	$918,698	$3,809,205	$1.34
Lincoln, Santa Fe, and Socorro	519,349	20,585	18,995	....	558,929	2.68
McKinley	1,162,037	20,856	10,642	....	1,193,535	1.62
Rio Arriba and San Juan	7,970	6,550	569	....	15,089	1.63
Small mines	....	3,611	....	....	3,611	1.90
	4,552,160	78,718	30,793	918,698	5,580,369	1.47
Average value per ton	1.58	1.56	1.22	1.09	1.47	....

Coal produced in New Mexico in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at the mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
						Underground.	Surface.	Total.	
Colfax	2,102,815	16,073	4,228	991,488	3,114,604	2,268	578	2,846	336
Lincoln, Santa Fe, and Socorro	181,890	18,616	7,786	....	208,292	349	188	537	298
McKinley	634,849	6,314	24,135	....	665,298	552	165	717	286
Rio Arriba and San Juan	8,400	2,075	300	....	10,775	22	4	26	227
Small mines	....	1,558	....	....	1,558	......	......	......	....
	2,927,954	44,636	36,449	991,488	4,000,527	3,191	935	4,126	321

Value of coal produced in New Mexico in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total value.	Average value per ton.
Colfax	$3,892,677	$25,452	$5,804	$1,365,481	$5,289,414	$1.70
Lincoln, Santa Fe and Socorro	666,078	60,708	21,268		748,054	3.59
McKinley	1,344,963	10,794	38,420		1,394,177	2.10
Rio Arriba and San Juan	16,800	3,329	483		20,612	1.91
Small mines		2,909			2,909	1.87
	5,920,518	103,192	65,975	1,365,481	7,455,166	1.86
Average value per ton	2.02	2.31	1.81	1.38	1.86	

Coal produced in New Mexico, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Colfax	2,749,765	3,015,363	2,866,442	2,837,613	3,114,604	+ 276,991
Lincoln, Santa Fe, and Socorro	120,129	a 145,574	157,206	208,617	208,292	− 325
McKinley	824,762	706,731	785,490	735,600	665,298	− 70,302
Rio Arriba and San Juan	11,100	7,775	8,285	9,285	10,775	+ 1,490
Small mines	3,050	2,246	517	1,896	1,558	− 338
	3,708,806	3,877,689	3,817,940	3,793,011	4,000,527	+ 207,516
Total value	$5,401,260	$6,230,871	$5,481,361	$5,580,369	$7,455,166	+$1,874,797

a Santa Fe and Socorro counties only.

NORTH DAKOTA.

The production of lignite in North Dakota in 1917 was 790,548 tons, valued at $1,425,750, an increase compared with 1916 of 155,636 tons, or 24.5 per cent, in quantity and of $479,668, or 51 per cent, in value, and was the highest recorded. The development of the immense reserve of lignite in North Dakota has only begun. These deposits, so little used, now are a reserve of fuel as yet untapped. North Dakota is not an industrial State and the use of fuel is largely confined to householders, brickyards, public utilities, and small manufacturing plants, in which, through education fostered by the State Government, lignite is coming more into favor as a fuel.

Lignite in its raw state is not a desirable fuel, and it is noted with interest that the studies of briquetting processes are bearing fruit in commercial plants in this State. The thick, flat-lying beds of lignite in western North Dakota lend themselves to extraction by the open-pit and steam-shovel method, and in 1917 the first large scale operation of this kind was started.

Lignite produced in North Dakota in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Adams	3,748	7,701	300	11,749	14	4	18	228
Burke	14,250	9,150		23,400	8	7	15	230
Burleigh, McLean, and Mercer	205,389	16,368	10,804	232,561	199	48	247	262
Divide	59,333	5,888	2,650	67,871	78	23	101	268
Morton	6,335	28,486	50	34,871	26	5	31	244
Ward	61,710	8,872	3,800	74,382	97	36	133	220
Williams	5,245	37,728	120	43,093	40	11	51	256
Other counties [a]	84,742	10,827	2,500	98,069	91	27	118	212
Small mines		48,916		48,916				
	440,752	173,936	20,224	634,912	553	161	714	244

[a] Billings, Bowman, Dunn, Hettinger, and Stark.

Value of lignite produced in North Dakota in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Adams	$8,433	$13,324	$600	$22,357	$1.90
Burke	22,288	14,572		36,860	1.58
Burleigh, McLean, and Mercer	289,926	24,147	10,834	324,907	1.40
Divide	97,192	9,520	4,288	111,000	1.63
Morton	12,500	34,311	70	46,881	1.34
Ward	103,645	16,302	2,000	121,947	1.64
Williams	8,520	59,628	150	68,298	1.58
Other counties [a]	113,041	18,271	2,500	133,812	1.36
Small mines		80,020		80,020	1.64
	655,545	270,095	20,442	946,082	1.49
Average value per ton	1.49	1.55	1.01	1.49	

[a] Billings, Bowman, Dunn, Hettinger, and Stark.

Lignite produced in North Dakota in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Burke	20,000	4,351		24,351	17	21	38	231
Burleigh and Mercer	243,039	11,709	11,847	266,595	189	42	231	273
Divide	98,553	4,164	6,126	108,843	86	37	123	270
Hettinger	2,000	3,710		5,710	8		8	183
McLean	13,151	9,798	200	23,149	29	13	42	281
Morton		24,464	184	24,648	23	1	24	249
Ward	63,931	21,302	3,143	88,376	106	48	154	253
Williams	7,101	32,337	8,945	48,383	36	7	43	265
Other counties [a]	111,796	16,692	3,632	132,120	125	33	158	222
Small mines		68,373		68,373				
	559,571	196,900	34,077	790,548	619	202	821	255

[a] Adams, Billings, Bowman, Dunn, Oliver, and Stark.

Value of lignite produced in North Dakota in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Burke	$32,730	$9,800	....	$42,530	$1.75
Burleigh and Mercer	402,934	19,582	$17,060	439,576	1.65
Divide	180,904	10,189	7,801	198,894	1.83
Hettinger	3,200	6,934	....	10,134	1.77
McLean	30,322	18,298	150	48,770	2.1[illegible]
Morton	....	33,302	240	33,542	1.36
Ward	152,712	55,202	3,143	211,057	2.39
Williams	14,169	62,163	12,881	89,213	1.84
Other counties [a]	188,926	29,986	5,282	224,194	1.70
Small mines	....	127,840	....	127,840	1.87
	1,005,897	373,296	46,557	1,425,750	1.80
Average value per ton	1.80	1.90	1.37	1.80	....

[a] Adams, Billings, Bowman, Dunn, Oliver, and Stark.

Lignite produced in North Dakota, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Adams	9,584	11,062	10,627	11,749	(a)	(a)
Burke	12,175	11,750	10,000	23,400	24,351	+ 951
Burleigh	194,002	(a)	(a)	[b] 232,561	[b] 289,744	+ 57,183
Divide	(a)	(a)	(a)	67,871	108,843	+ 40,972
Hettinger	7,550	5,100	4,182	(a)	5,710	(a)
McLean	8,716	10,161	9,695	(b)	(b)	(b)
Morton	40,486	34,323	50,024	34,871	24,648	− 10,223
Stark	55,557	(a)	(a)	(a)	(a)	(a)
Ward	77,110	68,157	61,506	74,382	88,376	+ 13,994
Williams	27,758	38,750	32,970	43,093	48,383	+ 5,290
Other counties	[a] 45,015	[a] 298,469	[a] 316,422	[a] 98,069	[a] 132,120	+ 28,012
Small mines	17,367	28,913	32,652	48,916	68,373	+ 19,457
	495,320	506,685	528,078	634,912	790,548	+ 155,636
Total value	$750,652	$771,379	$766,072	$946,082	$1,425,750	+$479,668

[a] Other counties include Bowman, Divide, Merrcer, and Oliver, in 1913; Billings, Bowman, Burliegh, Divide, Oliver, and Stark in 1914; Billings, Bowman, Burleigh, Divide, Dunn, Oliver, and Stark in 1915; Billings, Bowman, Dunn, Hettinger, and Stark in 1916; and Adams, Billings, Bowman, Dunn, Oliver, and Stark counties; and increase in Hettinger in 1917.
[b] Burleigh County includes McLean and Mercer counties.

OHIO.

A new high record for Ohio was reached in 1917 with the production of 40,748,734 tons of coal, a gain over 1916 of 6,020,515 tons, or 17 per cent, more than 4,000,000 tons over the previous high record attained in 1913, and nearly double the output in 1901.

The demand for coal from Ohio in 1917 was continuous throughout the year and at all times in excess of the supply. The supply of labor appears to have been ample, the number of men employed in 1917, 45,509, having shown an increase of 10 per cent over 1916, and the average daily output per man, the index of the efficiency of the labor, was 4.26 tons, the same as in 1916. The use of machines kept pace with the increase in mining activity, for there were 180 more mining machines in use, a gain of 11 per cent, and the percentage of machine-mined product was 87.9 compared with 91.1 in 1916. Steam shovels played an increasingly important part in 1917, as there were 36 steam shovels in use, twice the number in 1916, and the quantity of coal recovered from the pits was more than doubled, 1,249,000 tons against 551,000 tons.

Fifty-seven per cent of the increase in production in 1917 was effected by the increase in labor and the remainder, or 43 per cent, by the increase in the number of days worked. The number of days

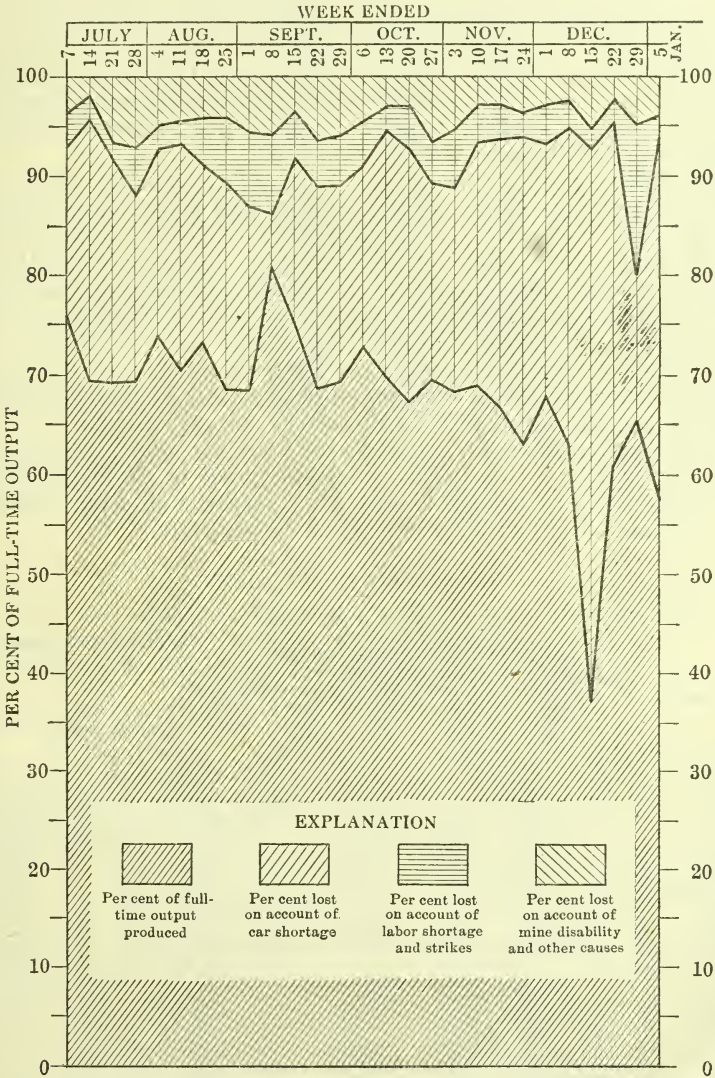


FIGURE 32.—Percentage of full-time operation of coal mines and of losses by causes, in Ohio, July to December, 1917.

worked in 1917 was 210 which, although a gain over 197 days in 1916, represented only 70 per cent of the full year, 304 days. Statistics collected from the operators weekly in the last half of the year indicate that the average loss of time through lack of cars and other transportation disability was 20 per cent of the full working time, which represents a theoretical loss of nearly 12,000,000 tons of production. It is not believed, however, had the mines in Ohio been fully supplied with cars in which to load this coal and had the railroads been able to transport it, that the market tributary to the Ohio fields would have absorbed this additional quantity of coal. The fact remains, however, that, had the cars been supplied, the mines could have worked more days and sufficient coal would have been produced to meet the insistent demands in the territory reached by these fields.

The percentage of full time worked by the mines in Ohio in the last half of the year, as compiled from weekly reports furnished by the operators, and the percentage of time lost for various causes, are shown graphically in figure 32.

More than three-fourths of the increase in output of the State was in the southern Ohio fields. Athens and Perry counties, in the Hocking field, recorded a combined gain of nearly 3,500,000 tons. The Pittsburgh No. 8 field in northern Ohio, in which more than 40 per cent of the total output is produced, recorded an increase of about 1,000,000 tons, and the Cambridge field, in Guernsey County, had a decrease of 436,000 tons, or 10 per cent.

The absence of labor trouble in Ohio in 1917 was notable; the number of men-days lost because of strikes, all of which were local, was 56,875, a total of 7,710 men having been affected for an average of 7 days, compared with 7,594 men for an average of 21 days in 1916.

The increase in value of the coal produced in Ohio in 1917 was $54,746,241, or 119 per cent, and the average value per ton at the mine increased from $1.33 to $2.48, or 86 per cent.

Coal produced in Ohio in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
						Underground.	Surface.	Total.	
Athens	3,613,756	33,154	65,021	....	3,711,931	5,377	622	5,999	157
Belmont	9,736,069	475,570	119,302	....	10,330,941	9,913	1,039	10,952	205
Carroll	248,344	48,343	4,450	....	301,137	425	40	465	237
Columbiana	541,836	35,702	11,989	....	589,527	596	66	662	248
Coshocton	241,940	48,078	3,280	....	293,298	436	72	508	184
Gallia, Morgan, and Scioto	249,761	1,707	7,560	....	259,028	269	33	302	212
Guernsey	4,246,785	44,333	95,043	....	4,386,161	3,907	329	4,236	212
Harrison	949,227	12,346	12,055	....	973,628	776	125	901	188
Hocking	1,347,938	36,183	17,332	....	1,401,453	1,520	250	1,770	196
Holmes	....	5,180	....	....	5,180	13	3	16	133
Jackson	560,733	95,500	37,867	....	694,100	1,254	183	1,437	189
Jefferson	5,081,893	349,935	100,381	720	5,532,929	4,527	793	5,320	220
Lawrence	116,462	62,334	701	....	179,497	331	62	393	213
Mahoning	2,663	16,210	200	....	19,073	46	11	57	207
Medina	....	9,050	10	....	9,060	20	4	24	242
Meigs	953,724	43,446	11,765	....	1,008,935	1,285	245	1,530	215
Muskingum	325,545	49,039	1,702	....	376,286	492	88	580	188
Noble	837,583	7,993	11,951	....	857,527	768	47	815	219
Perry	1,276,392	28,195	30,172	....	1,334,759	2,069	294	2,363	146
Portage and Summit	85,951	12,170	9,722	....	107,843	140	41	181	171
Stark	148,180	136,988	11,213	....	296,381	540	88	628	198
Tuscarawas	1,235,739	232,297	36,460	....	1,504,496	1,576	232	1,808	210
Vinton	80,489	22,864	1,514	....	104,867	168	20	188	154
Wayne	114,903	4,528	18,218	....	137,649	232	27	259	147
Small mines	....	312,533	....	....	312,533	....	....	....	....
	31,995,913	2,123,678	607,908	720	34,728,219	36,680	4,714	41,394	197

Value of coal produced in Ohio in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total value.	Average value per ton.
Athens	$4,834,229	$40,627	$66,235		$4,941,091	$1.33
Belmont	12,249,142	564,035	120,289		12,933,466	1.25
Carroll	365,998	58,556	5,620		430,174	1.43
Columbiana	851,323	52,924	17,898		922,145	1.56
Coshocton	383,293	67,704	3,547		454,544	1.55
Gallia, Morgan, and Scioto	354,348	2,906	4,080		361,334	1.39
Guernsey	5,316,452	52,852	119,886		5,489,190	1.25
Harrison	1,296,524	13,421	12,553		1,322,498	1.36
Hocking	1,833,090	56,846	14,693		1,904,629	1.36
Holmes		8,297			8,297	1.60
Jackson	1,058,337	133,012	45,298		1,236,647	1.78
Jefferson	6,555,642	478,650	100,317	648	7,135,257	1.29
Lawrence	168,063	75,238	637		243,938	1.36
Mahoning	6,085	29,433	400		35,918	1.88
Medina		22,104	30		22,134	2.44
Meigs	1,396,273	47,806	12,857		1,456,936	1.44
Muskingum	387,924	73,105	1,571		462,600	1.23
Noble	1,044,841	10,611	15,401		1,070,853	1.25
Perry	1,747,247	34,087	30,707		1,812,041	1.36
Portage and Summit	218,739	27,369	10,841		256,949	2.38
Stark	371,088	231,838	15,769		618,695	2.09
Tuscarawas	1,777,597	315,469	40,466		2,133,532	1.42
Vinton	101,109	24,067	2,218		127,394	1.21
Wayne	253,974	9,999	31,882		295,855	2.15
Small mines		474,790			474,790	1.52
	42,571,318	2,905,746	673,195	648	46,150,907	1.33
Average value per ton	1.33	1.37	1.11	.90	1.33	

Coal produced in Ohio in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
						Underground.	Surface.	Total.	
Athens	6,004,615	35,819	115,794		6,156,228	5,882	831	6,713	220
Belmont	10,481,835	557,644	127,025		11,166,504	9,811	1,372	11,183	212
Carroll	356,600	62,364	13,863		432,827	559	61	620	228
Columbiana	489,592	63,630	13,095		566,317	672	101	773	235
Coshocton	244,222	50,432	6,498		301,152	428	85	513	201
Gallia, Morgan, and Scioto	327,121	3,119	9,258		339,498	360	49	409	201
Guernsey	3,794,783	56,586	98,483		3,949,852	3,781	420	4,201	180
Harrison	1,190,574	11,542	14,137		1,216,253	810	492	1,302	184
Hocking	1,888,879	37,116	28,086		1,954,081	1,921	389	2,310	219
Holmes		14,630	6		14,636	20		20	207
Jackson	716,856	108,122	38,864		863,842	1,311	208	1,519	220
Jefferson	5,135,736	356,279	105,075	630	5,597,720	3,972	1,282	5,254	216
Lawrence	148,068	65,939	1,747		215,754	342	75	417	244
Mahoning	5,233	36,775	20		42,028	68	7	75	247
Medina		10,083	5		10,088	19	1	20	298
Meigs	1,110,573	45,814	15,449		1,171,836	1,427	260	1,687	211
Muskingum	372,773	97,113	6,926		476,812	538	113	651	213
Noble	887,458	9,867	15,571		912,896	855	62	917	207
Perry	2,271,373	60,334	44,377		2,376,084	2,744	552	3,296	205
Portage and Summit	82,727	25,653	9,450		117,830	148	43	191	223
Stark	200,370	160,974	11,878		373,222	489	98	587	213
Tuscarawas	1,474,281	225,050	48,466		1,747,797	1,961	366	2,327	208
Vinton	164,052	12,541	19,736		196,329	283	39	322	219
Wayne	114,758	1,868	7,472		124,098	168	34	202	159
Small mines		425,050			425,050				
	37,462,479	2,534,344	751,281	630	40,748,734	38,569	6,940	45,509	210

Value of coal produced in Ohio in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by empoyees.	Used at mines for steam and heat	Made into coke at mines.	Total value.	Average value per ton.
Athens	$13,965,388	$67,369	$186,952		$14,219,709	$2.31
Belmont	25,291,823	955,018	253,585		26,500,426	2.37
Carroll	857,435	137,349	34,778		1,029,562	2.38
Columbiana	1,310,734	172,672	34,044		1,517,450	2.68
Coshocton	653,256	119,671	10,435		783,362	2.60
Gallia, Morgan, and Scioto	738,754	2,184	7,669		748,607	2.21
Guernsey	9,180,258	123,285	220,238		9,523,781	2.41
Harrison	3,113,975	24,757	30,402		3,169,134	2.61
Hocking	5,009,855	77,268	50,153		5,137,276	2.63
Holmes		27,643			27,643	1.89
Jackson	1,995,249	209,469	98,908		2,303,626	2.67
Jefferson	13,657,531	777,475	219,553	$1,200	14,655,759	2.62
Lawrence	353,440	140,824	4,413		498,677	2.31
Mahoning	15,699	101,626	30		117,355	2.79
Medina		40,358	20		40,378	4.00
Meigs	3,251,463	135,473	40,612		3,427,548	2.92
Muskingum	821,997	193,866	17,561		1,033,424	2.17
Noble	2,321,080	24,622	40,047		2,385,749	2.61
Perry	5,424,681	108,400	85,539		5,618,620	2.36
Portage and Summit	314,870	70,854	15,159		400,883	3.40
Stark	707,775	449,739	23,264		1,180,778	3.16
Tuscarawas	4,174,772	529,214	134,803		4,838,789	2.77
Vinton	450,425	33,126	40,411		523,962	2.67
Wayne	279,937	6,209	13,259		299,405	2.41
Small mines		915,245			915,245	2.15
	93,890,397	5,443,716	1,561,835	1,200	100,897,148	2.48
Average value per ton	2.51	2.15	2.08	1.90	2.48	

Coal produced in Ohio, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Athens	4,968,633	3,298,189	2,520,488	3,711,931	6,156,228	+2,444,297
Belmont	10,436,259	2,849,181	4,304,566	10,330,941	11,166,504	+ 835,563
Carroll	379,064	235,480	344,966	301,137	432,827	+ 131,690
Columbiana	522,804	342,366	541,862	589,527	566,317	− 23,210
Coshocton	364,411	153,046	198,434	293,298	301,152	+ 7,854
Gallia, Morgan, and Scioto	298,744	207,924	109,380	259,028	339,498	+ 80,470
Guernsey	4,321,992	2,936,707	3,232,961	4,386,161	3,949,852	− 436,309
Harrison	730,221	184,892	214,630	973,628	1,216,253	+ 242,625
Hocking	1,678,623	1,231,340	1,264,529	1,401,453	1,954,081	+ 552,628
Holmes	8,987	8,934	6,117	5,180	14,636	+ 9,456
Jackson	587,044	532,831	565,309	694,100	863,842	+ 169,742
Jefferson	5,178,922	2,172,881	3,608,453	5,532,929	5,597,720	+ 64,791
Lawrence	176,098	160,077	127,373	179,497	215,754	+ 36,257
Mahoning	15,786	15,903	12,556	19,073	42,028	+ 22,955
Medina, Portage, and Summit	[a] 158,174	125,063	115,124	116,903	127,918	+ 11,015
Meigs	642,725	534,784	943,889	1,008,935	1,171,836	+ 162,901
Muskingum	472,748	328,329	386,986	376,286	476,812	+ 100,526
Noble	787,141	501,942	596,786	857,527	912,896	+ 55,369
Perry	2,177,564	1,186,674	1,136,476	1,334,759	2,376,084	+1,041,325
Stark	417,238	457,933	352,020	296,381	373,222	+ 76,841
Tuscarawas	1,419,922	921,236	1,367,535	1,504,496	1,747,797	+ 243,301
Vinton	122,492	84,372	103,804	104,867	196,329	+ 91,462
Wayne	97,233	88,345	74,649	137,649	124,098	− 13,551
Small mines	237,702	284,686	305,798	312,533	425,050	+ 112,517
	36,200,527	18,843,115	22,434,691	34,728,219	40,748,734	+6,020,515
Total value	$39,948,058	$21,250,642	$24,207,075	$46,150,907	$100,897,148	+$54,746,241

[a] Includes Trumbull County.

OKLAHOMA.

A new high record for Oklahoma was reached in 1917 with the production of 4,368,844 tons of coal, valued at $12,335,413, an increase over 1916 of 778,833 tons, or 22 per cent, in quantity and of $4,809,986, or 64 per cent, in value, and over 1913, the year of previous high record, of 221,074 tons, or 5 per cent. Every coal-producing district and field shared in the increase, the largest gain, 302,020 tons, having been in Pittsburg County.

Although conditions appear to have been favorable for an increase in the efficiency of the mine labor, with an increase in the number of days worked from 178 to 211, and a gain in the proportion of both the machine-mined coal and that recovered from steam-shovel pits, the average recovery of coal per employee per day fell from 2.60 tons in 1916 to 2.45 in 1917. The total number of men rose from 7,800 in 1916 to 8,495 in 1917, a gain of nearly 9 per cent, but the advantage of more men and more days worked was in part offset by the lessened average effectiveness of the labor. There was a notable decrease in the time reported lost because of strikes, the record for 1917 showing only 37,301 men days against 126,452 men days in 1916.

Coal produced in Oklahoma in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Coal	501,011	5,535	18,408	524,954	1,056	114	1,170	194
Latimer	759,651	4,461	46,392	810,504	1,308	199	1,507	200
Le Flore	250,928	2,458	12,776	266,162	454	106	560	169
Okmulgee	836,248	2,507	13,451	852,206	1,521	246	1,767	180
Pittsburg	881,495	10,985	84,563	977,043	1,980	369	2,349	165
Tulsa	57,601	1,764	365	59,730	154	18	172	159
Other counties [a]	108,429	2,447	2,693	113,569	147	128	275	138
Small mines		3,843		3,843				
	3,395,363	34,000	178,648	3,608,011	6,620	1,180	7,800	178

[a] Atoka, Haskell, Rogers, and Wagoner.

Value of coal produced in Oklahoma in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Coal	$1,104,181	$15,356	$33,209	$1,152,746	$2.20
Latimer	1,650,128	9,317	73,834	1,733,279	2.14
Le Flore	434,772	4,823	17,207	456,802	1.72
Okmulgee	1,507,374	6,410	15,295	1,529,079	1.79
Pittsburg	2,127,114	26,964	133,346	2,287,424	2.34
Tulsa	123,598	4,223	730	128,551	2.15
Other counties [a]	217,191	6,543	4,360	228,094	2.01
Small mines		9,452		9,452	2.46
	7,164,358	83,088	277,981	7,525,427	2.09
Average value per ton	2.11	2.44	1.56	2.09	

[a] Includes Atoka, Haskell, Rogers, and Wagoner.

Coal produced in Oklahoma in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Coal	545,422	7,221	29,127	581,770	1,173	138	1,311	202
Latimer	796,472	8,782	36,008	841,262	1,014	335	1,349	224
Le Flore	266,830	2,066	16,343	285,239	489	128	617	189
Okmulgee	1,031,030	3,265	17,453	1,051,748	1,809	305	2,114	211
Pittsburg	1,184,377	8,269	86,417	1,279,063	2,223	422	2,645	214
Tulsa	68,937	4,200	....	73,137	100	16	116	234
Other counties [a]	259,094	3,168	3,842	266,104	209	134	343	215
Small mines [b]	....	8,521	....	8,521	....	....	....	....
	4,152,162	45,492	189,190	4,386,844	7,017	1,478	8,495	211

[a] Atoka, Haskell, Rogers, and Wagoner. [b] Includes Craig County.

Value of coal produced in Oklahoma in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Coal	$1,481,767	$21,303	$71,187	$1,574,257	$2.71
Latimer	2,307,173	25,366	95,037	2,427,576	2.89
Le Flore	664,997	5,704	34,855	705,556	2.47
Okmulgee	2,763,567	10,832	36,368	2,810,767	2.67
Pittsburg	3,675,766	31,062	197,505	3,904,333	3.05
Tulsa	203,299	10,400	....	213,699	2.92
Other counties [a]	658,216	10,672	6,156	675,044	2.54
Small mines [b]	....	24,181	....	24,181	2.84
	11,754,785	139,520	441,108	12,335,413	2.81
Average value per ton	2.83	3.07	2.33	2.81	....

[a] Atoka, Haskell, Rogers, and Wagoner. [b] Includes Craig County.

Coal produced in Oklahoma, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Atoka and Haskell	....	....	....	82,752	230,174	+ 147,422
Coal	889,299	676,292	556,479	524,954	581,770	+ 56,816
Haskell and Latimer	738,679	[a] 666,274	[a] 740,869	[a] 810,504	[a] 841,262	+ 30,758
Le Flore	201,853	264,023	256,642	266,162	285,239	+ 19,077
Okmulgee	820,659	905,128	869,244	852,206	1,051,748	+ 199,542
Pittsburg	1,429,350	1,373,771	1,132,272	977,043	1,279,063	+ 302,020
Rogers and Wagoner	31,067	29,568	20,943	30,817	35,930	+ 5,113
Tulsa	52,300	68,792	96,160	59,730	73,137	+ 13,407
Small mines	2,563	4,765	[b] 20,971	3,843	[c] 8,521	+ 4,678
	4,165,770	3,988,613	3,693,580	3,608,011	4,386,844	+ 778,833
Total value	$8,542,748	$8,204,015	$7,435,906	$7,525,427	$12,335,413	+$4,809,986

[a] Latimer County only. [b] Includes Atoka County. [c] Includes Craig County.

OREGON.

The first production of coal in Oregon recorded by the Geological Survey was in 1880 and exceeded the output in 1917. The production in 1917, 28,327 tons, was in fact the lowest recorded in any year for that State, where, however, coal has never ranked as a mineral of importance.

Coal produced in Oregon, 1913–1917.

Year.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
1913	31,582	8,617	5,864	46,063	$116,724	$2.53	203	283
1914	37,152	5,798	8,608	51,558	143,556	2.78	190	266
1915	30,142	2,272	6 817	39,231	111,240	2.84	151	206
1916	28,373	7,482	6,737	42,592	113,976	2.68	106	236
1917	13,736	9,087	5,504	28,327	95,663	3.38	104	251

PENNSYLVANIA.

PENNSYLVANIA ANTHRACITE.

PRODUCTION.

The production of Pennsylvania anthracite (including the output of the Bernice Basin) in 1917 was 88,939,117 gross tons (99,611,811 net tons), valued at $283,650,723, compared with 78,195,083 gross tons (87,578,493 net tons), valued at $202,009,561, in 1916, and 81,718,680 gross tons (91,524,922 net tons) in 1913, the highest previous record. The increase over 1916 was 13.8 per cent and over 1913, 8.8 per cent.

The demand, particularly for the prepared or domestic sizes, was strong throughout the year, notwithstanding the tendency on the part of many buyers to withhold their purchases during the summer or storage season in the expectation of lower prices under governmental control. The requirements of the country for anthracite for domestic use, for the military uses of the Government, for water-gas manufacture, and for industrial purposes to replace coke withdrawn for the iron industry, were greater in 1917 than in any previous period. The increase in demand began in 1916 and in that year and in the first three months of 1917 the consumption of anthracite was greater than the production by several million tons, the difference having been taken from the storage piles of the larger anthracite companies in the Eastern States and from the upper Lake docks in the Northwest.

The smaller or steam sizes of anthracite, buckwheat No. 1, and finer, were in great demand in 1917. The shortage of bituminous coal in the Eastern States was pronounced throughout the year, and the fine sizes of anthracite were eagerly sought as substitutes or for mixture with bituminous coal by industrial plants, especially during the last third of the year. This abnormally large demand, together with the fact that no restrictions with respect to mine prices were fixed by the Government, caused the business of washeries operating on culm piles and of dredges to flourish. The output of bank and river coal from washeries and dredges increased 53.4 per cent, compared with 11.5 per cent increase in freshly mined anthracite.

With the exception of Sullivan County (Bernice Basin), all the regions recorded increases in 1917 over 1916, the Schuylkill region 10.7 per cent, the Lehigh region 19.9 per cent, and the Wyoming region 14.0 per cent. The output of Sullivan County decreased 3.3 per cent.

The shipments reported to the Geological Survey include Sullivan County, the product of dredges, and all local shipments within the region, and in 1917 amounted to 77,490,043 gross tons, valued at $269,193,801 at the breaker, an average value per gross ton of $3.47, compared with $3.05 per ton in 1916. Shipments of freshly mined anthracite had an average value per ton of $3.58 in 1917, against $2.94 in 1916; the average value of washery product was $2.04 in 1917 and $1.24 in 1916; and the average value of dredge product was $1.50 in 1917 and $0.81 in 1916. The washery and dredge products are largely steam sizes and the proportionately greater increase in value is due to the fact that prices were regulated solely by the law of supply and demand, whereas prices of prepared or domestic sizes if not actually regulated by the Government prior to the establishment of the Fuel Administration were carefully scrutinized and restrained from the time the United States entered the war.

The quantity of anthracite sold locally and used by employees increased from 1,978,649 gross tons, valued at $4,619,356, or $2.33 per ton, in 1916 to 2,127,109 tons, valued at $6,070,907. or $2.85 per ton, in 1917.

Anthracite used at the mines and breakers for steam and heat represents more than 10 per cent of the total output. In 1917 the quantity so used was 9,321,965 gross tons, or 10.5 per cent of the total output, compared with a maximum in recent years of 11.25 per cent in 1915. The percentage of fuel required for operating the mines and breakers may be expected to increase in future years because of the greater depth of the workings and because of the mining of thinner beds of coal. The more extensive development of central power stations and the use of lower grades of coal will continue as in recent years to offset the requirement of larger quantities of anthracite as mine fuel.

Anthracite produced in 1890–1917.

Year.	Quantity. (gross tons).	Value.	Year.	Quantity (gross tons).	Value.
1890	41,489,858	a $66,383,772	1912	75,322,855	$177,622,626
1895	51,785,122	a 82,019,272	1913	81,718,680	195,181,127
1900	51,221,353	a 85,757,851	1914	81,090,631	188,181,399
1905	69,339,152	a 141,879,000	1915	79,459,876	184,653,498
1910	75,433,246	160,275,302	1916	78,195,083	202,009,561
1911	80,771,488	175,189,392	1917	88,939,117	283,650,723

a Excludes value of coal used at collieries.

Anthracite produced in 1916 and 1917.

Region.	Shipments.		Sold to local trade and employees.		Mine fuel.		Total production.		Men employed.			Average number of days worked.
	Gross tons.	Value.	Gross tons.	Value.	Gross tons.	Value.	Gross tons.	Value.	Underground.	Surface.	Total.	
1916.												
Lehigh:												
Freshly mined coal	9,125,745	$25,944,901	269,686	$499,231	1,153,480	$661,116	10,548,911	$27,105,248	13,185	6,119	19,304	262
Washery product	311,800	556,834	3,650	4,946	64,694	33,226	380,144	595,006	....	211	211	105
	9,437,545	26,501,735	273,336	504,177	1,218,174	694,342	10,929,055	27,700,254	13,185	6,330	19,515	261
Average value per ton	$2.81		$1.84		$0.57		$2.53		....	....	....	....
Schuylkill:												
Freshly mined coal	18,577,444	52,863,290	398,889	1,007,061	3,280,583	1,249,388	22,256,916	55,119,739	32,801	14,204	47,005	254
Washery product	1,073,137	1,379,144	372	856	189,494	99,199	1,263,003	1,479,199	....	741	741	236
Dredge product	26,895	20,976	58,425	59,357	54,209	24,891	139,529	105,224	....	118	118	175
	19,677,476	54,263,410	457,686	1,067,274	3,524,286	1,373,478	23,659,448	56,704,162	32,801	15,063	47,864	254
Average value per ton	$2.76		$2.33		$0.39		$2.40		....	....	....	....
Wyoming:												
Freshly mined coal	36,223,557	109,757,517	1,155,534	2,953,453	3,354,968	1,682,018	40,734,059	114,392,988	70,022	20,474	90,496	252
Washery product	1,719,277	1,904,169	81,422	68,153	573,193	264,355	2,373,892	2,236,677	21	971	992	231
Dredge product	2,500	2,875	981	2,582	300	150	3,781	5,607	7	53	60	153
	37,945,334	111,664,561	1,237,937	3,024,188	3,928,461	1,946,523	43,111,732	116,635,272	70,050	21,498	91,548	252
Average value per ton	$2.94		$2.44		$0.50		$2.71		....	....	....	....
Sullivan County:												
Freshly mined coal	441,008	907,181	9,690	23,717	44,150	38,975	494,848	969,873	669	273	942	223
Average value per ton	$2.06		$2.45		$0.88		$1.96		....	....	....	....
Total freshly mined coal	64,367,754	189,472,889	1,833,799	4,483,462	7,833,181	3,631,497	74,034,734	197,587,848	116,677	41,070	157,747	....
Average value per ton	$2.94		$2.44		$0.46		$2.67		....	....	....	....
Total washery product	3,104,214	3,840,147	85,444	73,955	827,381	396,780	4,017,039	4,310,882	21	1,923	1,944	219
Average value per ton	$1.24		$0.87		$0.48		$1.07		....	....	....	....
Total dredge product	29,395	23,851	59,406	61,939	54,509	25,041	143,310	110,831	7	171	178	168
Average value per ton	$0.81		$1.04		$0.46		$0.77		....	....	....	....
Grand total	[a] 67,501,363	193,336,887	1,978,649	4,619,356	8,715,071	4,053,318	78,195,083	202,009,561	116,705	43,164	159,869	253
Average value per ton	$2.86		$2.33		$0.47		$2.58		....	....	....	....

[a] Includes 24,286 tons of coal sold locally and not shipped and 2,090 tons used as fuel.

Anthracite produced in 1916 and 1917—Continued.

Region.	Shipments.		Sold to local trade and employees.		Mine fuel.		Total production.		Men employed.			Average number of days worked.
	Gross tons.	Value.	Gross tons.	Value.	Gross tons.	Value.	Gross tons.	Value.	Under-ground.	Surface.	Total.	
1917.												
Lehigh:												
Freshly mined coal	10,503,941	$37,228,470	335,488	$748,733	1,272,068	$1,415,509	12,111,497	$39,392,712	12,454	6,662	19,116	292
Washery product	953,022	2,207,667	6,187	3,471	38,624	22,317	997,833	2,233,455	....	180	180	232
	11,456,963	39,436,137	341,675	752,204	1,310,692	1,437,826	13,109,330	41,626,167	12,454	6,842	19,296	292
Average value per ton		$3.44		$2.20		$1.10		$3.18	....	....	....	....
Schuylkill:												
Freshly mined coal	20,349,001	72,846,775	432,014	1,299,150	3,465,017	2,381,973	24,246,032	76,527,898	29,012	14,056	43,068	283
Washery product	1,634,742	3,783,948	78	292	163,439	195,147	1,798,259	3,979,387	....	954	954	285
Dredge product	44,312	65,080	53,512	71,128	51,602	64,682	149,426	200,890	....	121	121	166
	22,028,055	76,695,803	485,604	1,370,570	3,680,058	2,641,802	26,193,717	80,708,175	29,012	15,131	44,143	282
Average value per ton		$3.48		$2.82		$0.72		$3.08	....	....	....	....
Wyoming:												
Freshly mined coal	40,797,136	146,831,874	1,282,496	3,895,399	3,643,026	3,786,228	45,722,658	154,513,501	67,870	20,639	88,509	283
Washery product	2,777,753	4,962,053	6,928	16,957	647,009	453,209	3,431,690	5,432,219	38	1,342	1,380	c 390
Dredge product	2,880	5,724	....	....	80	140	2,960	5,864	....	5	5	150
	43,577,769	151,799,651	1,289,424	3,912,356	4,290,115	4,239,577	49,157,308	159,951,584	67,908	21,986	89,894	284
Average value per ton		$3.48		$3.03		$0.99		$3.25	....	....	....	....
Sullivan County:												
Freshly mined coal	427,256	1,262,210	10,406	35,777	41,100	66,810	478,762	1,364,797	615	226	841	275
	427,256	1,262,210	10,406	35,777	41,100	66,810	478,762	1,364,797	615	226	841	275
Average value per ton		$2.95		$3.44		$1.63		$2.85	....	....	....	....
Total freshly mined coal	72,077,334	258,169,329	2,060,404	5,979,059	8,421,211	7,650,520	82,558,949	271,798,908	109,951	41,583	151,534	284
Average value per ton		$3.58		$2.90		$0.91		$3.29	....	....	....	....
Total washery product	5,365,517	10,953,668	13,193	20,720	849,072	670,673	6,227,782	11,645,061	38	2,476	2,514	339
Average value per ton		$2.04		$1.57		$0.79		$1.87	....	....	....	....
Total dredge product	47,192	70,804	53,512	71,128	51,682	64,822	152,386	206,754	....	126	126	165
Average value per ton		$1.50		$1.33		$1.25		$1.36	....	....	....	....
Grand total	a 77,490,043	b 269,193,801	2,127,109	6,070,907	9,321,965	8,386,015	88,939,117	283,650,723	109,989	44,185	154,174	285
Average value per ton		$3.47		$2.85		$0.90		$3.19	....	....	....	....

a Includes 29,760 tons sold locally and used at mines.

b Includes the value of 55,728 tons sold locally and used at mines.

c Part night shifts.

SHIPMENTS.

Anthracite shipped from the Schuylkill, Lehigh, and Wyoming regions in 1807 and from 1820 to 1917, in gross tons.[a]

Year.	Schuylkill region.		Lehigh region.		Wyoming region.		Total.
	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.
1807					55		55
1820			365				365
1821			1,073				1,073
1822	1,480	39.79	2,240	60.21			3,720
1823	1,128	16.23	5,823	83.77			6,951
1824	1,567	14.10	9,541	85.90			11,108
1825	6,500	18.60	28,393	81.40			34,893
1826	16,767	34.90	31,280	65.10			48,047
1827	31,360	49.44	32,074	50.56			63,434
1828	47,284	61.00	30,232	39.00			77,516
1829	79,973	71.35	25,110	22.40	7,000	6.25	112,083
1830	89,984	51.50	41,750	23.90	43,000	24.60	174,734
1831	81,854	46.29	40,966	23.17	54,000	30.54	176,820
1832	209,271	57.61	70,000	19.27	84,000	23.12	363,271
1833	252,971	51.87	123,001	25.22	111,777	22.91	487,749
1834	226,692	60.19	106,244	28.21	43,700	11.60	376,636
1835	339,508	60.54	131,250	23.41	90,000	16.05	560,758
1836	432,045	63.16	148,211	21.66	103,861	15.18	684,117
1837	530,152	60.98	223,902	25.75	115,387	13.27	869,441
1838	446,875	60.49	213,615	28.92	78,207	10.59	738,697
1839	475,077	58.05	221,025	27.01	122,300	14.94	818,402
1840	490,596	56.75	225,313	26.07	148,470	17.18	864,379
1841	624,466	65.07	143,037	14.90	192,270	20.03	959,773
1842	583,273	52.62	272,540	24.59	252,599	22.79	1,108,412
1843	710,200	56.21	267,793	21.19	285,605	22.60	1,263,598
1844	887,937	54.45	377,002	23.12	365,911	22.43	1,630,850
1845	1,131,724	56.22	429,453	21.33	451,836	22.45	2,013,013
1846	1,308,500	55.82	517,116	22.07	518,389	22.11	2,344,005
1847	1,665,735	57.79	633,507	21.98	583,067	20.23	2,882,309
1848	1,733,721	56.12	670,321	21.70	685,196	22.18	3,089,238
1849	1,728,500	53.30	781,556	24.10	732,910	22.60	3,242,966
1850	1,840,620	54.80	690,456	20.56	827,823	24.64	3,358,899
1851	2,328,525	52.34	964,224	21.68	1,156,167	25.98	4,448,916
1852	2,636,835	52.81	1,072,136	21.47	1,284,500	25.72	4,993,471
1853	2,665,110	51.30	1,054,309	20.29	1,475,732	28.41	5,195,151
1854	3,191,670	53.14	1,207,186	20.13	1,603,478	26.73	6,002,334
1855	3,552,943	53.77	1,284,113	19.43	1,771,511	26.80	6,608,567
1856	3,603,029	52.01	1,351,970	19.52	1,972,581	28.47	6,927,580
1857	3,373,797	50.77	1,318,541	19.84	1,952,603	29.39	6,644,941
1858	3,273,245	47.86	1,380,030	20.18	2,186,094	31.96	6,839,369
1859	3,448,708	44.16	1,628,311	20.86	2,731,236	34.98	7,808,255
1860	3,749,632	44.04	1,821,674	21.40	2,941,817	34.56	8,513,123
1861	3,160,747	39.74	1,738,377	21.85	3,055,140	38.41	7,954,264
1862	3,372,583	42.86	1,351,054	17.17	3,145,770	39.97	7,869,407
1863	3,911,683	40.90	1,894,713	19.80	3,759,610	39.30	9,566,006
1864	4,161,970	40.89	2,054,669	20.19	3,960,836	38.92	10,177,475
1865	4,356,959	45.14	2,040,913	21.14	3,254,519	33.72	9,652,391
1866	5,787,902	45.56	2,179,364	17.15	4,736,616	37.29	12,703,882
1867	5,161,671	39.74	2,502,054	19.27	5,325,000	40.99	12,988,725
1868	5,330,737	38.62	2,502,582	18.13	5,968,146	43.25	13,801,465
1869	5,775,138	41.66	1,949,673	14.06	6,141,369	44.28	13,866,180
1870	4,968,157	30.70	3,239,374	20.02	7,974,660	49.28	16,182,191
1871	6,552,772	41.74	2,235,707	14.24	6,911,242	44.02	15,699,721
1872	6,694,890	34.03	3,873,339	19.70	9,101,549	46.27	19,669,778
1873	7,212,601	33.97	3,705,596	17.46	10,309,755	48.57	21,227,952
1874	6,866,877	34.09	3,773,836	18.73	9,504,408	47.18	20,145,121
1875	6,281,712	31.87	2,834,605	14.38	10,596,155	53.75	19,712,472
1876	6,221,934	33.63	3,854,919	20.84	8,424,158	45.53	18,501,011
1877	8,195,042	39.35	4,332,760	20.80	8,300,377	39.85	20,828,179
1878	6,282,226	35.68	3,237,449	18.40	8,085,587	45.92	17,605,262
1879	8,960,829	34.28	4,595,567	17.58	12,586,293	48.14	26,142,689
1880	7,554,742	32.23	4,463,221	19.05	11,419,279	48.72	23,437,242

a 1914–1917, inclusive of dredge shipments.

Anthracite shipped from the Schuylkill, Lehigh, and Wyoming regions in 1807 and from 1820 to 1917, in gross tons—Continued.

Year.	Schuylkill region.		Lehigh region.		Wyoming region.		Total.
	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.	Percentage.	Quantity.
1881	9,253,958	32.46	5,294,676	18.58	13,951,383	48.96	28,500,017
1882	9,459,288	32.48	5,689,437	19.54	13,971,371	47.98	29,120,096
1883	10,074,726	31.69	6,113,809	19.23	15,604,492	49.08	31,793,027
1884	9,478,314	30.85	5,562,226	18.11	15,677,753	51.04	30,718,293
1885	9,488,426	30.01	5,898,634	18.65	16,236,470	51.34	31,623,530
1886	9,381,407	29.19	5,723,129	17.81	17,031,826	53.00	32,136,362
1887	10,609,028	30.63	4,347,061	12.55	19,684,929	56.82	34,641,018
1888	10,654,116	27.93	5,639,236	14.78	21,852,366	57.29	38,145,718
1889	10,486,185	29.28	6,294,073	17.57	19,036,835	53.15	35,817,093
1890	10,867,822	29.68	6,329,658	17.28	19,417,979	53.04	36,615,459
1891	12,741,258	31.50	6,381,838	15.78	21,325,240	52.72	40,448,336
1892	12,626,784	30.14	6,451,076	15.40	22,815,480	54.46	41,893,340
1893	12,357,444	28.68	6,892,352	15.99	23,839,741	55.33	43,089,537
1894	12,035,005	29.08	6,705,434	16.20	22,650,761	54.72	41,391,200
1895	14,269,932	30.68	7,298,124	15.69	24,943,421	53.63	46,511,477
1896	13,097,571	30.34	6,490,441	15.03	23,589,473	54.63	43,177,485
1897	12,181,061	29.26	6,249,540	15.00	23,207,263	55.74	41,637,864
1898	12,078,875	28.83	6,253,109	14.92	23,567,767	56.25	41,899,751
1899	14,199,009	29.79	6,887,909	14.45	26,578,286	55.76	47,665,204
1900	13,502,732	29.94	6,918,627	15.33	24,686,125	54.73	45,107,484
1901	16,019,591	29.92	7,211,974	13.45	30,337,036	56.63	53,568,601
1902	8,471,391	27.15	3,470,736	11.12	19,258,763	61.73	31,200,890
1903	16,474,790	27.75	7,164,783	12.07	35,723,258	60.18	59,362,831
1904	16,379,293	28.49	7,107,220	12.36	34,006,009	59.15	57,492,522
1905	17,703,099	28.83	7,849,205	12.78	35,857,897	58.39	61,410,201
1906	16,011,285	28.75	7,046,617	12.65	32,640,693	58.60	55,698,595
1907	20,141,288	30.01	8,329,653	12.41	38,638,452	57.58	67,109,393
1908	18,006,464	27.85	7,786,255	12.04	38,872,295	60.11	64,665,014
1909	16,864,147	27.21	7,532,271	12.16	37,573,467	60.63	61,969,885
1910	17,845,020	27.49	8,627,539	13.29	38,433,227	59.22	64,905,786
1911	19,118,300	27.38	9,682,147	13.86	41,033,354	58.76	69,833,801
1912	18,213,960	28.16	8,800,125	13.61	37,653,164	58.23	64,667,249
1913	19,417,385	27.44	10,180,021	14.39	41,160,906	58.17	70,758,312
1914	18,416,586	26.33	10,272,308	14.69	41,258,463	58.98	69,947,357
1915	18,043,709	26.46	10,190,421	14.95	39,945,344	58.59	68,179,474
1916	19,677,476	29.34	9,437,545	14.07	37,945,335	56.59	67,060,356
1917	22,028,055	28.58	11,456,963	14.87	43,577,769	56.55	77,062,787
	692,285,206	30.95	343,502,627	15.36	1,201,117,944	53.69	2,236,905,777

The proportions of sizes in the output of the breakers remain fairly constant from year to year. In the years 1913 to 1916 the percentage of freshly mined anthracite marketed in sizes above pea was from 62.2 to 63.3, but in 1917 the percentage increased to 64.7, whereas the percentage of pea size in 1913 to 1916 was from 11.2 to 12.1 but decreased in 1917 to 8.7 for the reason, it is understood, that pea coal was more or less commonly mixed with chestnut, the next larger size. The greatly increased production of washery and dredge coal is reflected in the increase in the percentage of size below pea in the total of all production from 26.9 per cent in 1913 and 28.5 per cent in 1916 to 30.3 per cent in 1917.

Anthracite shipped in 1916 and 1917, by regions and sizes, in gross tons.

Size.	Lehigh region.		Schuylkill region.			Wyoming region.			Sullivan County.	Total.	Percentage of total.
	Mines.	Washeries.	Mines.	Washeries.	Dredges.	Mines.	Washeries.	Dredges.	Mines.		
1916.											
Lump	6,598	0	86,984	0	0	25,980	0	0	0	119,562	0.2
Broken	422,134	0	884,671	0	0	2,226,024	0	0	10,497	3,543,326	5.2
Egg	1,168,670	5,220	2,097,981	214	0	5,170,986	257	0	43,704	8,487,032	12.6
Stove	1,782,280	7,885	3,435,862	7,562	100	8,298,618	486	0	66,003	13,598,796	20.1
Chestnut	1,895,311	58,447	3,810,027	46,704	0	9,072,939	45,071	0	70,000	14,998,499	22.2
Pea	1,119,934	50,685	2,380,968	134,307	232	3,669,496	112,051	0	53,131	7,520,804	11.1
Buckwheat No. 1	1,304,711	39,252	3,435,643	302,013	3,790	4,176,258	267,150	1,000	40,000	9,569,817	14.2
Buckwheat No. 2	627,820	52,546	1,328,136	236,254	2,693	1,619,330	694,941	1,000	20,000	4,582,720	6.8
Buckwheat No. 3	502,521	92,135	712,191	211,321	14,730	1,266,882	521,760	500	20,000	3,342,040	5.0
Boiler	264,044	5,630	283,983	94,666	0	661,539	77,236	0	7,778	1,394,876	2.1
Other	31,722	0	120,998	40,096	5,350	35,505	325	0	109,895	343,891	.5
	9,125,745	311,800	18,577,444	1,073,137	26,895	36,223,557	1,719,277	2,500	441,008	67,501,363	100.0
1917.											
Lump	15,176	....	104,521	....	....	34,900	....	....	....	154,597	0.2
Broken	485,577	1,061	1,032,732	....	....	2,990,125	....	....	22,394	4,531,889	5.9
Egg	1,386,859	13,743	2,517,914	3,478	....	6,456,305	11,295	....	41,861	10,431,455	13.5
Stove	1,902,895	14,167	3,577,834	12,888	200	8,715,512	41,829	....	59,180	14,324,505	18.5
Chestnut	2,296,760	176,741	4,335,248	120,871	....	10,594,746	159,303	....	69,780	17,753,449	22.8
Pea	1,066,363	87,827	2,104,780	246,012	523	3,078,971	190,471	300	48,756	6,824,003	8.8
Buckwheat No. 1	1,531,493	123,049	3,553,580	461,008	4,997	5,170,433	814,616	....	....	11,659,176	15.0
Buckwheat No. 2	806,394	168,497	1,239,449	258,882	5,434	2,389,077	1,251,822	....	....	6,119,555	7.9
Buckwheat No. 3	538,490	314,998	1,274,067	272,642	13,325	451,897	208,265	....	....	3,073,684	4.0
Boiler	294,521	51,487	366,853	227,073	18,483	645,565	82,513	2,580	....	1,689,075	2.2
Other[a]	179,413	1,452	242,023	31,888	1,350	269,605	17,639	....	185,285	928,655	1.2
	10,503,941	953,022	20,349,001	1,634,742	44,312	40,797,136	2,777,753	2,880	427,256	77,490,043	100.0

[a] Includes quantity reported as culm, buckwheat No. 4, buckwheat No. 5, screenings, and mine run.

Anthracite shipped, 1913–1917, by sizes, in gross tons.

	Sizes above pea.		Pea.		Sizes below pea.		Total.
	Gross tons.	Percentage of total.	Gross tons.	Percentage of total.	Gross tons.	Percentage of total.	Gross tons.
1913:							
Freshly mined coal	43,781,936	63.3	8,056,919	11.6	17,366,691	25.1	69,205,546
Total shipments	43,935,224	61.6	8,209,479	11.5	19,198,469	26.9	71,343,172
1914:							
Freshly mined coal	43,112,545	62.8	8,142,829	11.8	17,472,101	25.4	68,727,475
Total shipments	43,176,836	61.3	8,277,619	11.7	19,009,591	27.0	70,464,046
1915:							
Freshly mined coal	41,125,513	62.2	8,011,934	12.1	17,036,370	25.7	66,173,817
Total shipments	41,213,703	60.0	8,210,668	12.0	19,242,085	28.0	68,666,456
1916:							
Freshly mined coal	40,575,269	63.1	7,223,529	11.2	16,568,956	25.7	64,367,754
Total shipments	40,747,215	60.4	7,520,804	11.1	19,233,344	28.5	67,501,363
1917:							
Freshly mined coal	46,640,319	64.7	6,298,870	8.7	19,138,145	26.6	72,077,334
Total shipments	47,195,895	60.9	6,824,003	8.8	23,470,145	30.3	77,490,043

Shipments by months, 1913–1917, as reported by the Anthracite Bureau of Information, are given in the following tables:

Anthracite shipped in 1913–1917, by months, in gross tons.[b]

Month.	1913[a]	1914[a]	1915	1916	1917
January	6,336,419	5,175,732	4,833,599	5,884,350	5,940,725
February	5,674,169	4,121,451	4,349,915	5,696,306	5,178,432
March	4,909,288	5,164,703	5,075,293	6,127,351	6,989,075
April	5,966,189	6,072,164	6,655,625	4,528,784	5,592,299
May	5,995,742	6,281,553	5,954,949	5,547,899	6,917,525
June	5,970,047	6,130,186	5,459,610	5,636,975	7,049,037
July	5,487,852	5,391,857	5,103,665	5,432,878	6,724,252
August	5,369,900	5,483,743	5,462,127	5,531,797	7,013,996
September	5,572,279	6,246,192	5,662,157	5,544,076	6,372,756
October	6,338,194	6,644,476	6,683,007	5,870,204	7,110,950
November	5,786,931	5,928,286	6,494,442	5,992,997	6,545,313
December	5,662,618	5,702,258	6,149,387	5,582,747	5,698,945
	69,069,628	68,342,601	67,883,776	67,376,364	77,133,305

[a] The figures for the Lehigh & New England R. R. are not included in 1913 and 1914, and the totals for these years are therefore not comparable with 1915, 1916, and 1917.
[b] Does not include shipments from Sullivan County nor from dredges.

LABOR STATISTICS.

Statistics of labor employed in the production of Pennsylvania anthracite in 1916 and 1917 are given in the following table. In the Wyoming district only were machines reported in use in the mining of anthracite. In 1916, 172 machines were used to produce 1,642,000 gross tons; in 1917, 155 machines produced 1,746,000 gross tons. Anthracite recovered from steam-shovel pits in 1916 was 1,774,800 gross tons, compared with 2,055,000 gross tons in 1917. One hundred and five steam shovels were in use in 1916, and 76 in 1917. In 1917 there were 244 active breakers, 59 washeries, and 26 dredges.

Men employed in the anthracite regions, 1916 and 1917, by regions.

	1916			1917		
	Underground.	Surface.	Total.	Underground.	Surface.	Total.
Lehigh district:						
Breakers	13,185	6,119	19,304	12,454	6,662	19,116
Washeries		211	211		180	180
Total	13,185	6,330	19,515	12,454	6,842	19,296
Change in 1917				−731	+512	−219
Percentage of change				−5.5	+8.1	−1.1
Schuylkill district:						
Breakers	32,801	14,204	47,005	29,012	14,056	43,068
Washeries		741	741		954	954
Dredges		118	118		121	121
Total	32,801	15,063	47,864	29,012	15,131	44,143
Change in 1917				−3,789	+68	−3,721
Percentage of change				−11.6	+5	−7.8
Wyoming district:						
Breakers	70,022	20,474	90,496	67,870	20,639	88,509
Washeries		992	992		1,380	1,380
Dredges		60	60		5	5
Total	70,022	21,526	91,548	67,870	22,024	89,894
Change in 1917				−2,152	+498	−1,654
Percentage of change				−3.1	+2.3	−1.8
Sullivan County:						
Breakers	669	273	942	615	226	841
Change in 1917				−54	−47	−101
Percentage of change				−8.1	−17.2	−10.7
Grand total	116,677	43,192	159,869	109,951	44,223	154,174
Change in 1917				−6,726	+1,031	−5,695
Percentage of change				−5.8	+2.4	−3.6

VALUE OF ANTHRACITE.

The value of anthracite reported to the Geological Survey and shown in this report is the value at the breaker less degradation losses and selling costs. The dollars received from the sale of each size are reported and these amounts are divided by the total shipments of each size, the figure thus obtained representing the average realization price per ton.

Value of anthracite shipped in 1916, by regions and sizes.

Size.	Lehigh region.				Schuylkill region.					
	Mines.	Average value.	Washeries.	Average value.	Mines.	Average value.	Washeries.	Average value.	Dredges.	Average value.
Lump	$26,331	$3.99	$0	$0	$293,531	$3.37	$0	$0	$0	$0
Broken	1,349,753	3.20	0	0	2,925,979	3.21	0	0	0	0
Egg	4,390,201	3.76	19,636	3.76	7,895,656	3.76	685	3.20	0	0
Stove	6,933,405	3.89	31,559	4.00	13,703,757	3.99	28,507	3.77	377	3.77
Chestnut	7,586,884	4.00	233,220	3.99	15,562,132	4.08	201,198	4.31	0	0
Pea	2,702,897	2.41	118,806	2.34	5,786,791	2.43	328,046	2.44	183	.79
Buckwheat No. 1	1,822,326	1.40	49,587	1.26	4,898,092	1.43	423,669	1.40	4,029	1.06
Buckwheat No. 2	556,741	.89	41,501	.79	1,147,333	.86	197,295	.84	2,693	1.00
Buckwheat No. 3	325,974	.65	58,796	.64	434,174	.61	119,304	.56	9,166	.62
Boiler	243,298	.92	3,729	.66	170,207	.60	63,410	.67	0	0
Other	7,091	.22	0	0	45,638	.38	17,030	.42	4,528	.85
	25,944,901	2.84	556,834	1.79	52,863,290	2.85	1,379,144	1.29	20,976	.78

Value of anthracite shipped in 1916, by regions and sizes—Continued.

Size.	Wyoming region.						Sullivan County.		Total.	
	Mines.	Average value.	Washeries.	Average value.	Dredges.	Average value.	Mines.	Average value.		Average value.
Lump	$76,802	$2.96	$0	$0	$0	$0	$0	$0	$396,664	$3.32
Broken	7,121,270	3.20	0	0	0	0	31,864	3.04	11,428,866	3.23
Egg	19,139,198	3.70	951	3.70	0	0	124,390	2.85	31,570,717	3.72
Stove	30,915,946	3.73	1,817	3.74	0	0	181,393	2.75	51,796,761	3.81
Chestnut	34,972,749	3.85	176,601	3.92	0	0	187,283	2.68	58,920,067	3.93
Pea	8,381,511	2.28	262,419	2.34	0	0	109,768	2.07	17,690,421	2.35
Buckwheat No.1	6,384,955	1.53	397,833	1.49	1,150	1.15	73,600	1.84	14,055,241	1.47
Buckwheat No.2	1,529,585	.94	695,267	1.00	1,150	1.15	36,800	1.84	4,208,365	.92
Buckwheat No.3	738,616	.58	309,779	.59	575	1.15	36,800	1.84	2,033,184	.61
Boiler	485,377	.73	59,421	.77	0	0	14,294	1.84	1,039,736	.75
Other	11,508	.32	81	.25	0	0	110,989	1.01	196,865	.57
	109,757,517	3.03	1,904,169	1.11	2,875	1.15	907,181	2.06	193,336,887	2.86

Value of anthracite shipped in 1917, by regions and sizes.

State.	Lehigh region.				Schuylkill region.					
	Mines.	Average value.	Washeries.	Average value.	Mines.	Average value.	Washeries.	Average value.	Dredges.	Average value.
Lump	$71,249	$4.69			$454,315	$4.35				
Broken	1,959,940	4.04	$3,903	$3.68	4,349,743	4.21				
Egg	6,072,465	4.38	55,718	4.05	10,898,753	4.33	$14,091	$4.05		
Stove	8,564,135	4.50	59,607	4.21	16,251,417	4.54	59,562	4.62	$800	4.00
Chestnut	10,517,571	4.58	783,332	4.43	20,091,143	4.63	575,084	4.76		
Pea	3,585,138	3.36	284,645	3.24	6,626,854	3.15	734,734	2.99	1,947	3.72
Buckwheat No. 1	4,159,153	2.72	357,138	2.90	9,169,133	2.58	1,171,963	2.54	8,608	1.72
Buckwheat No. 2	1,144,962	1.42	268,637	1.59	2,346,748	1.89	489,174	1.89	9,874	1.82
Buckwheat No. 3	531,103	0.97	310,956	0.99	1,894,758	1.49	381,837	1.40	14,122	1.06
Boiler	542,700	1.84	81,652	1.59	500,349	1.36	333,122	1.47	27,123	1.47
Others	80,054	0.45	2,079	1.43	263,562	1.09	24,381	0.76	2,606	1.93
Total	37,228,470	3.54	2,207,667	2,32	72,846,775	3.58	3,783,948	2.31	65,080	1.47

State.	Wyoming region.						Sullivan County.		Total.	
	Mines.	Average value.	Washeries.	Average value.	Dredges.	Average value.	Mines.	Average value.	Total.	Average value.
Lump	$112,072	$3.21							$637,636	$4.12
Broken	11,374,169	3.80					$89,845	$4.01	17,777,600	3.92
Egg	26,789,815	4.15	$49,673	$4.40			165,431	3.95	44,045,946	4.22
Stove	37,311,857	4.28	170,224	4.07			232,599	3.93	62,650,201	4.37
Chestnut	46,072,502	4.35	697,953	4.38			297,268	4.26	79,034,853	4.45
Pea	9,272,144	3.01	617,409	3.24	$1,209	$4.03	156,008	3.20	21,280,088	3.12
Buckwheat No. 1	10,924,967	2.15	1,399,785	1.72					27,190,747	2.33
Buckwheat No. 2	3,114,398	1.30	1,534,235	1.23					8,908,028	1.46
Buckwheat No. 3	669,001	1.48	327,591	1.57					4,129,368	1.34
Boiler	795,260	1.23	140,900	1.71	4,515	1.75			2,425,621	1.44
Others	395,689	1.47	24,283	1.38			321,059	1.73	1,113,713	1.20
Total	146,831,874	3.60	4,962,053	1.79	5,724	1.99	1,262,210	2.95	269,193,801	3.47

GOVERNMENT PRICES.

The Committee on Coal Production of the Council of National Defense that in June, 1917, arranged with the producers of bituminous coal a schedule of maximum prices (the Peabody prices) made no change in the ruling prices of anthracite. The Federal Trade Commission had earlier in the year examined the current prices of anthracite and it was generally understood that the prices at the mines were satisfactory to that body. Shortly after the President under the authority granted by the Lever Act of August 10, 1917, had fixed a scale of maximum prices for bituminous coal, a schedule of maximum prices for Pennsylvania anthracite was announced. The statement was as follows:

EXECUTIVE ORDER OF THE PRESIDENT OF THE UNITED STATES OF AUGUST 23, 1917, EFFECTIVE SEPTEMBER 1, 1917, ISSUED AS PUBLICATION NO. 3 OF THE UNITED STATES FUEL ADMIMISTRATION, FIXING PRICES FOR ANTHRACITE COAL AT THE MINE.[1]

The following regulations shall apply to the intrastate, interstate, and foreign commerce of the United States, and the prices and margins referred to herein shall be in force pending further investigation or determination thereof by the President.

* * * * * * *

4. Effective September 1, 1917, the maximum prices per ton of 2,240 pounds free on board cars at the mines for the grades and sizes of anthracite coal hereinafter specified shall not exceed the prices indicated in paragraph 5 when such coal is produced and sold by the Philadelphia & Reading Coal & Iron Co., Lehigh Coal & Navigation Co., Lehigh & Wilkes-Barre Coal Co., Hudson Coal Co., Delaware & Hudson Co., Scranton Coal Co., Lehigh Valley Coal Co., Coxe Bros. & Co., Pennsylvania Coal Co., Hillside Coal & Iron Co., Delaware, Lackawanna & Western Railroad Co., Delaware, Lackawanna & Western Coal Co., Susquehanna Coal Co., Susquehanna Collieries Co., Lytle Coal Co., or the M. A. Hanna Coal Co.

5. The grades and sizes for which the maximum prices are specified are as follows: White ash anthracite coal of the grade that between January 1, 1915, and January 1, 1917, was uniformly sold and recognized in the coal trade as coal of white-ash grade; red ash anthracite coal of the grade that between January 1, 1915, and January 1, 1917, was uniformly sold and recognized in the trade as coal of red-ash grade; and Lykens Valley anthracite coal that is mined exclusively from the Lykens Valley seams and of the grade that between January 1, 1915, and January 1, 1917, was uniformly sold and recognized in the coal trade as coal of Lykens Valley grade.

White-ash grade:	
Broken	$4.55
Egg	4.45
Stove	4.70
Chestnut	4.80
Pea	4.00
Red-ash grade:	
Broken	4.75
Egg	4.65
Stove	4.90
Chestnut	4.90
Pea	4.10
Lykens Valley grade:	
Broken	5.00
Egg	4.90
Stove	5.30
Chestnut	5.30
Pea	4.35

6. Producers of anthracite coal who are not specified in paragraph 4 shall not sell the various grades and sizes of anthracite coal at prices that exceed by more than 75 cents per ton of 2,240 pounds free on board cars at the mines the prices enumerated in paragraph 5; *Provided*, That any producer of anthracite coal who incurs the expense of rescreening it at Atlantic or Lake ports for transshipment by water may increase the price thereof by not more than 5 cents per ton of 2,240 pounds.

[1] The omitted portion of this Executive order, paragraphs 1 to 3 thereof, deals with jobbers' margins.

7. Producers of anthracite coal specified in paragraph 4 of these regulations shall not sell anthracite coal to producers of anthracite coal not specified in paragraph 4.

8. Dealers and selling agents shall not sell coal produced by the producers included in paragraph 4 on the basis of the prices fixed at the mine for coal produced by producers not specified in said paragraph.

The price of pea coal in this order was about 60 cents above the current quotations, and by order of the Fuel Administrator was, on October 1, 1917, reduced by that amount. Effective December 1, 1917, the President authorized an increase of 35 cents a gross ton on all prices to cover the increase in wages granted mine labor.

PENNSYLVANIA BITUMINOUS.

The statement that the production of bituminous coal in Pennsylvania increased 2,152,718 tons, or 1.3 per cent, in 1917 does not convey the full significance of the history of the industry in that State. Although the production in 1917 of 172,448,142 tons of bituminous coal was the second highest recorded and only 1,333,000 tons below the mark attained in 1913, the increase over 1916 was below the average for the United States and far below the quantity required to supply the steadily increasing demands of the great industrial region of the North Atlantic and New England States.

Particular significance attaches to the fact that compared with an increase in total output of 2,152,718 tons, or 1.3 per cent, the shipments of bituminous coal from the mines to domestic users, industries, and railroads and for consumption at tidewater increased more than 5,700,000 tons, or 4.7 per cent, and the quantity used locally about the mines and loaded directly into engine tenders increased more than 1,000,000 tons, or 25 per cent. The decrease was in the quantity of coal made into beehive coke at the mines, 34,706,737 tons in 1917, against 39,526,106 tons in 1916, a decrease of 4,800,000 tons, or 12 per cent. In other words, there was an increase in coal shipped as coal of nearly 5 per cent and a decrease in coal shipped from the mines as coke of 12 per cent.

Two causes contributed to this result, the relative importance of which can not be accurately estimated. The car supply in the Connellsville region (Fayette and Westmoreland counties), where the greater part of the beehive coke is produced, was relatively less for loading coke than for loading coal, and the price of coal was proportionately greater for coal than coke, thereby inducing the operator, with the choice of loading his coal into cars or charging it into beehive ovens, to ship his product as coal. The average realization price at the mines in Fayette County for coal shipped in 1916 was $1.27, and in 1917, $2.48, a gain of 95 per cent, compared with $1.22 for coal charged into beehive ovens in 1916 and $2.07 in 1917, a gain of 70 per cent. This difference was due not to lack of demand for coke but to the fact that, with the limited car supply, the greater part of the output obtainable from the merchant ovens (those not owned nor controlled by the steel producing companies), was under contract at prices considerably below the current market quotations for coke and no greater than the prices for spot coal, to which market consequently a considerable portion of this product of the mines was diverted.

This condition obtained throughout the summer, even after the price of coal at the mines was fixed by the President, and until the price of coke was fixed by the War Industries Board as part of the regulation of iron and steel prices. This fixed price for Connellsville coke offered relatively more profit to the coal operators than the fixed price for coal, and hence, except as interfered with by contracts, the tendency after September was for production of coke rather than for shipment of coal. Scarcity of cars and inadequacy of transportation, however, limited the output materially in the last quarter of the year.

The total number of men employed in the production of bituminous coal in Pennsylvania in 1917 was 173,968, a gain of 5,756, or 3.4 per cent, over 1916, but about the same number as in 1915 and nearly 6 per cent below the number employed in 1914, the highest recorded. The increase of 3.4 per cent in the number of men was largely offset, however, by the decrease in efficiency of the labor, for the average daily output in tons per man fell from 3.91 in 1916 to 3.80 tons in 1917, or 2.8 per cent, and the average days worked in the State increased only 2, or 0.8 per cent. The decrease in the effectiveness of the labor was not due to change in the method of mining, for the proportion of machine-mined product remained constant in the two years at 55.4 per cent of the total, the number of mining machines reported in use increased from 5,768 in 1916 to 6,004 in 1917, and 31 steam shovels were reported in use in open-pit mining at the end of 1917, against none so reported in 1916. There was also a notable decrease in the time reported lost on account of strikes, the record for 1916 showing a total of 1,200,479 men-days, compared with 544,322 men-days in 1917, a decrease of more than half. The time lost because of strikes in 1917, however, was equivalent to more than 1 per cent of the total time worked and may be considered to have represented a loss in output comparable to the increase in total output for the State.

The portion of the bituminous region of Pennsylvania included in Blair, Cambria, Indiana, Jefferson, Clearfield, and the counties to the north and east, generally described as the Central Pennsylvania field, had an increase in production of 1,400,000 tons, or nearly 3 per cent; the Northwestern Pennsylvania field, Butler, Mercer, Armstrong, Clarion, Lawrence, and Beaver counties, had an increase of 261,500 tons, or 3 per cent; and Somerset County, an increase of 114,000 tons, or 1.2 per cent; and the Broad Top field, Bedford and Huntingdon counties, an increase of 418,736 tons, or 25 per cent, the largest in any district.

In southwestern Pennsylvania, Allegheny, Greene, and Washington counties, which roughly correspond to the Pittsburgh district, had an increase of 4,379,000 tons, or 12 per cent, but the important districts in Westmoreland and Fayette counties—including the Irwin Basin, Greensburg, Latrobe, Ligonier, and Connellsville districts—had a decrease of 4,638,742 tons, or 7 per cent. There was a notable increase in the reported output of the small mines not regularly tabulated by counties with the commercial mines. These mines, most of which are "country banks," had a very prosperous year, many without tipples loading coal into railroad cars on sidings from wagons or trucks. The output of these mines more than doubled, the recorded production in 1917 being 404,102 tons, compared with 200,108 tons in 1916.

The increase in central Pennsylvania and in Somerset County were largely attained by increase in labor supply, and in the Broad Top field by both increased labor supply and greater working time. The mines in the northwestern counties made their gain through the greater number of days worked. In the southwestern counties the supply of labor was slightly greater in Allegheny, Greene, and Washington counties, and less in Westmoreland and Fayette counties, and the respective increase and decrease in production in these districts was the result of gains and losses in days worked.

The statistics of production and value of the output of bituminous coal in Pennsylvania are given in the following tables:

Bituminous coal produced in Pennsylvania in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
						Underground.	Surface.	Total.	
Allegheny	15,915,161	638,181	452,408	1,681	17,007,431	15,319	2,128	17,447	237
Armstrong	5,115,517	158,939	155,732	....	5,430,188	5,111	990	6,101	246
Beaver	34,405	56,098	1,050	....	91,553	118	16	134	244
Bedford	546,953	14,581	12,258	147,795	721,587	1,022	136	1,158	231
Blair	377,163	1,884	11,920	44,825	435,792	514	67	581	255
Bradford and Lycoming	35,004	2,809	1,192	....	39,005	55	25	80	258
Butler	1,091,775	57,670	30,563	....	1,180,008	1,252	215	1,467	234
Cambria	16,833,310	1,121,485	304,568	1,328,987	19,588,350	19,034	2,322	21,356	252
Cameron and McKean	23,590	5,138	131	....	28,859	55	15	70	294
Center	1,728,385	88,880	1,742	....	1,819,007	1,917	224	2,141	256
Clarion	1,256,650	86,601	25,293	....	1,368,544	1,564	239	1,803	242
Clearfield	8,218,194	184,572	180,547	293,510	8,876,823	9,416	1,330	10,746	251
Clinton	406,586	12,818	2,658	....	422,062	335	78	413	281
Elk	882,394	34,449	20,740	....	937,583	1,054	206	1,260	242
Fayette	7,364,658	569,020	654,509	25,661,661	34,249,848	20,562	7,883	28,445	295
Greene	609,390	14,160	19,726	101,584	744,860	550	157	707	304
Huntingdon	867,802	29,496	19,593	45,441	962,332	1,289	113	1,402	247
Indiana	10,614,057	79,036	179,001	150,686	11,022,780	9,253	2,073	11,326	265
Jefferson	4,518,522	70,405	166,242	1,009,356	5,764,525	4,461	1,019	5,480	270
Lawrence and Mercer	565,853	6,990	42,151	....	614,994	798	160	958	262
Somerset	8,954,639	160,887	225,042	....	9,340,568	8,129	1,389	9,518	243
Tioga	789,762	29,773	10,026	....	829,561	1,326	210	1,536	229
Washington	16,353,087	269,177	305,927	1,191,162	18,119,353	16,782	2,352	19,134	229
Westmoreland	20,078,792	319,029	552,464	9,549,418	30,499,703	19,270	5,679	24,949	277
Small mines	....	200,108	....	....	200,108	....	.....	.....	....
	123,181,649	4,212,186	3,375,483	39,526,106	170,295,424	139,186	29,026	168,212	259

Value of bituminous coal produced in Pennsylvania in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total value.	Average value per ton.
Allegheny	$21,437,687	$920,527	$482,614	$1,576	$22,842,404	$1.34
Armstrong	6,176,298	163,388	187,898	....	6,527,584	1.20
Beaver	53,975	85,739	975	....	140,689	1.54
Bedford	991,671	20,255	15,853	180,537	1,208,316	1.67
Blair	577,071	2,838	12,291	47,245	639,445	1.47
Bradford and Lycoming	57,606	4,452	1,788	....	63,846	1.64
Butler	1,505,093	68,394	37,789	....	1,611,276	1.37
Cambria	23,852,633	1,696,436	365,331	2,087,036	28,001,436	1.43
Cameron and McKean	39,180	5,254	173	....	44,607	1.55
Center	2,638,452	123,480	2,158	....	2,764,090	1.52
Clarion	1,562,352	112,324	31,682	....	1,706,358	1.25
Clearfield	11,327,583	255,292	204,289	430,660	12,217,824	1.38
Clinton	571,985	20,915	2,886	....	595,786	1.41
Elk	1,106,387	43,215	23,458	....	1,173,060	1.25
Fayette	9,366,645	725,213	783,355	31,275,874	42,151,087	1.23
Greene	933,485	11,034	22,460	126,980	1,093,959	1.47
Huntingdon	1,174,065	46,039	24,878	57,700	1,302,682	1.35
Indiana	12,424,240	112,030	187,806	143,770	12,867,846	1.17
Jefferson	5,608,240	73,391	165,274	1,089,459	6,936,364	1.20
Lawrence and Mercer	851,026	10,540	55,853	....	917,419	1.49
Somerset	12,192,934	196,585	313,977	....	12,703,496	1.36
Tioga	1,427,484	58,846	17,022	....	1,503,352	1.81
Washington	22,391,997	387,061	357,557	1,073,530	24,210,145	1.34
Westmoreland	25,223,606	410,264	629,853	11,918,014	38,181,737	1.25
Small mines	....	280,367	....	....	280,367	1.40
	163,491,695	5,833,879	3,927,220	48,432,381	221,685,175	1.30
Average value per ton	1.33	1.39	1.16	1.23	1.30	....

Bituminous coal produced in Pennsylvania in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
						Underground.	Surface.	Total.	
Allegheny	16,538,226	999,313	297,292	1,546	17,836,377	14,261	2,591	16,852	253
Armstrong	5,200,366	145,752	228,743	....	5,574,861	5,101	1,056	6,157	256
Beaver	103,067	25,108	988	....	129,163	186	32	218	240
Bedford	736,625	20,979	14,427	175,022	947,053	1,316	178	1,494	250
Blair	177,325	46,900	6,857	40,516	271,598	285	80	365	266
Bradford and Lycoming	39,682	6,115	1,354	....	47,151	65	44	109	277
Butler	1,113,461	62,942	25,560	....	1,201,963	1,217	239	1,456	256
Cambria	16,686,302	1,353,173	293,292	1,398,003	19,730,770	19,650	3,000	22,650	253
Cameron and McKean	8,994	2,936	235	....	12,165	38	22	60	186
Center	1,956,618	41,093	1,696	....	1,999,407	2,044	287	2,331	253
Clarion	1,252,481	96,112	31,901	....	1,380,494	1,484	334	1,818	251
Clearfield	8,630,851	289,400	200,701	215,581	9,336,533	9,978	1,530	11,508	253
Clinton	383,138	16,029	2,645	....	401,812	318	70	388	297
Elk	867,606	14,438	25,143	....	907,187	977	246	1,223	282
Fayette	9,188,001	426,296	725,731	21,742,999	32,083,027	21,885	6,481	28,366	284
Greene	732,422	19,785	25,559	122,612	900,378	811	180	991	269
Huntingdon	1,078,835	10,515	21,248	45,004	1,155,602	1,235	176	1,411	274
Indiana	11,552,915	67,923	205,572	227,356	12,053,766	10,174	2,126	12,300	272
Jefferson	4,411,280	142,859	175,967	821,552	5,551,658	4,672	929	5,601	270
Lawrence	116,407	3,622	12,900	....	132,929	203	50	253	268
Mercer	481,615	7,722	38,084	....	527,421	644	246	890	263
Somerset	8,987,561	235,092	231,884	....	9,454,537	9,525	1,911	11,436	243
Tioga	821,804	33,570	11,429	....	866,803	1,286	217	1,503	251
Washington	19,449,476	366,916	347,853	1,349,358	21,513,603	16,896	3,209	20,105	251
Westmoreland	18,444,885	443,951	571,758	8,567,188	28,027,782	19,436	5,047	24,483	264
Small mines [a]	5,994	397,200	908	....	404,102	....	......	......	....
	128,965,937	5,275,741	3,499,727	34,706,737	172,448,142	143,687	30,281	173,968	261

[a] Includes Fulton County.

Value of bituminous coal produced in Pennsylvania in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total value.	Average value per ton.
Allegheny	$43,289,192	$2,220,207	$510,525	$3,246	$46,023,170	$2.58
Armstrong	13,943,453	301,221	572,586	....	14,817,260	2.66
Beaver	255,844	65,387	2,395	....	323,626	2.51
Bedford	2,208,872	48,282	30,605	332,467	2,620,226	2.77
Blair	462,539	88,044	12,381	68,047	631,011	2.32
Bradford and Lycoming	120,332	19,194	3,683	....	143,209	3.04
Butler	3,104,688	156,032	62,108	....	3,322,828	2.76
Cambria	44,048,699	3,101,227	648,924	3,175,426	50,974,276	2.58
Cameron and McKean	29,376	7,210	585	....	37,171	3.06
Center	5,313,461	115,676	3,141	....	5,432,278	2.72
Clarion	3,031,385	183,321	66,841	....	3,281,547	2.38
Clearfield	23,479,698	668,629	429,304	574,101	25,151,732	2.69
Clinton	905,814	43,712	5,978	....	955,504	2.38
Elk	1,995,379	30,207	38,471	....	2,064,057	2.28
Fayette	22,773,358	1,014,457	1,699,831	44,957,326	70,444,972	2.20
Greene	2,372,790	44,737	38,463	300,399	2,756,389	3.06
Huntingdon	2,829,857	25,902	53,991	71,826	2,981,576	2.58
Indiana	28,548,598	126,861	435,476	512,345	29,623,280	2.46
Jefferson	11,976,824	308,353	264,567	1,537,206	14,086,950	2.54
Lawrence	342,526	6,686	25,059	....	374,271	2.82
Mercer	1,401,286	18,167	80,464	....	1,499,917	2.84
Somerset	22,906,721	464,963	472,242	....	23,843,926	2.52
Tioga	2,493,478	82,742	23,299	....	2,599,519	3.00
Washington	50,594,230	763,244	675,221	2,350,275	54,382,970	2.53
Westmoreland	44,053,346	877,200	1,108,074	16,002,836	62,041,456	2.21
Small mines [a]	15,521	837,749	2,417	....	855,687	2.12
	332,497,267	11,619,410	7,266,631	69,885,500	421,268,808	2.44
Average value per ton	2.58	2.20	2.08	2.01	2.44	....

[a] Includes Fulton County.

Bituminous coal produced in Pennsylvania, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Allegheny	20,117,823	16,808,202	17,417,815	17,007,431	17,836,377	+ 828,946
Armstrong	5,321,622	4,579,389	5,159,882	5,430,188	5,574,861	+ 144,673
Beaver	248,585	101,809	87,891	91,553	129,163	+ 37,610
Bedford	850,792	634,219	635,791	721,587	947,053	+ 225,466
Blair	391,717	308,945	308,541	435,792	271,598	− 164,194
Bradford and Lycoming	(a)	36,374	50,904	39,005	47,151	+ 8,146
Butler	1,080,002	981,704	1,036,877	1,180,008	1,201,963	+ 21,955
Cambria	19,621,378	18,034,487	18,716,451	19,588,350	19,730,770	+ 142,420
Cameron and McKean	48,942	40,538	47,011	28,859	12,165	− 16,694
Center	1,497,271	1,264,075	1,430,749	1,819,007	1,999,407	+ 180,400
Clarion	1,427,848	1,341,392	1,291,119	1,368,544	1,380,494	+ 11,950
Clearfield	8,278,015	7,149,023	8,022,894	8,876,823	9,336,533	+ 459,710
Clinton	343,054	326,545	359,275	422,062	401,812	− 20,250
Elk	1,201,065	963,238	1,045,554	937,583	907,187	− 30,396
Fayette	32,607,963	23,336,180	28,424,067	34,249,848	32,083,027	−2,166,821
Greene	316,752	290,497	546,008	744,860	900,378	+ 155,518
Huntingdon	935,774	851,128	1,010,750	962,332	1,155,602	+ 193,270
Indiana	10,204,684	9,422,996	9,553,857	11,022,780	12,053,766	+1,030,986
Jefferson	5,801,864	5,089,623	4,895,409	5,764,525	5,551,658	− 212,867
Lawrence	94,283	123,987	[b]131,746	[b]614,994	132,929	+ 45,356
Mercer	777,601	716,995	[b]694,411	(a)	527,421	
Somerset	9,928,776	10,238,763	10,343,369	9,340,568	9,454,537	+ 113,969
Tioga	943,748	679,221	788,003	829,561	866,803	+ 37,242
Washington	18,309,317	15,495,674	15,898,719	18,119,353	21,513,603	+3,394,250
Westmoreland	33,258,702	28,995,427	29,892,561	30,499,703	28,027,782	−2,471,921
Small mines	[c]173,639	172,863	165,483	200,108	[b]404,102	+ 203,994
	173,781,217	147,983,294	157,955,137	170,295,424	172,448,142	+2,152,718
Total value	$193,039,806	$159,006,296	$167,419,705	$221,685,175	$421,268,808	+$199,583,633

[a] Lawrence County includes Mercer County in 1916.
[b] Includes Fulton County.
[c] Small mines include Lycoming County; no production in Bradford County.

SOUTH DAKOTA.

The lignite produced in South Dakota is from several small districts in the northwestern part of the State. Few of the mines are so located as to be able to ship their product on the railroads, and the use of the fuel is confined to the locality of the mines. The output declined from 8,886 tons in 1916 to 8,042 tons in 1917, or 9.5 per cent. The average realization price per ton at the mines increased from $2.03 to $2.90, and the total value of the output increased $5,325, or about 30 per cent.

Lignite produced in South Dakota in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
				Underground.	Surface.	Total.	
Dewey, Harding, and Ziebach	891	1,435	2,326	8	2	10	174
Meade		781	781	7		7	139
Perkins		5,779	5,779	11	10	21	133
	891	7,995	8,886	26	12	38	145

Value of lignite produced in South Dakota in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Total value.	Average value per ton.
Dewey, Harding, and Ziebach	$1,782	$2,887	$4,669	$2.01
Meade		2,930	2,930	3.75
Perkins		10,422	10,422	1.80
	1,782	16,239	18,021	2.03
Average value per ton	2.00	2.03	2.03	

Lignite produced in South Dakota in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
				Underground.	Surface.	Total.	
Dewey, Harding, Ziebach	647	2,445	3,092	9		9	179
Meade		995	995	10		10	121
Perkins		3,955	3,955	15		15	161
	647	7,395	8,042	34		34	154

Value of lignite produced in South Dakota in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Total value.	Average value per ton.
Dewey, Harding, Ziebach	$2,414	$7,792	$10,206	$3.30
Meade		3,710	3,710	3.73
Perkins		9,430	9,430	2.38
	2,414	20,932	23,346	2.90
Average value per ton	3.73	2.83	2.90	

Lignite produced in South Dakota, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Dewey and Harding	1,040	5,142	5,645	a 2,326	a 3,092	+ 766
Meade	575	625	400	781	995	+ 214
Perkins	8,925	6,083	4,548	5,779	3,955	− 1,824
	10,540	11,850	10,593	8,886	8,042	− 844
Total value	$20,648	$20,456	$16,384	$18,021	$23,346	+$5,325

a Includes Ziebach County.

TENNESSEE.

The production of coal in Tennessee in 1917 was 6,194,221 tons, valued at $13,592,998, compared with 6,137,449 tons, valued at $7,522,445 in 1916. The increase in quantity was slight, 56,772 tons, or less than 1 per cent, but the increase in value was $6,070,553, or 81 per cent. Although the number of men engaged in mining coal in Tennessee increased from 9,211 in 1916 to 10,421 in 1917, a gain of 13 per cent, and the average days worked increased from 239 to 241, or 0.8 per cent, the average daily output per employee declined from 2.79 tons to 2.46 tons, a decrease of 12 per cent. Labor trouble interfered with production in 1917, the time reported lost on that account (192,730 men-days, compared with 3,784 men-days in 1916) representing nearly 8 per cent of the total time worked in the year, or an equivalent of more than 400,000 tons of coal.

The largest producing districts, Campbell and Claiborne counties, recorded a combined decrease of 500,000 tons in 1917. The operations on the Tennessee Central Railroad, in Fentress and Overton counties and the district on the Harriman & Northeastern Railroad, in Morgan County, had the only substantial increases in the State.

Coal produced in Tennessee in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
						Underground.	Surface.	Total.	
Anderson	492,275	6,984	12,564	....	511,823	891	140	1,031	184
Campbell	1,256,098	26,683	54,732	171,399	1,508,912	2,135	424	2,559	218
Claiborne	1,501,533	17,470	31,287	....	1,550,290	1,146	259	1,405	263
Fentress	294,801	1,760	4,120	....	300,681	250	106	356	289
Grundy	279,074	2,297	3,273	50,501	335,145	470	43	513	307
Marion	516,918	4,399	8,789	31,382	561,488	741	166	907	268
Morgan	257,914	8,957	10,396	72,180	349,447	546	148	694	213
Scott	47,786	15,518	1,800	....	65,104	122	12	134	234
Other counties [a]	620,334	9,882	47,132	271,872	949,220	1,360	252	1,612	....
Small mines	....	5,339	....	....	5,339	....	....	....	....
	5,266,733	99,289	174,093	597,334	6,137,449	7,661	1,550	9,211	239

[a] Bledsoe, Hamilton, Overton, Rhea, Roane, Sequatchie, and White.

Value of coal produced in Tennessee in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total value.	Average value per ton.
Anderson	$561,547	$8,717	$13,402	....	$583,666	$1.14
Campbell	1,896,500	39,027	60,877	$130,411	2,126,815	1.41
Claiborne	1,597,005	18,330	29,377	....	1,644,712	1.06
Fentress	311,068	1,862	4,532	....	317,462	1.06
Grundy	293,731	2,447	3,438	51,048	350,664	1.05
Marion	724,709	6,794	12,564	47,073	791,140	1.41
Morgan	328,150	11,274	11,261	72,180	422,865	1.21
Scott	63,810	20,516	2,400	....	86,726	1.33
Other counties [a]	782,552	15,447	39,248	351,633	1,188,880	1.25
Small mines	....	9,515	....	....	9,515	1.78
	6,559,072	133,929	177,099	652,345	7,522,445	1.23
Average value per ton	1.25	1.35	1.02	1.09	1.23	....

[a] Bledsoe, Hamilton, Overton, Rhea, Roane, Sequatchie, and White.

Coal produced in Tennessee in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
						Underground.	Surface.	Total.	
Anderson	401,022	8,002	9,534	....	418,558	512	293	805	195
Campbell	1,055,334	49,104	34,109	149,502	1,288,049	2,010	495	2,505	199
Claiborne	1,226,996	10,275	28,368	....	1,265,639	1,149	271	1,420	233
Fentress	428,713	317	5,005	....	434,035	364	103	467	250
Grundy	321,076	3,234	1,127	96,312	421,749	545	250	795	288
Marion	505,928	9,026	9,742	63,849	588,545	648	313	961	283
Morgan	418,392	12,467	14,047	100,574	545,480	1,004	252	1,256	259
Overton	122,804	797	1,141	....	124,742	108	30	138	235
Scott	101,902	12,567	2,259	....	116,728	259	51	310	221
Other counties [a]	588,419	15,541	59,366	313,352	976,678	1,454	310	1,764	271
Small mines	....	14,018	....	....	14,018	....	....	....	....
	5,170,586	135,348	164,698	723,589	6,194,221	8,053	2,368	10,421	241

[a] Includes Bledsoe, Cumberland, Hamilton, Rhea, Roane, Sequatchie, and White counties.

Value of coal produced in Tennessee in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total value.	Average value per ton.
Anderson	$1,002,556	$14,615	$17,124		$1,034,295	$2.47
Campbell	2,953,157	96,953	68,184	$179,980	3,298,274	2.56
Claiborne	2,399,096	19,802	51,730		2,470,628	1.95
Fentress	813,075	712	9,941		823,728	1.90
Grundy	619,773	4,915	2,051	142,685	769,424	1.82
Marion	1,151,773	24,030	24,047	166,007	1,365,857	2.32
Morgan	1,179,932	18,830	32,788	75,430	1,306,980	2.40
Overton	246,981	1,276	1,560		249,817	2.00
Scott	274,820	19,317	6,475		300,612	2.58
Other counties [a]	1,233,110	31,782	99,901	574,923	1,939,716	1.99
Small mines		33,667			33,667	2.40
	11,874,273	265,899	313,801	1,139,025	13,592,998	2.19
Average value per ton	2.30	1.96	1.91	1.57	2.19	

[a] Includes Bledsoe, Cumberland, Hamilton, Rhea, Roane, Sequatchie, and White counties.

Coal produced in Tennessee, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Anderson	659,345	579,619	510,522	511,823	418,558	− 93,265
Bledsoe, Rhea, Roane, Sequatchie, and White	[a] 867,879	[a] 1,327,870	[a] 993,257	[a] 949,220	[a] 976,678	[a] +152,200
Campbell	1,779,338	1,675,521	1,663,708	1,508,912	1,288,049	−220,863
Claiborne	1,456,468	1,371,052	1,141,142	1,550,290	1,265,639	−284,651
Fentress	(a)	(a)	259,987	300,681	434,035	+133,354
Grundy	319,736	(a)	305,812	335,145	421,749	+ 86,604
Hamilton	366,545	(a)	(a)	(a)	(a)	(a)
Marion	677,505	538,165	479,134	561,488	588,545	+ 27,057
Morgan	497,484	371,797	371,406	349,447	545,480	+196,033
Overton	86,165	(a)	(a)	(a)	124,742	(a)
Scott	146,083	75,174	(a)	65,104	116,728	+ 51,624
Small mines	3,636	4,060	5,393	5,339	14,018	+ 8,679
	6,860,184	5,943,258	5,730,361	6,137,449	6,194,221	+ 56,772
Total value	$7,839,721	$6,776,573	$6,479,916	$7,522,445	$13,592,998	+$6,070,553

[a] Bledsoe, etc., include Cumberland and Fentress counties in 1913; Fentress, Grundy, Hamilton, and Overton counties in 1914; Hamilton, Overton, and Scott counties in 1915; Hamilton and Overton counties in 1916; and Cumberland and Hamilton counties, and increase in Scott County, in 1917.

TEXAS.

The combined production of bituminous coal and lignite in Texas in 1917 was 2,355,815 tons, valued at $4,177,608, an increase, compared with 1916, of 368,312 tons, or 18 per cent, in quantity and of $1,084,945, or 35 per cent, in value.

The production of bituminous coal increased from 1,025,093 tons in 1916 to 1,259,276 tons in 1917, and of lignite from 962,410 tons to 1,096,539 tons. The number of men engaged in the production of bituminous coal decreased from 2,926 in 1916 to 2,793 in 1917, but the number of days worked increased from 217 to 274. In the lignite mines the number of men employed was about the same in both years, but the number of days worked increased from 220 in 1916 to 244 in 1917.

Coal produced in Texas in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees. Underground.	Surface.	Total.	Average number of days worked.
Bituminous:								
Erath, Maverick, Palo Pinto, Webb, Wise, Young	999,484	9,977	15,632	1,025,093	2,564	362	2,926	217
Lignite:								
Bastrop, Fayette, Henderson, Hopkins, Houston, Leon, Medina, Milam, Robertson, Titus, Wood	940,463	7,693	14,254	962,410	1,337	218	1,555	220
	1,939,947	17,670	29,886	1,987,503	3,901	580	4,481	218

Value of coal produced in Texas in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Bituminous:					
Erath, Maverick, Palo Pinto, Webb, Wise, Young	$2,251,715.00	$28,463.00	$24,104.00	$2,304,282.00	$2.25
Average value per ton	2.25	2.85	1.54	2.25	....
Lignite:					
Bastrop, Fayette, Henderson, Hopkins, Houston, Leon, Medina, Milam, Robertson, Titus, Wood	771,147.00	6,348.00	10,886.00	788,381.00	0.82
Average value per ton	0.82	0.83	0.76	0.82	....
	3,022,862	34,811	34,990	3,092,663	1.56
Average value per ton	1.56	1.97	1.17	1.56	....

Coal produced in Texas in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Bituminous:								
Erath, Maverick, Palo Pinto, Webb, Wise, Young	1,221,788	5,258	32,230	1,259,276	2,400	393	2,793	274
Lignite:								
Bastrop, Henderson, Hopkins, Houston, Leon, Medina, Milam, Robertson, Titus, Wood	1,070,570	8,844	17,125	1,096,539	1,283	299	1,582	244
	2,292,358	14,102	49,355	2,355,815	3,683	692	4,375	263

Value of coal produced in Texas in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Bituminous:					
Erath, Maverick, Palo Pinto, Webb, Wise, Young	$3,088,997	$17,109	$34,147	$3,140,253	$2.49
Average value per ton	2.53	3.25	1.06	2.49	....
Lignite:					
Bastrop, Henderson, Hopkins, Houston, Leon, Medina, Milam, Robertson, Titus, Wood	1,014,224	8,136	14,995	1,037,355	.95
Average value per ton	0.95	0.92	0.88	0.95	....
	4,103,221	25,245	49,142	4,177,608	1.77
Average value per ton	1.79	1.79	1.00	1.77	....

UTAH.

The production of coal in Utah in 1917 increased 557,802 tons, or 16 per cent, over 1916 and established a new high record for the State, the total output, 4,125,230 tons, passing four millions for the first time. The greater part of the increase was in Carbon County, the largest producing district in the State. About 40 per cent of the increase was taken by the railroads for fuel and the remainder was supplied to local industries and shipped over the West and Northwest for the retail trade.

The number of men employed increased from 3,129 in 1916 to 3,485 in 1917, but the number of days the miners worked decreased from 228 to 219. Utah maintained the record for average annual and daily production per employee with 1,184 tons per year and 5.40 tons per day, both gains over 1916 and the highest recorded in any State.

Coal produced in Utah in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees. Underground.	Surface.	Total.	Average number of days worked.
Carbon	2,326,864	50,705	67,822	736,853	3,182,244	2,098	648	2,746	229
Emery and Grand	328,259	5,059	6,613		339,931	221	71	292	214
Summit and Uinta	31,757	6,100	4,000		41,857	78	13	91	254
Small mines		3,396			3,396				
	2,686,880	65,260	78,435	736,853	3,567,428	2,397	732	3,129	228

Value of coal produced in Utah in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke	Total value.	Average value per ton.
Carbon	a$4,931,616	$75,905	$31,917	(a)	$5,039,438	$1.58
Emery and Grand	644,141	9,338	3,714	0	657,193	1.93
Summit and Uinta	74,785	13,750	2,000	0	90,535	2.16
Small mines	0	8,778	0	0	8,778	2.59
	5,650,542	107,771	37,631	(a)	5,795,944	1.62
Average value per ton	1.65	1.65	.48	(a)	1.62	

a Value of coal made into coke at the mines included in loaded at mines for shipment.

Coal produced in Utah in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees. Underground.	Surface.	Total.	Average number of days worked.
Carbon	2,898,191	53,153	81,231	669,316	3,701,891	2,256	773	3,029	222
Emery and Grand	367,318	7,126	3,283		377,727	206	113	319	221
Summit and Uinta	27,249	9,277	1,614		38,140	107	30	137	146
Small mines a		7,472			7,472				
	3,292,758	77,028	86,128	669,316	4,125,230	2,569	916	3,485	219

a Includes Iron County.

Value of coal produced in Utah in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke	Total value.	Average value per ton.
Carbon	$7,529,719	$89,303	$70,766	(a)	$7,689,788	$2.08
Emery and Grand	714,061	15,602	1,223		730,886	1.93
Summit and Uinta	61,191	24,710	4,035		89,936	2.36
Small mines [b]		20,772			20,772	2.78
	8,304,971	150,387	76,024	(a)	8,531,382	2.07
Average value per ton	2.10	1.95	.88	(a)	2.07	

[a] Value of coal made into coke at the mines included in loaded at mines for shipment.
[b] Includes Iron County.

Coal produced in Utah, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Carbon	2,830,102	2,669,511	2,671,055	3,182,244	3,701,891	+ 519,647
Emery	[a] 314,915	[b] 357,768	[b] 390,080	[b] 339,931	[b] 377,727	+ 37,796
Summit, Uinta	108,027	73,025	42,677	41,857	38,140	− 3,717
Small mines	1,784	2,732	4,903	3,396	[b] 7,472	+ 4,076
	3,254,828	3,103,036	3,108,715	3,567,428	4,125,230	+ 557,802
Total value	$5,384,127	$4,935,454	$4,916,016	$5,795,944	$8,531,382	+$2,735,438

[a] Includes Grand and Sevier counties. [b] Includes Grand County.

VIRGINIA.

Although the increase in production in Virginia in 1917 over 1916 was only 379,617 tons, or 4 per cent, the output, 10,087,091 tons, is the highest recorded and for the first time passed the 10,000,000 mark. All sections of the producing districts shared in the increase, and Dickenson County appeared for the first time as a shipper of commercial coal. There was a substantial increase in the number of men employed, from 9,777 in 1916 to 11,168 in 1917, and a gain of 1 day in the number worked in the year, but the average effectiveness of the labor decreased more than 9 per cent, as is indicated by the decrease in the average daily output from 3.65 tons in 1916 to 3.31 tons in 1917.

The mines in the southwestern Virginia field, Wise and Lee counties, where 60 per cent of the coal in the State is produced, operated about 95 per cent of full time with almost no loss because of car shortage. The record for the State of 273 days worked represents 90 per cent of full-time operation, assuming 304 working days in a year. These facts indicate that it is only by increasing the development in this field, adding to the labor supply, and increasing the effectiveness of the men, that further progress can be looked for in the coal industry in Virginia. Fortunately there are large untouched reserves of coal of excellent quality and thickness in this field and also the possibility of improvement in the average daily performance of the labor.

Coal produced in Virginia in 1916.

County.	Loaded at mine for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
						Underground.	Surface.	Total.	
Lee	813,543	4,638	9,819		828,000	805	160	965	255
Russell	1,907,651	41,501	884		1,950,036	680	998	1,678	290
Tazewell	1,418,706	23,315	24,514	121,509	1,588,044	1,286	287	1,573	234
Wise	3,324,897	48,176	53,654	1,802,218	5,228,945	4,397	894	5,291	283
Other counties[a] and small mines.	48,844	39,100	24,505		112,449	191	79	270	237
	7,513,641	156,730	113,376	1,923,727	9,707,474	7,359	2,418	9,777	272

[a] Montgomery and Pulaski.

Value of coal produced in Virginia in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total value.	Average value per ton.
Lee	$926,672	$6,720	$9,230		$942,622	$1.14
Russell	1,870,773	40,853	1,017		1,912,643	.98
Tazewell	1,987,484	30,990	32,681	$103,885	2,155,040	1.36
Wise	3,442,866	52,454	53,644	1,511,478	5,060,442	.97
Other counties[a] and small mines.	120,873	44,269	25,535		190,677	1.70
	8,348,668	175,286	122,107	1,615,363	10,261,424	1.06
Average value per ton	1.11	1.12	1.08	.84	1.06	

[a] Montgomery and Pulaski.

Coal produced in Virginia in 1917.

County.	Loaded at mine for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
						Underground.	Surface.	Total.	
Dickenson	13,489	54	50		13,593	58	20	78	95
Lee	855,446	6,346	9,850		871,642	981	208	1,189	254
Russell	1,957,404	16,482	26,654		2,000,540	1,766	342	2,108	280
Tazewell	1,497,864	26,867	26,512	80,606	1,631,849	1,334	614	1,948	228
Wise	3,327,940	80,243	65,179	1,954,093	5,427,455	4,280	1,235	5,515	295
Other counties[a] and small mines	81,483	43,543	16,986		142,012	188	142	330	230
	7,733,626	173,535	145,231	2,034,699	10,087,091	8,607	2,561	11,168	273

[a] Includes Montgomery, Pulaski, and Wythe.

Value of coal produced in Virignia in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total value.	Average value per ton.
Dickenson	$32,055	$133			$32,188	$2.37
Lee	2,086,765	11,874	$21,275		2,119,914	2.43
Russell	3,567,441	30,762	47,326		3,645,529	1.82
Tazewell	3,995,301	57,295	52,238	$119,912	4,224,746	2.59
Wise	6,418,796	147,122	97,557	3,064,162	9,727,637	1.79
Other counties[a] and small mines	233,614	102,820	39,265		375,699	2.65
	16,333,972	350,006	257,661	3,184,074	20,125,713	2.00
Average value per ton	2.11	2.02	1.77	1.56	2.00	

[a] Includes Montgomery, Pulaski, and Wythe.

Coal produced in Virginia, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase, 1917.
Dickenson					13,593	+ 13,593
Lee	763,315	732,935	742,311	828,000	871,642	+ 43,642
Montgomery and Pulaski	(a)	45,151	51,141	109,543	[b] 127,836	+ 18,293
Russell	[c] 1,512,356	1,236,114	1,493,421	1,950,036	2,000,540	+ 50,504
Tazewell	[c] 1,447,351	1,323,530	1,647,081	1,588,044	1,631,849	+ 43,805
Wise	5,103,559	4,620,702	4,186,309	5,228,945	5,427,455	+ 198,510
Small mines	1,487	1,103	2,333	2,906	14,176	+ 11,270
	8,828,068	7,959,535	8,122,596	9,707,474	10,087,091	+ 379,617
Total value	$8,952,653	$8,032,448	$7,962,934	$10,261,424	$20,125,713	+$9,864,289

[a] Included with Russell County.
[b] Includes Wythe.
[c] Includes Henrico, Montgomery, and Pulaski.

WASHINGTON.

The production of coal in Washington in 1917 was 4,009,902 tons, compared with 3,038,588 tons in 1916, an increase of 971,314 tons, or 32 per cent. The increase was general, the Roslyn field in Kittitas County, in the central part of the State, recording a gain of 425,610 tons, the largest, and the King County field having a gain of 403,867 tons. The mines operated 271 days in 1917, compared with 217 in 1916, and the number of men employed increased from 4,797 in 1916 to 5,312 in 1917. The number of men engaged in mining coal in Washington reached the highest point in 1911, with more than 6,400 men, but declined in the years that followed till the lowest record since 1906 was reached in 1916. The average daily output per man declined slightly in 1917, with the decrease in the proportion of machine-mined coal.

Coal produced in Washington in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
						Underground.	Surface.	Total.	
King	821,718	30,280	58,111		910,109	1,370	480	1,850	191
Kittitas	1,252,871	19,976	45,182		1,318,029	1,309	199	1,508	224
Lewis	88,193	16,643	5,317		110,153	137	33	170	200
Pierce	371,433	8,155	12,130	136,863	528,581	848	278	1,126	256
Thurston and Whatcom	166,816	900	4,000		171,716	100	43	143	185
	2,701,031	75,954	124,740	136,863	3,038,588	3,764	1,033	4,797	217

Value of coal produced in Washington in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines	Total value.	Average value per ton
King	$1,822,810	$69,398	$78,351		$1,970,559	$2.17
Kittitas	3,058,690	43,737	67,548		3,169,975	2.41
Lewis	172,495	32,583	4,558		209,636	1.90
Pierce	827,994	19,169	24,249	$402,868	1,274,280	2.41
Thurston and Whatcom	276,328	1,650	5,000		282,978	1.65
	6,158,317	166,537	179,706	402,868	6,907,428	2.27
Average value per ton	2.28	2.19	1.44	2.94	2.27	

Coal produced in Washington in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
						Underground.	Surface.	Total.	
King	1,215,299	18,209	80,468		1,313,976	1,497	556	2,053	265
Kittitas	1,665,698	19,523	58,418		1,743,639	1,410	240	1,650	289
Lewis	101,571	21,985	9,495		133,051	165	41	206	244
Pierce	427,741	5,440	18,018	157,568	608,767	886	373	1,259	266
Thurston and Whatcom [a]	204,020	6,449			210,469	114	30	144	233
	3,614,329	71,606	166,399	157,568	4,009,902	4,072	1,240	5,312	271

[a] Includes Skagit County.

Value of coal produced in Washington in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total value.	Average value per ton.
King	$3,427,919	$53,742	$169,257		$3,650,918	$2.78
Kittitas	4,419,325	47,479	96,860		4,563,664	2.62
Lewis	243,699	46,924	13,711		304,334	2.29
Pierce	1,248,939	15,894	37,782	$562,530	1,865,145	3.06
Thurston and Whatcom [a]	331,370	11,931			343,301	1.63
	9,671,252	175,970	317,610	562,530	10,727,362	2.68
Average value per ton	2.68	2.46	1.91	3.57	2.68	

[a] Includes Skagit County.

Coal produced in Washington, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase, 1917.
King	1,373,699	1,041,780	850,095	910,109	1,313,976	+ 403,867
Kittitas	1,334,155	1,242,800	879,392	1,318,029	1,743,639	+ 425,610
Lewis	151,446	103,860	80,888	110,153	133,051	+ 22,898
Pierce	856,425	556,519	497,633	528,581	608,767	+ 80,186
Thurston and Whatcom	162,166	119,861	121,087	171,716	[a]210,469	+ [a]38,753
	3,877,891	3,064,820	2,429,095	3,038,588	4,009,902	+ 971,314
Total value	$9,243,137	$6,751,511	$5,276,299	$6,907,428	$10,727,362	+$3,819,934

[a] Includes Skagit County.

WEST VIRGINIA.

In a year of record-breaking production of coal West Virginia was the one important State that had no increase. The production in 1917, 86,441,667 net tons, was 18,460 tons, or a fraction of 1 per cent, below 1916, which remains the record year to date. With no increase in output, the increase in value at the mines, from $102,366,092 to $200,659,368, or 96 per cent, is notable.

Shipments from the mines decreased 1,764,000 tons, or 2.2 per cent; the quantity sold and used locally increased 726,000 tons, or 41 per cent; and the coal made into beehive coke at the mines increased 996,000 tons, or 26 per cent.

The failure to increase production in the face of an extraordinary demand was due to the decrease in the number of days worked. The number of men engaged in mining coal in West Virginia in 1917 was 88,422, a gain of 13 per cent over 1916. The effectiveness of the labor expressed in average daily output declined from 4.68 tons to 4.35 tons, or 7 per cent. As a net result of the greater man power production would have been increased but for the fact that the mines were unable to work as many days in the year as in 1916. Except for the interference with mining operations during the severe storms in the middle of December, the reason for the inability of the mines to operate more days in 1917 was the inability of the railroads to furnish the cars for loading the coal, that is, car shortage.

In the northern and central parts of the State, the Panhandle district—Ohio, Brooke, Hancock, and Marshall counties—had an increas- of 58,000 tons, but the larger Fairmont district gained only about 40,000 tons. Every county but Gilmer in the Fairmont region had more men engaged in mining and, except in Randolph County, all worked less days in 1917 than in 1916. The largest gain was 534,000 tons in Monongalia County, as a result of a three-fold increase in the labor supply. The largest decrease was in Marion County, from 6,097,000 tons in 1916 to 5,256,000 in 1917, with a slight increase in the number of men, but a decrease of 10 per cent in days worked.

The Upper Potomac district, or Tucker, Grant, and Mineral counties, had a substantial gain, largely the result of better car supply, and thereby increased operating time.

The production of Pocahontas coal decreased nearly 400,000 tons and the output of New River coal from Fayette County decreased, but in Raleigh County there was an increase of 250,000 tons. In the Kanawha field, Kanawha and Boone counties had increases and Logan County a slight decrease. The Kenova-Thacker district in Mingo County had a small decrease.

The increases were in the Panhandle, Upper Potomac, New River, and Kanawha fields, and the decreases were in the Pocahontas field and in Fayette County, which includes parts of both the New River and Kanawaha fields. The Fairmont and Kenova-Thacker districts recorded little change.

Coal produced in West Virginia in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
						Underground.	Surface.	Total.	
Barbour	1,264,692	16,919	22,507	62,991	1,367,109	924	151	1,075	247
Boone	743,943	6,750	9,043	....	759,736	724	178	902	183
Braxton	293,051	31,012	5,465	....	329,528	205	45	250	224
Brooke	699,585	12,114	8,553	....	720,252	718	114	832	266
Clay	466,147	5,783	8,782	....	480,712	363	92	455	233
Fayette	10,155,529	182,546	131,594	528,357	10,998,026	9,702	2,088	11,790	245
Gilmer	117,374	4,398	3,709	....	125,481	117	24	141	201
Grant	197,278	596	5,185	....	203,059	166	18	184	244
Hancock	....	4,763	....	....	4,763	6	1	7	189
Harrison	4,953,619	135,074	34,417	63,864	5,186,974	3,517	612	4,129	231
Kanawha	5,876,599	97,376	53,167	....	6,027,142	5,353	999	6,352	214
Lincoln	179,692	1,814	1,760	....	183,266	203	65	268	183
Logan	9,229,779	129,172	53,451	....	9,412,402	5,653	1,344	6,997	200
McDowell	17,799,948	223,561	297,087	2,164,529	20,485,125	14,049	2,965	17,014	250
Marion	5,635,387	122,480	205,873	133,329	6,097,069	3,924	880	4,804	239
Marshall	913,338	273,652	22,614	....	1,209,604	855	126	981	284
Mason	63,196	54,727	1,714	....	119,637	207	37	244	165
Mercer	3,344,308	33,108	35,307	280,448	3,693,171	2,684	583	3,267	247
Mineral	683,966	2,847	5,437	....	692,250	730	176	906	217
Mingo	3,366,349	33,019	74,769	....	3,474,137	2,841	652	3,493	246
Monongalia	480,114	12,017	2,061	96,147	590,339	405	103	508	219
Ohio	529,374	107,009	1,570	....	637,953	471	61	532	235
Preston	1,025,097	20,265	36,248	197,472	1,279,082	1,090	194	1,284	237
Putnam	588,642	2,395	13,311	....	604,348	881	186	1,067	251
Raleigh	6,826,540	89,510	73,722	....	6,989,772	4,941	1,017	5,958	240
Randolph	519,843	28,713	10,920	172,821	732,297	444	110	554	209
Taylor	1,419,017	4,889	14,684	27,534	1,466,124	1,012	186	1,198	250
Tucker	1,225,569	16,147	29,320	19,699	1,290,735	1,308	188	1,496	245
Upshur	141,990	2,880	2,094	12,223	159,187	87	39	126	243
Webster	16,949	4,000	250	....	21,199	16	2	18	246
Wyoming	694,680	4,262	739	....	699,681	688	139	827	254
Other counties[a]	309,086	15,132	5,852	....	330,070	334	74	408	272
Small mines	....	89,897	....	....	89,897	......	......	......	......
	79,760,681	1,768,827	1,171,205	3,759,414	86,460,127	64,618	13,449	78,067	237

[a] Greenbrier, Lewis, Nicholas, and Wayne.

Value of coal produced in West Virginia in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total value.	Average value per ton.
Barbour	$1,240,189	$15,706	$23,646	$68,745	$1,348,286	$0.99
Boone	927,835	7,623	10,541		945,999	1.25
Braxton	331,713	27,740	4,312		363,765	1.10
Brooke	891,916	15,095	7,632		914,643	1.27
Clay	535,779	5,540	8,137		549,456	1.14
Fayette	12,625,692	204,531	135,316	588,951	13,554,490	1.23
Gilmer	132,970	5,712	3,331		142,013	1.13
Grant	204,119	624	11,136		215,879	1.06
Hancock		6,389			6,389	1.34
Harrison	5,704,611	152,484	36,635	77,478	5,971,208	1.15
Kanawha	6,985,169	105,463	59,868		7,150,500	1.19
Lincoln	268,628	2,690	2,415		273,733	1.49
Logan	10,177,795	125,009	49,888		10,352,692	1.10
McDowell	22,158,070	254,714	291,778	1,663,791	24,368,353	1.19
Marion	6,624,185	141,627	183,516	150,324	7,099,652	1.16
Marshall	1,046,582	402,069	22,614		1,471,265	1.22
Mason	90,720	69,225	2,268		162,213	1.36
Mercer	4,104,193	37,753	39,047	201,963	4,382,956	1.19
Mineral	931,156	3,477	6,555		941,188	1.36
Mingo	3,914,000	27,990	64,538		4,006,528	1.15
Monongalia	634,266	12,880	2,204	95,506	744,856	1.26
Ohio	633,760	139,182	1,705		774,647	1.21
Preston	1,184,306	25,978	45,977	271,597	1,527,858	1.19
Putnam	772,888	2,874	12,853		788,615	1.30
Raleigh	8,616,001	108,612	77,036		8,801,649	1.26
Randolph	532,669	34,992	9,335	146,589	723,585	0.99
Taylor	1,470,844	5,776	12,822	34,968	1,524,410	1.04
Tucker	1,472,744	18,238	35,338	23,216	1,549,536	1.20
Upshur	173,721	3,298	2,871	11,612	191,502	1.20
Webster	26,892	6,000	500		33,392	1.58
Wyoming	881,274	4,224	900		886,398	1.27
Other counties [a]	451,008	14,952	5,674		471,634	1.43
Small mines		126,802			126,802	1.41
	95,745,695	2,115,269	1,170,388	3,334,740	102,366,092	1.18
Average value per ton	1.20	1.20	1.00	0.89	1.18	

[a] Greenbrier, Lewis, Nicholas, and Wayne.

Coal produced in West Virginia in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
						Underground.	Surface.	Total.	
Barbour	1,301,475	7,293	27,546	69,574	1,405,888	1,265	286	1,551	196
Boone	878,290	18,925	13,181	....	910,396	882	251	1,133	157
Braxton	239,090	29,733	5,248	....	274,071	246	79	325	176
Brooke	686,509	179,683	9,461	....	875,653	1,037	307	1,344	218
Clay	512,315	6,885	10,327	....	529,527	404	122	526	227
Fayette	8,952,720	227,637	127,504	751,941	10,059,802	9,131	2,162	11,293	246
Gilmer	102,660	2,266	3,650	....	108,576	103	25	128	187
Hancock	2,272	9,642	....	....	11,914	21	......	21	194
Harrison	5,053,462	211,681	42,651	76,457	5,384,251	3,961	1,137	5,098	188
Kanawha	6,352,009	104,615	58,383	....	6,515,007	5,867	1,470	7,337	202
Lincoln	218,185	4,392	4,600	....	227,177	289	81	370	154
Logan	9,213,652	142,055	53,210	....	9,408,917	6,660	2,041	8,701	188
McDowell	16,911,836	294,661	285,572	2,556,643	20,048,712	13,468	4,565	18,033	246
Marion	4,643,011	132,613	188,860	291,621	5,256,105	4,089	1,092	5,181	213
Marshall	641,333	442,370	25,748	....	1,109,451	1,028	186	1,214	247
Mason	162,760	26,665	9,751	....	199,176	252	61	313	225
Mercer	2,998,959	37,119	26,908	263,741	3,326,727	2,500	680	3,180	231
Mineral	872,003	2,697	5,221	....	879,921	839	244	1,083	224
Mingo	3,287,536	29,061	63,882	....	3,380,479	2,927	823	3,750	236
Monongalia	915,595	7,580	6,930	197,172	1,127,277	1,211	383	1,594	204
Nicholas	179,152	18,142	2,772	....	200,066	247	79	326	221
Ohio	458,387	160,991	14,307	....	633,685	697	95	792	242
Preston	915,876	57,801	40,701	323,594	1,337,972	1,277	369	1,646	225
Putnam	488,879	7,067	23,727	....	519,673	708	223	931	250
Raleigh	7,050,751	111,989	76,519	....	7,239,259	5,684	1,502	7,186	248
Randolph	627,825	38,246	12,246	179,712	858,029	463	97	560	246
Taylor	1,375,040	4,647	13,160	466	1,393,313	1,024	242	1,266	195
Tucker	1,390,449	18,751	30,833	19,104	1,459,137	1,249	233	1,482	264
Upshur	192,287	6,272	4,005	25,600	228,164	258	113	371	149
Wayne	62,507	183	777	....	63,467	83	30	113	204
Webster	18,707	6,262	....	....	24,969	40	11	51	170
Wyoming	1,087,487	13,534	3,360	....	1,104,381	963	234	1,197	242
Other counties [a]	203,679	47,944	3,911	....	255,534	282	44	326	262
Small mines	....	84,991	....	....	84,991	......	......	......	......
	77,996,698	2,494,393	1,194,951	4,755,625	86,441,667	69,155	19,267	88,422	225

[a] Grant, Greenbrier, Lewis, Summers, and Wetzel.

Value of coal produced in West Virginia in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Made into coke at mines.	Total value.	Average value per ton.
Barbour	$2,737,932	$14,404	$55,864	$182,913	$2,991,113	$2.13
Boone	2,460,549	33,489	24,125	....	2,518,163	2.77
Braxton	530,216	59,796	10,953	....	600,965	2.19
Brooke	1,854,529	429,479	15,334	....	2,299,342	2.63
Clay	1,242,478	10,095	14,654	....	1,267,227	2.39
Fayette	20,969,117	465,696	229,003	1,731,450	23,395,266	2.33
Gilmer	293,745	3,751	8,025	....	305,521	2.81
Hancock	4,158	25,139	....	....	29,297	2.46
Harrison	11,721,064	472,624	81,934	109,847	12,385,469	2.30
Kanawha	15,084,157	172,580	106,881	....	15,363,618	2.36
Lincoln	681,090	12,715	12,900	....	706,705	3.11
Logan	23,106,486	264,570	88,050	....	23,459,106	2.49
McDowell	39,429,510	496,431	487,785	3,260,540	43,674,266	2.18
Marion	10,887,196	281,197	376,929	396,016	11,941,338	2.27
Marshall	1,390,955	973,091	40,343	....	2,404,389	2.17
Mason	431,767	60,096	18,879	....	510,742	2.56
Mercer	7,434,666	66,858	41,204	498,125	8,040,853	2.42
Mineral	2,331,651	4,868	9,848	....	2,346,367	2.67
Mingo	7,791,227	40,985	120,097	....	7,952,309	2.35
Monongalia	2,231,887	16,189	17,530	553,842	2,819,448	2.50
Nicholas	487,209	36,655	6,290	....	530,154	2.65
Ohio	1,036,419	333,989	28,789	....	1,399,197	2.21
Preston	2,033,950	146,603	78,545	616,337	2,875,435	2.15
Putnam	1,180,970	14,510	50,632	....	1,246,112	2.40
Raleigh	17,100,069	227,679	120,169	....	17,447,917	2.41
Randolph	1,365,900	79,573	24,404	233,077	1,702,954	1.98
Taylor	3,164,728	7,162	26,682	2,010	3,200,582	2.30
Tucker	2,690,796	43,662	55,835	51,171	2,841,464	1.95
Upshur	597,643	9,058	8,430	56,320	671,451	2.94
Wayne	170,836	283	777	....	171,896	2.71
Webster	47,219	15,346	....	....	62,565	2.51
Wyoming	2,850,259	25,740	7,350	....	2,883,349	2.61
Other counties [a]	388,943	66,470	5,898	....	461,311	1.81
Small mines	....	153,477	....	....	153,477	1.81
	185,729,321	5,064,260	2,174,139	7,691,648	200,659,368	2.32
Average value per ton	2.38	2.03	1.82	1.62	2.32	....

[a] Grant, Greenbrier, Lewis, Summers, and Wetzel.

Coal produced in West Virginia, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Barbour	1,415,301	1,331,948	1,320,069	1,367,109	1,405,888	+ 38,779
Boone	445,856	592,558	661,898	759,736	910,396	+ 150,660
Braxton	282,517	306,608	(a)	329,528	274,071	− 55,457
Brooke	(a)	554,870	615,446	720,252	875,653	+ 155,401
Clay	371,296	563,561	584,205	480,712	529,527	+ 48,815
Fayette	9,944,027	9,038,738	10,182,958	10,998,026	10,059,802	− 938,224
Gilmer	93,337	114,876	148,125	125,481	108,576	− 16,905
Grant	223,045	179,642	215,935	203,059	(a)	(a)
Greenbrier and Lewis	b 790,285	c 265,664	d 590,358	e 330,070	f 255,534	− f 14,062
Hancock	(a)	(a)	(a)	4,763	11,914	+ 7,151
Harrison	5,584,437	5,291,683	5,112,161	5,186,974	5,384,251	+ 197,277
Kanawha	5,372,953	5,989,055	5,305,224	6,027,142	6,515,007	+ 487,865
Lincoln	(a)	(a)	44,956	183,266	227,177	+ 43,911
Logan	4,753,516	6,618,951	7,918,963	9,412,402	9,408,917	− 3,485
McDowell	16,498,447	14,588,564	17,411,439	20,485,125	20,048,712	− 436,413
Marion	6,052,672	6,731,542	6,689,713	6,097,069	5,256,105	− 840,964
Marshall	866,049	1,153,126	990,960	1,209,604	1,109,451	− 100,153
Mason	148,691	121,911	122,779	119,637	199,176	+ 79,539
Mercer	3,317,012	2,961,141	3,489,049	3,693,171	3,326,727	− 366,444
Mineral	851,475	633,406	660,250	692,250	879,921	+ 187,671
Mingo	2,690,418	2,839,014	2,871,739	3,474,137	3,380,479	− 93,658
Monongalia	394,640	414,821	400,222	590,339	1,127,277	+ 536,938
Nicholas	(a)	(a)	(a)	(a)	200,066	(a)
Ohio	412,640	570,347	576,867	637,953	633,685	− 4,268
Preston	1,331,907	1,240,650	1,239,614	1,279,082	1,337,972	+ 58,890
Putnam	622,776	544,859	547,669	604,348	519,673	− 84,675
Raleigh	5,697,581	5,454,059	5,883,485	6,989,772	7,239,259	+ 249,487
Randolph	593,525	520,360	451,696	732,297	858,029	+ 125,732
Taylor	1,046,770	1,308,704	1,068,594	1,466,124	1,393,313	− 72,811
Tucker	1,293,489	1,504,215	1,651,567	1,290,735	1,459,137	+ 168,402
Upshur	96,822	119,757	98,147	159,187	228,164	+ 68,977
Wayne	(a)	(a)	(a)	(a)	63,467	(a)
Webster	(a)	(a)	(a)	21,199	24,969	+ 3,770
Wyoming	(a)	75,058	243,735	699,681	1,104,381	+ 404,700
Small mines	62,652	77,938	86,246	89,897	84,991	− 4,906
	71,254,136	71,707,626	77,184,069	86,460,127	86,441,667	− 18,460
Total value	$71,822,804	$71,391,408	$74,561,349	$102,366,092	$200,659,368	+$98,293,276

a Included with Greenbrier and other counties.
b Includes Brooke, Hancock, Lincoln, Nicholas, Wayne, Webster, and Wyoming counties.
c Includes Hancock, Lincoln, Nicholas, Wayne, and Webster counties.
d Includes Braxton, Hancock, Nicholas, Wayne, and Webster counties.
e Includes Nicholas and Wayne counties.
f Includes Grant, Summers, and Wetzel; and increase in Nicholas and Wayne counties.

WYOMING.

The production of coal in Wyoming in 1917 was 8,575,619 tons, valued at $16,593,283, compared with 7,910,647 tons, valued at $12,239,707 in 1916, a gain of 664,972 tons, or 8.5 per cent, in quantity, and of $4,353,576, or 35.6 per cent, in value. The largest gain was made in Sheridan County, 359,356 tons. Southern Wyoming—Carbon, Uinta, Lincoln, and Sweetwater counties—had an increase of 188,916 tons, and the smaller district in the central part of the State—Fremont, Hot Springs, and Park counties—recorded a gain of 127,130 tons.

There was a slight gain in the number of men employed and a decrease of 2 in the days worked. The increase in production was effected by the increase in the average daily output per man, from 4.40 tons in 1916 to 4.74 tons in 1917. The average annual output per man was 1,165 tons, the second largest for any State in 1917.

Coal produced in Wyoming in 1916.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Carbon and Uinta	750,255	13,803	26,755	790,813	532	131	663	282
Fremont, Hot Springs, and Park	588,925	19,874	35,636	644,435	493	110	603	216
Johnson and Weston	338,179	8,778	19,787	366,744	359	58	417	255
Lincoln	1,783,918	12,163	92,628	1,888,709	1,504	246	1,750	273
Sheridan	1,274,329	14,883	24,851	1,314,063	928	256	1,184	196
Sweetwater	2,812,100	21,891	67,229	2,901,220	2,225	413	2,638	252
Small mines		4,663		4,663				
	7,547,706	96,055	266,886	7,910,647	6,041	1,214	7,255	248

Value of coal produced in Wyoming in 1916.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value.	Average value per ton.
Carbon and Uinta	$1,114,449	$18,604	$28,371	$1,161,424	$1.47
Fremont, Hot Springs, and Park	1,080,875	33,624	18,318	1,132,817	1.76
Johnson and Weston	662,191	14,933	19,787	696,911	1.90
Lincoln	2,690,067	20,817	65,870	2,776,754	1.47
Sheridan	1,926,209	22,900	9,072	1,958,181	1.49
Sweetwater	4,399,188	32,779	72,896	4,504,863	1.55
Small mines		8,757		8,757	1.88
	11,872,979	152,414	214,314	12,239,707	1.55
Average value per ton	1.57	1.59	0.80	1.55	

Coal produced in Wyoming in 1917.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Number of employees.			Average number of days worked.
					Underground.	Surface.	Total.	
Carbon and Uinta	860,191	14,935	33,600	908,726	569	168	737	295
Fremont, Hot Springs, and Park	692,342	43,282	35,941	771,565	526	124	650	258
Converse, Johnson, and Weston	327,397	7,882	21,578	356,857	313	61	374	284
Lincoln	1,837,567	12,668	90,578	1,940,813	1,243	242	1,485	287
Sheridan	1,620,137	12,998	40,284	1,673,419	1,152	317	1,469	199
Sweetwater	2,842,060	29,599	48,460	2,920,119	2,221	422	2,643	228
Small mines		4,120		4,120				
	8,179,694	125,484	270,441	8,575,619	6,024	1,334	7,358	246

Value of coal produced in Wyoming in 1917.

County.	Loaded at mines for shipment.	Sold to local trade and used by employees.	Used at mines for steam and heat.	Total value	Average value per ton.
Carbon and Uinta	$1,445,621	$45,163	$38,515	$1,529,299	$1.68
Fremont, Hot Springs, and Park	1,723,049	112,119	28,659	1,863,827	2.42
Converse, Johnson, and Weston	748,565	16,695	25,130	790,390	2.21
Lincoln	3,457,785	23,301	81,050	3,562,136	1.84
Sheridan	3,248,270	21,331	47,586	3,317,187	1.98
Sweetwater	5,410,299	56,193	52,305	5,518,797	1.89
Small mines		11,647		11,647	2.83
	16,033,589	286,449	273,245	16,593,283	1.93
Average value per ton	1.96	2.28	1.01	1.93	

Coal produced in Wyoming, 1913–1917, in net tons.

County.	1913	1914	1915	1916	1917	Increase or decrease, 1917.
Carbon and Uinta	682,495	684,618	669,652	790,813	908,726	+117,913
Converse, Johnson, and Weston	371,397	364,540	355,074	a 366,744	356,857	− 9.887
Fremont, Hot Springs, and Park	420,819	429,539	497,601	644,435	771,565	+127,130
Lincoln	1,871,461	1,482,421	1,416,301	1,888,709	1,940,813	+ 52,104
Sheridan	1,211,167	1,001,411	978,623	1,314,063	1,673,419	+359,356
Sweetwater	2,832,475	2,509,371	2,632,244	2,901,220	2,920,119	+ 18,899
Small mines	b 3,252	3,393	4,533	4,663	4,120	− 543
	7,393,066	6,475,293	6,554,028	7,910,647	8,575,619	+664,972
Total value	$11,510,045	$10,033,747	$9,555,804	$12,239,707	$16,593,283	+$4,353,576

a Johnson and Weston counties only.

b Includes Crook County.

NATURAL GAS.[1]

By John D. Northrop.

INTRODUCTION.

Since its organization in 1879 the United States Geological Survey has recognized the importance of a permanent statistical record of the mining and mineral industries of the United States, and since 1884 it has prepared and issued annually a report on the natural-gas industry. The following report, the thirty-fourth in this series, comprises a statistical review of the production and consumption of natural gas in the United States in the calendar year 1917, an account of the significant developments in the gas fields of the several States, and brief notes on the trend of the natural-gas industry in foreign countries, so far as conditions can be ascertained.

TERMS USED.

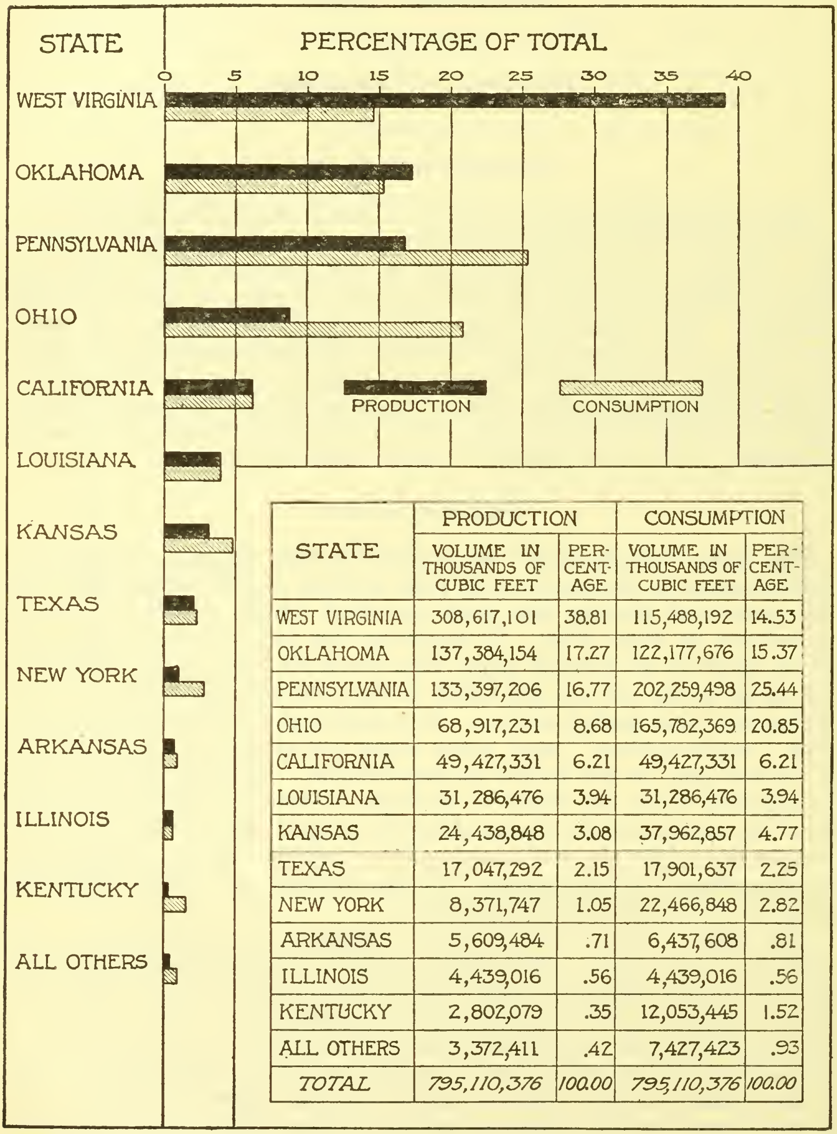
The term "production," as applied in this chapter, is used in a limited sense to designate only that portion of the natural gas actually produced during the year specified which found commercial utilization in that year. It excludes the large volume of gas (of which there is no reliable gage) that finds its way to the surface of the earth in the oil and gas fields of the country and escapes without performing any useful service. In a national sense it is synonymous with "consumption," and, were there no interstate transportation of natural gas, its use would be inexcusable. As natural gas is freely transported from one State to another, however, the term "production" is convenient for designating the output of gas in a given State irrespective of its place of consumption, and the term "consumption" is appropriate for designating the gas utilized in a given State irrespective of its place of production.

The term "value," as used in this chapter, invariably designates the market value of the commodity at the point of ultimate consumption, not of production, and takes no account of intervening purchases and sales, of which there are often three or four. As much of the gas utilized in the United States is sold by its original producer to transportation companies at a flat rate per well without regard to the volume of gas, effort to determine the value of that gas at the point of production is impracticable. Where field meters are in use the price received by the producer ranges from 1½ cents to 15 cents a thousand cubic feet, depending on the relative abundance of gas in the particular locality and on the nature of the market supplied.

[1] The statistical tables in this chapter, as in previous reports of this series, are the work of Miss Belle Hill, of the United States Geological Survey.

PRODUCTION.

The volume of natural gas produced commercially in the United States in 1917 established a new record of annual output for the natural-gas industry of the country. The volume produced and



STATE	PRODUCTION		CONSUMPTION	
	VOLUME IN THOUSANDS OF CUBIC FEET	PER-CENT-AGE	VOLUME IN THOUSANDS OF CUBIC FEET	PER-CENT-AGE
WEST VIRGINIA	308,617,101	38.81	115,488,192	14.53
OKLAHOMA	137,384,154	17.27	122,177,676	15.37
PENNSYLVANIA	133,397,206	16.77	202,259,498	25.44
OHIO	68,917,231	8.68	165,782,369	20.85
CALIFORNIA	49,427,331	6.21	49,427,331	6.21
LOUISIANA	31,286,476	3.94	31,286,476	3.94
KANSAS	24,438,848	3.08	37,962,857	4.77
TEXAS	17,047,292	2.15	17,901,637	2.25
NEW YORK	8,371,747	1.05	22,466,848	2.82
ARKANSAS	5,609,484	.71	6,437,608	.81
ILLINOIS	4,439,016	.56	4,439,016	.56
KENTUCKY	2,802,079	.35	12,053,445	1.52
ALL OTHERS	3,372,411	.42	7,427,423	.93
TOTAL	*795,110,376*	*100.00*	*795,110,376*	*100.00*

FIGURE 33.—Distribution by States of the production and consumption of natural gas in the United States in 1917

utilized within the year is estimated at not less than 795,110,376,000 cubic feet, a gain of 41,940,123,000 cubic feet, or 5.5 per cent, over the volume credited to 1916.

The market value of this gas likewise attained record proportions. It amounted to $142,089,334, a gain of $21,861,866, or 18 per cent, over the market value of the output in 1916. The average price per thousand cubic feet received for this gas at the point of consumption was 17.87 cents, a gain of 1.91 cents, or 12 per cent, over the price received in 1916.

Credit for the increased production in 1917 belongs, in the order stated, mainly, to California, Oklahoma, West Virginia, Arkansas, Pennsylvania, and Texas, which together produced 48,400,000,000 cubic feet more gas in 1917 than in 1916. Other gains of local importance were credited to New York, Illinois, Kentucky, Wyoming, Montana, and Tennessee. Offsetting to some extent these gains were material losses in the output of natural gas in 1917, compared with 1916, in Kansas, Ohio, Louisiana, Indiana, Missouri, Michigan, Iowa, the Dakotas, and Alabama. The largest individual loss—7,300,000,000 cubic feet—was charged to Kansas, the other losses being relatively small. The largest individual gain—17,800,000,000 cubic feet—was credited to California; Oklahoma was second, with an increase of 13,900,000,000 cubic feet over the output in 1916.

Much of the increased production of natural gas in the United States in 1917 is accounted for by the rapid and broad expansion of the natural-gas gasoline industry, but some of it was unquestionably due to the unusual severity of the early part of the winter of 1917–18 and the scarcity of fuels throughout the East during that period. Then, too, the augmented demand for natural gas for use in industries speeded to the limit on war contracts was an incentive to increased production which was not without its effect, despite the fact that the prior claims of domestic consumers in many eastern communities necessitated a strict rationing of industrial consumers.

As nearly as can be ascertained 5,722 wells were drilled for natural gas in the United States in 1917, a gain of 425 wells, or 8 per cent, over the number completed in 1916. Of these wells 3,984, or 69 per cent, were successful, and 1,738, an average of 3 in every 10 drilled, were failures. There were 2,704 exhausted gas wells abandoned during 1917, and at the end of that year not less than 39,277 active gas wells were in service in the country, exclusive of the wells that produced both gas and oil, a net gain of 1,280 gas wells during the year.

CONSUMPTION.

The principal beneficiaries of the increased production of natural gas in 1917 were, in the order named, Oklahoma-Missouri, California, West Virginia, Arkansas, Kentucky, and Texas, which together consumed 64,000,000,000 cubic feet more gas in 1917 than in 1916. Offsetting these gains were large decreases in consumption in Kansas (22,600,000,000 cubic feet) and Ohio (3,700,000,000 cubic feet), and small decreases elsewhere, so that the net gain in 1917 over 1916 was approximately 42,000,000,000 cubic feet.

Of the total volume of natural gas consumed in the United States in 1917 about 258,163,007,000 cubic feet, or 33 per cent, having a market value of $79,423,629, was distributed to 2,431,275 domestic consumers at an average price of 30.76 cents a thousand cubic feet, and the remaining 536,947,369,000 cubic feet, or 66 per cent, having a market value of $62,665,705, was distributed to 18,620 industrial consumers at an average rate of 11.67 cents a thousand.

Comparison of these data on the consumption of natural gas for domestic purposes with corresponding data for 1916 shows a gain in 1917 of 22,782,243,000 cubic feet, or 10 per cent, in volume; of $12,038,269, or 18 per cent, in market value; of 68,781, or 3 per cent, in the number of consumers supplied; and of 2.13 cents, or 7 per cent, in average sale price per thousand cubic feet. A similar comparison with regard to industrial consumption shows in 1917 a gain of 19,157,880,000 cubic feet, or 4 per cent, in volume; of $9,823,597, or 19 per cent, in market value; of 342, or 2 per cent, in the number of consumers supplied; and of 1.46 cents, or 14 per cent, in average sale price per thousand cubic feet.

The proportion of the entire volume consumed in 1916 that was distributed to domestic consumers in that year was 31 per cent and to industrial consumers 69 per cent.

On the assumption that an average of 2,396,885 families were supplied with natural gas during the entire year 1917, the average monthly consumption of each family was 9,000 cubic feet, and the average monthly cost to each household was $2.77. In 1916 the average monthly consumption was 8,600 cubic feet and the average monthly cost was $2.46, and in 1915 the average monthly consumption was 10,200 cubic feet and the average monthly cost was $2.89.

Analysis of the statistics of industrial consumption in 1917 shows that about 321,593,450,000 cubic feet of gas, having a market value of $41,555,740, was distributed to 6,300 consumers for use directly for manufacturing purposes in furnaces, kilns, and ovens, employed in the smelting of metals and the manufacture of brick, cement, pottery, and glass, at an average price of 12.92 cents a thousand cubic feet, and that about 215,353,919,000 cubic feet, having a market value of $21,109,965, was sold to 12,320 consumers for use as fuel in engines or under boilers in the generation of power.

STATISTICS OF PRODUCTION AND CONSUMPTION.

The following tables show, by States, the statistics of natural gas produced and used in the United States from 1887 to 1917, inclusive:

Approximate value of natural gas produced and used in the United States, 1887-1917.

State.	1887	1888	1889	1890	1891	1892
Pennsylvania	$13,749,500	$19,282,375	$11,593,989	$9,551,025	$7,834,016	$7,376,281
New York	333,000	332,500	530,026	552,000	280,000	216,000
Ohio	1,000,000	1,500,000	5,215,669	4,684,300	3,076,325	2,136,000
West Virginia	120,000	120,000	12,000	5,400	35,000	70,500
Illinois	....	....	10,615	6,000	6,000	12,988
Indiana	600,000	1,320,000	2,075,702	2,302,500	3,942,500	4,716,000
Kansas	....	....	15,873	12,000	5,500	40,795
Missouri	....	....	35,687	10,500	1,500	3,775
California	....	....	12,680	33,000	30,000	55,000
Kentucky and Tennessee	....	....	2,580	30,000	38,993	43,175
Texas and Alabama	....	....	1,728	....	....	100
Arkansas and Wyoming	....	....	375	....	250	100
Other	15,000	75,000	1,600,175	1,606,000	250,000	200,000
	15,817,500	22,629,875	21,107,099	18,792,725	15,500,084	14,870,714

State.	1893	1894	1895	1896	1897	1898	1899
Pennsylvania	$6,488,000	$6,279,000	$5,852,000	$5,528,610	$6,242,543	$6,806,742	$8,337,210
New York	210,000	249,000	241,530	256,000	200,076	229,078	294,593
Ohio	1,510,000	1,276,100	1,255,700	1,172,400	1,171,777	1,488,308	1,836,271
West Virginia	123,000	395,000	100,000	640,000	912,528	1,334,023	2,335,864
Illinois	14,000	15,000	7,500	6,375	5,000	2,498	2,067
Indiana	5,718,000	5,437,000	5,203,200	5,043,635	5,009,208	5,060,969	6,680,370
Kansas	50,000	86,600	112,400	124,750	105,700	174,640	332,592
Missouri	2,100	4,500	3,500	1,500	500	145	290
California	62,000	60,350	55,000	55,682	50,000	65,337	86,891
Kentucky, Tennessee	68,500	89,200	98,700	99,000	15,090	7,875	125,745
Texas	50	50	20	....	90,000	103,133	*a* 8,000
Alabama					....	765	
Arkansas, Wyoming	100	100	100	60	4,000	3,300	....
Utah	500	500	20,000	20,000	....	....	1,480
Colorado	....	12,000	7,000	4,500	....	....	3,500
South Dakota	....	....	....	....	20,000	20,000	....
Other	100,000	50,000	50,000	50,000	....	....	....
	14,346,250	13,954,400	13,006,650	13,002,512	13,826,422	15,296,813	20,074,873

State.	1900	1901	1902	1903	1904	1905
Pennsylvania	$10,215,412	$12,688,161	$14,352,183	$16,182,834	$18,139,914	$19,197,336
New York	335,367	293,232	346,471	493,686	522,575	623,251
Ohio	2,178,234	2,147,215	2,355,458	4,479,040	5,315,564	5,721,462
West Virginia	2,959,032	3,954,472	5,390,181	6,882,359	8,114,249	10,075,804
Illinois	1,700	1,825	1,844	3,310	4,745	7,223
Indiana	7,254,539	6,954,566	7,081,344	6,098,364	4,342,409	3,094,134
Kansas	356,900	659,173	824,431	1,123,849	1,517,643	2,261,836
Missouri	547	1,328	2,154	7,070	6,285	7,390
California	79,083	67,602	120,648	104,521	114,195	133,696
Texas, Alabama	20,000	18,577	14,953	13,851	14,082	14,409
Lousiana	....	....	....	....	....	1,500
Kentucky	286,243	270,871	365,656	390,601	322,404	237,290
Tennessee						300
Arkansas and Wyoming	....	....	....	2,460	6,515	21,135
Colorado	1,800	1,800	1,900	14,140	14,300	20,752
Oklahoma	....	....	360	1,000	49,665	130,137
South Dakota	9,817	7,255	10,280	10,775	12,215	15,200
	23,698,674	27,066,077	30,867,863	35,807,860	38,496,760	41,562,855

a Includes Louisiana.

Approximate value of natural gas produced and used in the United States, 1887–1917—Continued.

State.	1906	1907	1908	1909	1910	1911
Pennsylvania	$18,558,245	$18,844,156	$19,104,944	$20,475,207	$21,057,211	$18,520,796
New York	672,795	766,157	959,280	1,222,666	1,678,720	1,418,767
Ohio	7,145,809	8,718,562	8,244,835	9,966,938	8,626,954	9,367,347
West Virginia	13,735,343	16,670,962	14,837,130	17,538,565	23,816,553	28,435,907
Illinois	87,211	143,577	446,077	644,401	613,642	687,726
Indiana	1,750,715	1,572,605	1,312,507	1,616,903	1,473,403	1,192,418
Kansas	4,010,986	6,198,583	7,691,587	8,293,846	7,755,367	4,854,534
Missouri	7,210	17,010	22,592	10,025	12,611	10,496
California	134,560	168,397	307,652	446,933	476,697	800,714
Texas	....	....	....	....	....	1,014,945
Alabama } Louisiana }	150,695	178,276	236,837	453,253	956,683	858,145
Kentucky	287,501	380,176	424,271	485,192	456,293	407,689
Tennessee	300	300	350	350	300	300
Arkansas and Wyoming	34,500	126,582	164,930	} 226,925	301,151	295,858
Colorado	22,800	....	....			
Oklahoma	259,862	417,221	860,159	1,806,193	3,490,704	6,731,770
South Dakota	15,400	19,500	24,400	16,164	31,999	16,984
North Dakota	....	235	2,480	3,025	7,010	5,738
Oregon	....	100	250	50	....	....
Iowa	....	....	93	30	40	70
Michigan	....	....	....	255	820	1,330
	46,873,932	54,222,399	54,640,374	63,206,941	70,756,158	74,621,534

State.	1912	1913	1914	1915	1916	1917
Pennsylvania	$18,539,672	$21,695,845	$20,839,869	$21,139,605	$24,513,119	$28,716,492
New York	2,343,379	2,425,633	2,600,352	2,335,252	2,355,320	2,499,303
Ohio	11,891,299	10,521,930	14,667,790	17,391,060	15,601,144	18,434,814
West Virginia	33,324,475	34,164,850	35,076,755	36,424,263	47,603,396	57,389,161
Illinois	616,467	574,015	437,275	350,371	396,357	479,072
Indiana	1,014,295	843,047	755,407	695,380	503,373	453,310
Kansas	4,264,706	3,288,394	3,340,025	4,037,011	4,855,389	5,701,436
Missouri	11,576	6,795	5,319	7,731	17,594	8,230
California	1,134,456	1,883,450	2,910,784	4,069,004	5,440,277	6,816,524
Kentucky	522,455	509,846	490,875	614,998	752,635	580,380
Tennessee	375	600	300	400	1,150	2,450
Texas	1,405,077	2,073,823	2,469,770	2,593,873	3,143,871	3,192,625
Louisiana } Alabama }	1,747,379	2,119,948	2,227,999	2,163,934	2,660,445	3,262,987
South Dakota } North Dakota }	30,412	31,166	27,220	36,445	31,573	25,213
Wyoming } Colorado } Arkansas }	309,816	269,421	214,103	59,898	86,077	144,425
Arkansas				193,092	210,964	315,612
Oklahoma	7,406,528	7,436,389	8,050,039	9,195,804	12,014,706	13,984,656
Iowa	120	120	200	250	275	225
Michigan	1,470	1,405	1,442	1,510	948	1,013
Montana	....	....	....	2,500	38,855	81,406
	84,563,957	87,846,677	94,115,524	101,312,381	120,227,468	142,089,334

Natural gas produced and consumed in the United States in 1916 and 1917.

State.	Production.			Consumption.		
	Volume (M cubic feet).	Average price (cents per M cubic feet).	Value.	Volume (M cubic feet).	Average price (cents per M cubic feet).	Value.
1916.						
West Virginia	299,318,907	15.90	$47,603,396	[a] 105,104,008	8.19	$8,610,084
Pennsylvania	130,483,705	18.78	24,513,119	201,460,893	17.38	35,015,695
Oklahoma	123,517,358	9.73	12,014,706	[b] 93,704,221	7.54	7,062,142
Ohio	69,888,070	22.32	15,601,144	169,480,011	22.06	37,394,410
Louisiana	32,080,975	8.29	2,660,445	[c] 32,080,975	8.29	2,660,445
Kansas	31,710,438	15.31	4,855,389	[d] 60,564,112	16.07	9,731,518
California	31,643,266	17.19	5,440,277	31,643,266	17.19	5,440,277
Texas	15,809,579	19.89	3,143,871	15,809,579	19.89	3,143,871
New York	8,035,632	29.31	2,355,320	20,594,123	30.26	6,230,826
Illinois	3,533,701	11.22	396,357	[e] 3,533,701	11.22	396,357
Arkansas	2,387,935	8.83	210,964	[f] 3,347,398	8.59	287,399
Kentucky	2,106,542	35.73	752,635	9,887,956	23.58	2,331,687
Indiana	1,715,499	29.34	503,373	5,021,364	34.78	1,746,285
Wyoming Colorado	575,044	14.97	86,077	575,044	14.97	86,077
Montana	213,315	18.21	38,855	213,315	18.21	38,855
South Dakota Alabama North Dakota	77,478	40.75	31,573	77,478	40.75	31,573
Missouri	69,236	25.41	17,594	69,236	25.41	17,594
Tennessee	2,000	57.50	1,150	2,000	57.50	1,150
Michigan	1,298	73.04	948	1,298	73.04	948
Iowa	275	100.00	275	275	100.00	275
	753,170,253	15.96	120,227,468	753,170,253	15.96	120,227,468
1917.						
West Virginia	308,617,101	18.60	$57,389,161	[a] 115,488,192	9.14	$10,558,612
Oklahoma	137,384,154	10.18	13,984,656	[b] 122,177,676	8.92	10,900,827
Pennsylvania	133,397,206	21.53	28,716,492	202,259,498	20.16	40,773,689
Ohio	68,917,231	26.75	18,434,814	165,782,369	26.99	44,742,782
California	49,427,331	13.79	6,816,524	49,427,331	13.79	6,816,524
Louisiana	31,286,476	10.43	3,262,987	[c] 31,286,476	10.43	3,262,987
Kansas	24,438,848	23.33	5,701,436	[d] 37,962,857	22.29	8,463,767
Texas	17,047,292	18.73	3,192,625	17,901,637	19.18	3,433,123
New York	8,371,747	29.85	2,499,303	22,466,848	30.77	6,912,540
Arkansas	5,609,484	5.63	315,612	[f] 6,437,608	6.16	396,612
Illinois	4,439,016	10.79	479,072	[e] 4,439,016	10.79	479,072
Kentucky	2,802,079	20.71	580,380	12,053,445	25.84	3,114,402
Indiana	1,711,454	26.49	453,310	5,766,466	34.19	1,971,435
Wyoming Colorado	1,223,136	11.81	144,425	1,223,136	11.81	144,425
Montana	334,421	24.34	81,406	334,421	24.34	81,406
South Dakota Alabama North Dakota	59,666	42.26	25,213	59,666	42.26	25,213
Missouri	31,425	26.19	8,230	31,425	26.19	8,230
Tennessee	10,900	22.48	2,450	10,900	22.48	2,450
Michigan	1,184	85.55	1,013	1,184	85.55	1,013
Iowa	225	100.00	225	225	100.00	225
	795,110,376	17.87	142,089,334	795,110,376	17.87	142,089,334

[a] Includes gas piped from West Virginia and consumed in Maryland.
[b] Includes gas piped from Oklahoma and consumed in Missouri.
[c] Includes gas piped from Louisiana and consumed in Arkansas and Texas.
[d] Includes gas piped from Kansas and consumed in Missouri.
[e] Includes gas piped from Illinois and consumed in Indiana.
[f] Includes gas piped from Oklahoma.

Distribution of natural gas consumed in the United States in 1916 and 1917.

1916.

State.	Number of producers.	Consumers.		Gas consumed.		
				Domestic.		
		Domestic.	Industrial.	Volume (M cubic feet).	Average price (cents per M cubic feet).	Value.
Ohio	2,503	836,828	4,602	84,657,622	29.78	$25,208,751
Pennsylvania	1,586	463,264	4,676	55,605,995	27.26	15,159,479
Kansas [a]	414	202,222	1,354	20,876,693	25.45	5,314,011
West Virginia [b]	544	123,860	1,963	18,779,871	18.05	3,389,400
Oklahoma [c]	544	79,724	2,327	10,723,336	17.87	1,915,758
New York	360	159,886	676	18,824,887	31.22	5,877,898
California	87	242,775	175	5,629,022	63.93	3,598,695
Texas	83	68,218	931	5,423,295	38.96	2,112,893
Louisiana [d]	73	32,257	679	3,890,552	29.54	1,149,336
Kentucky	107	85,583	125	5,860,235	33.55	1,965,892
Indiana	995	44,118	471	3,357,872	37.50	1,259,245
Illinois [e]	218	14,485	121	635,298	26.72	169,729
Arkansas [f]	17	6,399	135	713,047	21.49	153,208
Wyoming	20	749	13	156,512	24.62	38,530
Colorado	17	10	9			
Montana	5	727	6	137,615	22.89	31,500
South Dakota	30	399	4			
Alabama	9	355	1	43,503	53.83	23,418
North Dakota	13	42	2			
Missouri	45	574	4	63,936	25.48	16,294
Tennessee	9	7	3	600	75.00	450
Michigan	12	9	1	598	100.00	598
Iowa	6	3	....	275	100.00	275
	7,697	2,362,494	18,278	235,380,764	28.63	67,385,360

State.	Gas consumed.					
	Industrial.			Total.		
	Volume (M cubic feet).	Average price (cents per M cubic feet).	Value.	Volume (M cubic feet).	Average price (cents per M cubic feet).	Value.
Ohio	84,822,389	14.37	$12,185,659	169,480,011	22.06	$37,394,410
Pennsylvania	145,854,898	13.61	19,856,216	201,460,893	17.38	35,015,695
Kansas [a]	39,687,419	11.13	4,417,507	60,564,112	16.07	9,731,518
West Virginia [b]	86,324,137	6.05	5,220,684	105,104,008	8.19	8,610,084
Oklahoma [c]	82,980,885	6.20	5,146,384	93,704,221	7.54	7,062,142
New York	1,769,236	19.95	352,928	20,594,123	30.26	6,230,826
California	26,014,244	7.08	1,841,582	31,643,266	17.19	5,440,277
Texas	10,386,284	9.93	1,030,978	15,809,579	19.89	3,143,871
Louisiana [d]	28,190,423	5.36	1,511,109	32,080,975	8.29	2,660,445
Kentucky	4,027,721	9.08	365,795	9,887,956	23.58	2,331,687
Indiana	1,663,492	29.28	487,040	5,021,364	34.78	1,746,285
Illinois [e]	2,898,403	7.82	226,628	3,533,701	11.22	396,357
Arkansas [f]	2,634,351	5.09	134,191	3,347,398	8.59	287,399
Wyoming	418,532	11.36	47,547	575,044	14.97	86,077
Colorado						
Montana	75,700	9.72	7,355	213,315	18.21	38,855
South Dakota						
Alabama	33,975	24.00	8,155	77,478	40.75	31,573
North Dakota						
Missouri	5,300	24.53	1,300	69,236	25.41	17,594
Tennessee	1,400	50.00	700	2,000	57.50	1,150
Michigan	700	50.00	350	1,298	73.04	948
Iowa	....	....	....	275	100.00	275
	517,789,489	10.21	52,842,108	753,170,253	15.96	120,227,468

[a] Includes the consumption of gas piped from Kansas to Missouri.
[b] Includes the consumption of gas piped from West Virginia to Maryland.
[c] Includes some gas piped from Oklahoma to Missouri.
[d] Includes the consumption of gas piped to Texas and to Arkansas from Louisiana.
[e] Includes the consumption of gas piped from Illinois to Vincennes, Ind.
[f] Includes the consumption of gas piped from Oklahoma to Arkansas.

Distribution of natural gas consumed in the United States in 1916 and 1917—Continued.

1917.

State.	Number of producers.	Consumers.		Gas consumed.		
				Domestic.		
		Domestic.	Industrial.	Volume (M cubic feet).	Average price (cents per M cubic feet).	Value.
Ohio	2,320	872,073	4,743	101,584,452	30.96	$31,455,004
Pennsylvania	1,613	480,500	4,417	63,135,783	28.69	18,110,975
Oklahoma [a]	565	94,605	2,183	12,873,023	20.29	2,612,468
West Virginia [b]	521	129,297	2,047	21,258,009	18.82	3,999,833
Kansas [c]	462	188,043	1,018	8,928,425	58.64	5,235,274
New York	349	164,308	698	20,737,081	31.42	6,516,538
California	100	239,448	1,038	4,914,374	68.03	3,343,443
Texas	85	73,706	854	7,194,724	34.25	2,464,099
Louisiana [d]	95	35,277	703	4,682,339	29.79	1,394,951
Kentucky	118	90,041	124	7,354,153	33.95	2,496,814
Indiana	941	42,322	497	3,475,321	37.55	1,305,137
Illinois [e]	225	11,622	118	481,770	34.67	167,023
Arkansas [f]	15	6,874	125	1,009,307	15.24	153,807
Wyoming	25	1,014	20	198,993	34.42	68,495
Colorado	17	7	5			
Montana	6	1,216	12	279,859	26.87	75,205
South Dakota	26	412	5			
Alabama	10	119	3	25,721	62.03	15,955
North Dakota	11	4	....			
Missouri	41	372	6	28,085	26.33	7,395
Tennessee	12	4	3	750	50.00	375
Michigan	10	9	1	613	100.00	613
Iowa	6	2	....	225	100.00	225
	7,573	2,431,275	18,620	258,163,007	30.76	79,423,629

State.	Gas consumed.					
	Industrial.			Total.		
	Volume (M cubic feet).	Average price (cents per M cubic feet).	Value.	Volume (M cubic feet).	Average price (cents per M cubic feet).	Value.
Ohio	64,197,917	20.70	$13,287,778	165,782,369	26.99	$44,742,782
Pennsylvania	139,123,715	16.29	22,662,714	202,259,498	20.16	40,773,689
Oklahoma [a]	109,304,653	7.58	8,288,359	122,177,676	8.92	10,900,827
West Virginia [b]	94,230,183	6.96	6,558,779	115,488,192	9.14	10,558,612
Kansas [c]	29,034,432	11.12	3,228,493	37,962,857	22.29	8,463,767
New York	1,729,767	22.89	396,002	22,466,848	30.77	6,912,540
California	44,512,957	7.80	3,473,081	49,427,331	13.79	6,816,524
Texas	10,706,913	9.05	969,024	17,901,637	19.18	3,433,123
Louisiana [d]	26,604,137	7.02	1,868,036	31,286,476	10.43	3,262,987
Kentucky	4,699,292	13.14	617,588	12,053,445	25.84	3,114,402
Indiana	2,291,145	29.08	666,298	5,766,466	34.19	1,971,435
Illinois [e]	3,957,246	7.89	312,049	4,439,016	10.79	479,072
Arkansas [f]	5,428,301	4.48	242,805	6,437,608	6.16	396,612
Wyoming	1,024,143	7.41	75,930	1,223,136	11.81	144,425
Colorado						
Montana	54,562	11.37	6,201	334,421	24.34	81,406
South Dakota						
Alabama	33,945	27.27	9,258	59,666	42.26	25,213
North Dakota						
Missouri	3,340	25.00	835	31,425	26.19	8,230
Tennessee	10,150	20.44	2,075	10,900	22.48	2,450
Michigan	571	70.05	400	1,184	85.56	1,013
Iowa	....	....	....	225	100.00	225
	536,947,369	11.67	62,665,705	795,110,376	17.87	142,089,334

[a] Includes some gas piped from Oklahoma to Missouri.
[b] Includes the consumption of gas piped from West Virginia to Maryland.
[c] Includes the consumption of gas piped from Kansas to Missouri.
[d] Includes the consumption of gas piped to Texas and to Arkansas from Louisiana.
[e] Includes the consumption of gas piped from Illinois to Vincennes, Ind.
[f] Includes the consumption of gas piped from Oklahoma to Arkansas.

Distribution of natural gas consumed for industrial purposes in the United States in 1916 and 1917.

1916.

State.	Industrial consumers.			Gas consumed.		
				Manufacturing.		
	Manufacturing.	Other industrial (power).	Total.	Volume (M cubic feet).	Average price (cents per M cubic feet).	Value.
Pennsylvania	1,801	2,875	4,676	131,571,641	13.71	$18,035,439
Ohio	2,327	2,275	4,602	65,615,184	14.25	9,346,974
West Virginia	913	1,050	1,963	61,597,981	5.67	3,491,136
Oklahoma	366	1,961	2,327	46,246,844	5.84	2,701,158
Kansas	75	1,279	1,354	25,431,022	10.84	2,757,520
California	....	175	175	....	....	....
Louisiana	94	585	679	3,158,555	7.59	239,866
Texas	45	886	931	1,608,948	7.30	117,430
Indiana	403	68	471	1,550,489	29.89	463,501
Kentucky	38	87	125	3,563,704	8.56	305,164
New York	14	662	676	456,776	23.16	105,777
Illinois	1	120	121	(a)	....	(a)
Arkansas	57	78	135	2,056,871	4.73	97,219
Wyoming	1	12	13	(a)	....	(a)
Colorado	....	9	9			
South Dakota	....	4	4	....	....	....
Alabama	....	1	1			
North Dakota	....	2	2			
Montana	1	5	6	(a)	....	(a)
Missouri	....	4	4	....	....	....
Tennessee	....	3	3	....	....	....
Michigan	....	1	1	....	....	....
	6,136	12,142	18,278	342,861,015	10.98	37,661,184

State.	Gas consumed.					
	Other industrial (power).			Total industrial.		
	Volume (M cubic feet).	Average price (cents per M cubic feet).	Value.	Volume (M cubic feet).	Average price (cents per M cubic feet).	Value.
Pennsylvania	14,283,257	12.75	$1,820,777	145,854,898	13.61	$19,856,216
Ohio	19,207,205	14.78	2,838,685	84,822,389	14.37	12,185,659
West Virginia	24,726,156	7.00	1,729,548	86,324,137	6.05	5,220,684
Oklahoma	36,734,041	6.66	2,445,226	82,980,885	6.20	5,146,384
Kansas	14,253,397	11.65	1,659,987	39,687,419	11.13	4,417,507
California	26,014,244	7.08	1,841,582	26,014,244	7.08	1,841,582
Louisiana	25,031,868	5.08	1,271,243	28,190,423	5.36	1,511,109
Texas	8,777,336	10.41	913,548	10,386,284	9.93	1,030,978
Indiana	113,003	20.83	23,539	1,663,492	29.28	487,040
Kentucky	464,017	13.07	60,631	4,027,721	9.08	365,795
New York	1,312,460	18.83	247,151	1,769,236	19.95	352,928
Illinois	2,898,403	7.82	226,628	2,898,403	7.82	226,628
Arkansas	577,480	6.40	36,972	2,634,351	5.09	134,191
Wyoming	418,532	11.36	47,547	418,532	11.36	47,547
Colorado						
South Dakota	33,975	24.00	8,155	33,975	24.00	8,155
Alabama						
North Dakota						
Montana	75,700	9.72	7,355	75,700	9.72	7,355
Missouri	5,300	24.53	1,300	5,300	24.53	1,300
Tennessee	1,400	50.00	700	1,400	50.00	700
Michigan	700	50.00	350	700	50.00	350
	174,928,474	8.68	15,180,924	517,789,489	10.21	52,842,108

a Included in "Other industrial."

Distribution of natural gas consumed for industrial purposes in the United States in 1916 and 1917—Continued.

1917.

State.	Industrial consumers.			Gas consumed.		
				Manufacturing.		
	Manufacturing.	Other industrial (power).	Total.	Volume (M cubic feet).	Average price (cents per M cubic feet).	Value.
Pennsylvania	1,433	2,984	4,417	123,851,370	16.53	$20,477,033
Ohio	2,450	2,293	4,743	46,740,047	20.81	9,728,790
Oklahoma	369	1,814	2,183	48,435,989	6.20	3,001,611
West Virginia	1,208	839	2,047	70,771,137	6.98	4,938,675
California	....	1,038	1,038	....	....	....
Kansas	84	934	1,018	14,094,485	10.36	1,459,626
Louisiana	124	579	703	4,406,270	6.66	293,632
Texas	95	759	854	1,964,307	10.02	196,857
Indiana	428	69	497	2,022,169	29.91	604,896
Kentucky	23	101	124	3,933,829	11.99	471,809
New York	27	671	698	520,704	32.31	168,242
Illinois	1	117	118	(a)	....	(a)
Arkansas	56	69	125	4,853,143	4.42	214,569
Wyoming	1	19	20	(a)	....	(a)
Colorado	....	5	5			
South Dakota	....	5	5	....	....	....
Alabama	....	3	3			
Montana	1	11	12	(a)	....	(a)
Tennessee	....	3	3	....	....	....
Missouri	....	6	6	....	....	....
Michigan	....	1	1	....	....	....
	6,300	12,320	18,620	321,593,450	12.92	41,555,740

State.	Gas consumed.					
	Other industrial (power).			Total industrial.		
	Volume (M cubic feet).	Average price (cents per M cubic feet).	Value.	Volume (M cubic feet).	Average price (cents per M cubic feet).	Value.
Pennsylvania	15,272,345	14.31	$2,185,681	139,123,715	16.29	$22,662,714
Ohio	17,457,870	20.39	3,558,988	64,197,917	20.70	13,287,778
Oklahoma	60,868,664	8.69	5,286,748	109,304,653	7.58	8,288,359
West Virginia	23,459,046	6.91	1,620,104	94,230,183	6.96	6,558,779
California	44,512,957	7.80	3,473,081	44,512,957	7.80	3,473,081
Kansas	14,939,947	11.84	1,768,867	29,034,432	11.12	3,228,493
Louisiana	22,197,867	7.09	1,574,404	26,604,137	7.02	1,868,036
Texas	8,742,606	8.83	772,167	10,706,913	9.05	969,024
Indiana	268,976	22.83	61,402	2,291,145	29.08	666,298
Kentucky	765,463	19.04	145,779	4,699,292	13.14	617,588
New York	1,209,063	18.84	227,760	1,729,767	22.89	396,002
Illinois	3,957,246	7.89	312,049	3,957,246	7.89	312,049
Arkansas	575,158	4.91	28,236	5,428,301	4.47	242,805
Wyoming, Colorado	1,024,143	7.41	75,930	1,024,143	7.41	75,930
South Dakota, Alabama	33,945	27.27	9,258	33,945	27.27	9,258
Montana	54,562	11.37	6,201	54,562	11.37	6,201
Tennessee	10,150	20.44	2,075	10,150	20.44	2,075
Missouri	3,340	25.00	835	3,340	25.00	835
Michigan	571	70.05	400	571	70.05	400
	215,353,919	9.80	21,109,965	536,947,369	11.67	62,665,705

a Included in "Other industrial."

Value of natural gas consumed in the United States, 1912–1917.

State.	1912	1913	1914	1915	1916	1917
Pennsylvania	$26,486,302	$28,709,565	$28,439,324	$30,087,667	$35,015,695	$40,773,689
Ohio	27,196,162	27,055,824	29,936,642	31,900,764	37,394,410	44,742,782
West Virginia	a 7,001,331	a 7,333,956	a 7,334,690	a 7,451,003	a 8,610,084	a 10,558,612
Kansas	b 8,521,858	b 6,983,802	b 7,163,746	b 8,174,289	b 9,731,518	b 8,463,767
New York	4,866,821	4,888,412	5,510,204	5,676,097	6,230,826	6,912,540
Oklahoma	3,149,376	3,740,981	4,226,318	5,058,526	7,062,142	10,900,827
Indiana	c 1,014,295	c 948,278	c 1,422,880	c 1,542,604	1,746,285	1,971,435
Texas	1,405,077	2,073,823	2,469,770	2,593,873	3,143,871	3,433,123
Louisiana, Alabama	d 1,747,379	d 2,119,948	d 2,227,999	d 2,163,934	d 2,660,445 (Louisiana)	d 3,262,987 (Louisiana)
South Dakota, North Dakota	30,412	31,166	27,220	36,445	31,573	25,213
Kentucky	1,070,664	1,225,116	1,787,308	1,942,423	2,331,687	3,114,402
California	1,134,456	1,883,450	2,910,784	4,069,004	5,440,277	6,816,524
Illinois	e 616,467	e 574,015	e 437,275	e 350,371	e 396,357	e 479,072
Missouri	11,576	6,795	5,319	7,731	17,594	8,230
Wyoming, Colorado	309,816	269,421	214,103	59,898	86,077	144,425
Arkansas				193,092	f 287,399	f 396,612
Montana	....	....	....	2,500	38,855	81,406
Michigan	1,470	1,405	1,442	1,510	948	1,013
Tennessee	375	600	300	400	1,150	2,450
Iowa	120	120	200	250	275	225
	84,563,957	87,846,677	94,115,524	101,312,381	120,227,468	142,089,334

a Includes value of gas piped from West Virginia to Maryland.
b Includes value of gas piped from Kansas to Missouri in 1908, 1909, 1914, 1915, 1916, and 1917, and from Kansas and Oklahoma to Missouri in 1910, 1911, 1912, and 1913.
c A portion of this was consumed in Chicago, Ill.
d Includes value of gas piped from Louisiana to Texas and Arkansas.
e Includes value of gas produced in Illinois and consumed in Vincennes, Ind.
f Includes value of gas piped from Oklahoma to Arkansas.

COMBINED VALUE OF NATURAL GAS AND PETROLEUM.

The following table shows the value of natural gas and of petroleum and their combined value in 1916 and 1917, by States, arranged in the order of the value of the combined production:

Value of natural gas and petroleum produced in the United States in 1916 and 1917.

State.	Natural gas.	Crude petroleum.	Total.
1916.			
Oklahoma	$12,014,706	$128,463,805	$140,478,511
West Virginia	47,603,396	21,914,080	69,517,476
California	5,440,277	53,702,733	59,143,010
Pennsylvania	24,513,119	19,149,855	43,662,974
Ohio	15,601,144	16,154,940	31,756,084
Illinois	396,357	29,237,168	29,633,525
Texas	3,143,871	25,760,335	28,901,206
Louisiana	2,660,445	14,669,774	17,330,219
Kansas	4,855,389	10,339,958	15,195,347
Wyoming, Colorado	86,077	5,644,080	5,947,296
Colorado		217,139	
New York	2,355,320	2,190,195	4,545,515
Kentucky	752,635	2,189,812 (Kentucky and Tennessee)	2,943,597
Tennessee	1,150		
Indiana	503,373	1,207,565	1,710,938
Arkansas	210,964	....	210,964
Montana	38,855	44,019	82,874
South Dakota, Alabama, North Dakota	31,573	....	31,573
Missouri	17,594	(a)	33,227 (Missouri, Michigan, Alaska, Iowa, Undistributed)
Michigan	948	(a)	
Alaska	....	(a)	
Iowa	275	....	
Undistributed	....	14,410	
	120,227,468	330,899,868	451,127,336

a Included in "Undistributed."

Value of natural gas and petroleum produced in the United States in 1916 and 1917—Continued.

State.	Natural gas.	Crude petroleum.	Total.
1917.			
Oklahoma	$13,984,656	$181,646,981	$195,631,637
California	6,816,524	86,161,764	92,978,288
West Virginia	57,389,161	27,246,960	84,636,121
Kansas	5,701,436	67,120,573	72,822,009
Pennsylvania	28,716,492	25,154,290	53,870,782
Texas	3,192,625	42,891,555	46,084,180
Ohio	18,434,814	21,104,483	39,539,297
Illinois	479,072	31,358,069	31,837,141
Louisiana	3,262,987	17,224,602	20,487,589
Wyoming	144,425	11,047,876	11,320,401
Colorado		128,100	
Kentucky	580,380	7,033,714	7,614,094
New York	2,499,303	2,850,378	5,349,681
Indiana	453 310	1,470,548	1,923,858
Arkansas	315,612	....	315,612
Montana	81,406	146,272	227,678
Tennessee	2,450	28,448	30,898
South Dakota			
Alabama	25,213	....	25,213
North Dakota			
Missouri	8,230	....	8,230
Michigan	1,013	(a)	a 1,013
Iowa	225	....	225
Undistributed	....	b 20,600	b 20,600
	142,089,334	522,635,213	664,724,547

a Petroleum produced in Michigan included in "Undistributed."
b Includes Alaska and Michigan petroleum.

SUMMARY OF WELLS DRILLED.

Wells drilled for natural gas in 1917.

State.	Productive Dec. 31, 1916.	Drilled in 1917.			Abandoned in 1917.	Productive Dec. 31, 1917.
		Gas.	Dry.	Total.		
Alabama	19	5	....	5	....	24
Arkansas	119	5	3	8	11	113
California	110	10	2	12	9	111
Colorado	13	....	....	....	....	13
Illinois	341	18	58	76	72	287
Indiana	1,967	42	17	59	179	1,830
Iowa	6	2	1	3	1	7
Kansas	2,561	554	370	924	536	2,579
Kentucky	263	35	52	87	12	286
Louisiana	260	63	49	112	54	269
Michigan	8	1	....	1	....	9
Missouri	54	1	1	2	8	47
Montana	13	3	2	5	1	15
New York	2,068	95	42	137	85	2,078
North Dakota	13	1	....	1	7	7
Ohio	6,053	552	254	806	626	5,979
Oklahoma	1,344	350	376	726	261	1,433
Pennsylvania	13,921	1,163	273	1,436	550	14,534
South Dakota	29	1	....	1	....	30
Tennessee	10	4	....	4	2	12
Texas	249	35	87	122	34	250
West Virginia	8,542	1,040	138	1,178	253	9,329
Wyoming	34	4	13	17	3	35
	37,997	3,984	1,738	5,722	2,704	39,277

ACREAGE CONTROLLED BY NATURAL-GAS PRODUCERS.

Land controlled by natural-gas producers in the United States in 1916 and 1917, in acres.

State.	1916				1917			
	In fee.	Leased.	Gas rights.	Total.	In fee.	Leased.	Gas rights.	Total.
Alabama	90	77,660	....	77,750	80	80,160	....	80,240
Arkansas	695	96,919	....	97,614	695	28,863	....	29,558
California	4,645	582	14,476	19,703	2,403	3,065	12,876	18,344
Colorado	2,566	2,300	....	4,866	2,572	300	....	2,872
Illinois	318	245,443	1,300	247,061	406	182,440	60	182,906
Indiana	90,112	77,371	2,627	170,110	90,872	83,583	2,702	177,157
Kansas	29,677	611,679	8,874	650,230	31,932	1,538,258	11,790	1,581,980
Kentucky	8,658	238,409	510	247,577	7,350	434,517	21,528	463,395
Louisiana	17,102	385,870	20,340	423,312	10,076	392,506	24,075	426,657
Missouri	933	1,500	....	2,433	780	3,000	....	3,780
Montana	280	48,640	....	48,920	2,280	42,900	....	45,180
New York	10,070	460,610	6,275	476,955	10,188	417,868	6,647	434,703
Ohio	33,889	1,513,426	10,916	1,558,231	26,226	2,215,312	18,490	2,260,028
Oklahoma	32,946	1,629,571	37,504	1,700,021	30,880	2,397,731	303,777	2,732,388
Pennsylvania	179,753	1,837,648	380,717	2,398,118	169,039	1,927,058	339,932	2,436,029
Tennessee	7	4,000	....	4,007	7	24,000	....	24,007
Texas	25,394	835,591	16,387	877,372	24,221	643,821	27,790	695,832
West Virginia	237,033	3,116,042	513,298	3,866,373	239,013	2,829,199	718,973	3,787,185
Wyoming	2,490	19,838	6,800	29,128	4,920	50,828	6,160	61,908
	676,658	11,203,099	1,020,024	12,899,781	653,940	13,295,409	1,494,800	15,444,149

NATURAL-GAS INDUSTRY BY STATES.

NEW YORK.

GENERAL STATEMENT.

As a contributor to the natural-gas supply of the United States New York is relatively unimportant, its rank among the States in which natural gas was produced in 1917 being ninth, based on the volume as well as on the market value of the output. Despite its modest rank as a producer of natural gas New York has the distinction of being the first State to recognize the utility of this gift of nature and to adapt it to the satisfaction of needs for fuel and illumination. Since 1821, the year in which natural gas was first obtained from a well 1½ inches in diameter and 27 feet deep put down in the borough limits of Fredonia, Chautauqua County, and was used for heat and light in that town, New York has been a factor in the natural-gas industry of the United States.

Since 1885, the first year for which statistics on the subject are available, the value of the annual output of natural gas in New York has increased steadily from $195,000 to more than $2,000,000, frequently exceeding, in recent years, the value of the annual output of crude petroleum in that State.

Natural gas is produced commercially in 16 counties in the central and western parts of New York. It is obtained from sandstone, shale, and limestone strata in the succession of rocks between the Potsdam sandstone of the Cambrian system and the Chemung formation of the Devonian system. In Allegany, Cattaraugus, and Steuben counties, where the gas is associated for the most part with petroleum, the supply is derived principally from the Chemung and the underlying Portage formation. In Chautauqua County gas is obtained from these formations as well as from the lower-lying Medina group of the Silurian system, which is the principal source of the gas produced in the northern part of that county and in Erie, Genesee, Niagara, Orleans, Monroe, and Livingston counties. In Wyoming, Ontario, Onondaga, and Oswego counties gas in relatively small volume is obtained from the Trenton limestone of the Ordovician system, and in Chemung County gas is obtained from glacial drift.

PRODUCTION.

The volume of natural gas produced in New York in 1917 is estimated at 8,371,747,000 cubic feet, a gain of 336,115,000 cubic feet, or 4 per cent, compared with 1916. Increased activity in the oil fields of the State, resulting in an augmented demand for natural gas for drilling and pumping, and increased conservation of oil-field gas resulting from an expansion of the local natural-gas gasoline industry account for the gain in production of natural gas in New York in 1917.

The increased volume and the gain of 0.51 cent in the average price per thousand cubic feet received made the market value of the New York output $2,499,303, a gain of $143,983, or 6 per cent, over the market value of the output in 1916.

Interest in the development of natural gas in New York in 1917 resulted in the drilling of 137 wells, 95, or 69 per cent, of which were successful, the remaining 42, or 31 per cent, being barren. Eighty-five exhausted gas wells were abandoned during the year and at its end there were 2,078 gas wells in service in the State, a net gain of 10 wells in 1917.

Except for a small volume transported across the State boundary and consumed in Bradford, Pa., all the natural gas produced in New York in 1917 was consumed within the State.

CONSUMPTION.

The volume of natural gas consumed in New York in 1917 was about 22,466,848,000 cubic feet, which exceeded the volume consumed in 1916 by 1,872,725,000 cubic feet, or 9 per cent, and was considerably larger than the volume consumed in the State in any other year for which statistics on the subject are available.

The average price paid for natural gas by all classes of consumers in New York in 1917 was 30.77 cents a thousand cubic feet, compared with 30.26 cents in 1916 and 30.23 cents in 1915. As a consequence of this slight increase in the average retail price and of the substantial increase in the volume of gas consumed the market value—$6,912,540—of the natural gas consumed in 1917 was greater by $681,714, or 11 per cent, than the market value of the volume consumed in 1916.

The market for natural gas in New York is predominantly domestic. Of the total volume of natural gas consumed in 1917, it is estimated that 20,737,081,000 cubic feet, or 92 per cent, was supplied to 164,308 domestic consumers at an average price of 31.42 cents a thousand cubic feet, the remaining 8 per cent being supplied to 698 industrial consumers at an average price of 22.89 cents a thousand.

Compared with 1916 the average domestic rate was greater in 1917 by 0.20 cent a thousand and the average industrial rate was greater by 2.94 cents a thousand. The volume of gas consumed for domestic purpose in 1917 exceeded the volume in 1916 by 1,912,194,000 cubic feet, or 10 per cent, and the number of beneficiaries of domestic gas service increased from 159,886 at the end of 1916 to 164,308 at the end of 1917, a net gain of about 3 per cent. The volume of gas consumed for industrial purposes in 1917 was less by 39,469,000 cubic feet, or 2 per cent, than in 1916, though its market value was greater by $43,074 than in 1916 and the number of industrial consumers was greater by 22 at the end of 1917 than at the beginning of the year.

The average volume of natural gas required monthly by each domestic consumer in New York in 1917 was 10,660 cubic feet and his average monthly expense for natural gas service was $3.35. In 1916 the average volume used monthly was 9,830 cubic feet and the average monthly cost was $3.07.

The deficiency between the volume of natural gas consumed in New York in 1917 and the volume produced in the State in that year was piped in from Pennsylvania.

Record of natural-gas industry in New York, 1898–1917.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1898	62	$229,078	[a] 68,662	103	$1,006,567	63	9	422
1899	84	294,593	[a] 76,544	121	1,236,007	36	7	447
1900	89	335,367	[a] 89,837	138	1,456,286	57	11	504
1901	114	293,232	[a] 95,161	98	1,694,925	53	14	557
1902	116	346,471	50,536	215	1,723,709	69	8	626
1903	144	493,686	57,935	208	1,944,667	75	11	700
1904	153	522,575	67,203	451	2,222,980	78	12	744
1905	148	623,251	67,848	447	2,434,894	89	17	839
1906	143	672,795	74,538	95	2,654,115	64	14	919
1907	208	766,157	83,805	155	3,098,533	61	13	1,049
1908	215	959,280	91,391	213	3,281,312	68	19	1,211
1909	282	1,222,666	92,958	570	3,286,523	86	18	1,340
1910	273	1,678,720	106,538	717	3,963,872	97	20	1,411
1911	302	1,418,767	116,314	208	4,276,324	167	53	1,531
1912	332	2,343,379	129,930	805	4,866,821	218	54	1,736
1913	366	2,425,633	136,830	639	4,888,412	200	54	1,929
1914	367	2,600,352	146,236	666	5,510,204	178	55	2,031
1915	346	2,335,252	153,972	815	5,676,097	176	50	2,046
1916	360	2,355,320	159,886	676	6,230,826	106	35	2,068
1917	349	2,499,303	164,308	698	6,912,540	95	42	2,078

[a] Number of fires supplied.

Depth and rock pressure of wells in New York, 1913–1917.

County.	Depth (feet).	Pressure (pounds).				
		1913	1914	1915	1916	1917
Allegany	600–2,000	7–250	15–150	10–250	8–200	8–200
Cattaraugus	400–3,300	0– 500	0–400	5–150	4–280	5– 75
Chautauqua	150–3,250	0– 700	0–800	0–750	0–402	1–640
Erie	360–3,200	42–[a] 1,000	15–750	30–700	30–900	80–700
Niagara	550	....	....	....	....	....
Genesee	1,150–1,905	400	450	500–600	500	500
Livingston	345–2,000	200–400	200–350	150–350	250–300	200–350
Monroe	440–1,400	160–400	160–205	220	210	....
Onondaga	1,000–3,000	400-600	300	150	....	....
Ontario	114–2,400	1–450	3– 60	50–480	50–200	50–150
Seneca	1,250–1,550					
Oswego	700–1,700	25–145	3–300	10–200	25–500	25
Schuyler	1,000–1,800	150–435	3–435	5–300	....	2–280
Yates	375–1,900					
Steuben	130–1,200	75–400	75–200	75–145	75–150	75–150
Wyoming	1,100–2,000	140–400	250–300	165–210	200	165–210

[a] New well.

PENNSYLVANIA.

GENERAL STATEMENT.

As a contributor to the volume of natural gas consumed annually in the United States, Pennsylvania has been an important factor since the earliest development of the natural-gas industry on a commercial scale. As early as 1872 waste gas from oil wells was utilized for light and fuel in Titusville, Crawford County, and in Karns City, Petrolia, Argyle, and Fairview, Butler County; and as early as 1873 it was employed as an industrial fuel in iron and steel plants near Pittsburgh. Between 1883, when gas from the Murrysville district, Westmoreland County, was first piped to Pittsburgh (and the natural-gas industry, as such, may be said to have really begun), and 1892 the value of the natural gas produced annually in Pennsylvania exceeded the combined value of the output from all the other gas-producing States, and until 1910 the value of Pennsylvania's annual output of natural gas was greater than that of any other State. In 1910 Pennsylvania was forced to yield first place, based on the market value of gas produced, to West Virginia, but since that year it has retained second place without serious competition.

The natural gas fields of Pennsylvania are essentially coincident with the oil fields of the State, though they extend a few miles beyond the oil belt along its eastern boundary. They are distributed over 23 counties in the western and northwestern parts of the State and occupy the broad belt of gently folded strata that make up the Allegheny Plateau.

Natural gas in Pennsylvania is obtained commercially from a great number of productive sandstone layers included in the stratigraphic range between the Kane sand in the lower part of the Devonian system and the Hurry-up sand at the base of the Conemaugh formation of the Pennsylvanian (upper Carboniferous) series.

The principal gas-yielding sands in the State are as follows: Northwestern Pennsylvania—Kane, Elk (Waugh and Porter), Bradford, Cherry Grove, Speechley, Tiona, Warren second, Warren first, and Elizabeth, of the Devonian system; western Pennsylvania—Gordon, Bowlder, and Thirty-foot, probably belonging to the Devonian system, and Fifty-foot, Gantz, and Berea (Butler County gas sand), of the Mississippian series; southwestern Pennsylvania—Fifth, Gordon, Bowlder, and Thirty-foot of the Devonian (?) system; Fifty-foot, Gantz, Murrysville, Berea, and Big Injun sands of the Mississippian series; and the Maxton sand and the Homewood and Mahoning sandstones of the Pennsylvanian series. In Erie County shallow wells sunk in the dark carbonaceous shale in the upper part of the Devonian system yield small volumes of low-pressure gas, rarely more than enough to supply the domestic requirements of two or three households each.

PRODUCTION.

It is estimated that the volume of natural gas produced commercially in Pennsylvania in 1917 was 133,397,206,000 cubic feet, a gain of 2,913,501,000 cubic feet, or 2 per cent, over the output in

1916. This volume is greater than that produced in Pennsylvania in any other year except 1912, when the output was in excess of 135,000,000,000 cubic feet.

The average price received for this gas at the place of consumption was 21.53 cents a thousand cubic feet and the market value of the entire output was $28,716,492, a gain of 2.75 cents, or 15 per cent, in unit selling price and of $4,203,373, or 17 per cent, in gross market value, compared with 1916.

In response to increased demands for natural gas resulting from the combination of an unusually early and severe winter and a shortage of coal with unprecedented industrial activity in the Pittsburgh district, field activity in the quest of natural gas in Pennsylvania attained record proportions in 1917. More wells were drilled for gas in Pennsylvania in that year than in any preceding year. In all 1,436 wells were completed, 1,163, or 81 per cent, of which were successful and only 273, an average of about 1 in every 5 drilled, were barren. In the course of the year 550 exhausted gas wells were abandoned and at its end there were 14,534 gas wells in service in the State, a net gain of 613 wells in 1917.

No new territory of consequence was discovered notwithstanding the augmented drilling campaign, which, because of the urgency of the need for gas, of the scarcity of prospective gas territory in the State, and of a limited supply both of drilling equipment and of labor, was restricted in the main to areas of known worth.

The discovery, late in October, of natural gas in fair volume and under a closed pressure of more than 320 pounds to the square inch, at moderate depth, near Knoxville, Tioga County, resulted in the starting of additional tests in that locality in the hope of developing an important gas field several miles northeast of the Gaines-Watrous district, heretofore the easternmost gas field in the State. Farther to the east in Bradford County considerable acreage was leased for natural-gas tests in the vicinity of Towanda, Wysox, Standing Stone, Sheshequin, Asylum, and Terrytown.

The deep well of the Peoples Natural Gas Co. (R. A. Geary No.770) on the Candor dome about 5 miles northeast of McDonald, Washington County, on which drilling had been in progress since November, 1911, was finally abandoned in the summer of 1917, at a total depth of 7,248 feet. The well was drilled in an effort to test the possibilities of the Clinton oil and gas zone, but was reluctantly abandoned because of the loss of drilling tools, probably in the Salina formation, only a few hundred feet at most above its objective.

CONSUMPTION.

Though third in rank in 1917 as a producer of natural gas, Pennsylvania easily retained the premier position it has long held as a consumer of that fuel. The volume of natural gas required annually for the operation of the blast furnaces, foundries, and rolling mills of the iron and steel industry and the large manufacturing plants of a score of other industries centered in the Pittsburgh district alone is more than double the volume required to supply the needs of nearly half a million domestic consumers of natural gas in the same State, and in each of the last seven years this Pittsburgh demand has exceeded the entire volume of gas produced in the State by several billion cubic feet.

It is estimated that 202,259,498,000 cubic feet of natural gas was consumed in Pennsylvania in 1917. This volume exceeds that consumed in 1916 by only 798,605,000 cubic feet, or about 0.4 per cent, but it establishes a new record for the consumption of gas in the State.

The market value of this gas at the place of consumption was $40,773,689, a gain of $5,757,994, or 16 per cent, over 1916, which is accounted for by an increase of 2.78 cents in the average retail price of the gas, the increase being from 17.38 cents a thousand in 1916 to 20.16 cents in 1917.

Of the total volume consumed in 1917 about 63,135,783,000 cubic feet, or 31 per cent, valued at $18,110,975, or 44 per cent of the total market value of all gas consumed in the State, was supplied to 480,500 domestic consumers at an average price of 28.69 cents a thousand cubic feet. Compared with corresponding figures for 1916 these data show in 1917 gains of 14 per cent in the volume of gas consumed for domestic purposes, of 19 per cent in its total market value, of 4 per cent in the number of domestic consumers, and of 1.43 cents in the average price per thousand cubic feet paid for natural-gas service by the consumer in Pennsylvania. The volume of natural gas required monthly by each domestic consumer in 1917 averaged 11,150 cubic feet, compared with 10,000 cubic feet in 1916, and his monthly gas bill averaged $3.20, compared with $2.73 in 1916.

The remaining 69 per cent of the gas consumed in Pennsylvania in 1917, representing 56 per cent of the market value of all gas consumed in the State in that year, was supplied to 4,417 industrial consumers, at an average price of 16.29 cents a thousand cubic feet. Compared with corresponding data for 1916 these statistics show loss of 5 per cent in the volume of gas used for industrial purposes and of 6 per cent in the number of industrial consumers, but gain of 14 per cent in the market value of the gas consumed and of 2.68 cents in the average price per thousand paid by industrial consumers. Further analysis of the statistics relating to industrial consumption in 1917 shows that 89 per cent of the gas consumed was utilized directly as a source of heat in manufacturing plants and that only 11 per cent was consumed in the generation of power, either directly in gas engines or indirectly under steam boilers.

The change in the ratio of the volume of gas supplied to domestic consumers to that of the volume supplied to industrial consumers from 28 to 72 in 1916 to 31 to 69 in 1917 was due of course in part to the increase of 4 per cent in the number of domestic consumers served, but in larger part to the unusual severity of the winter of 1917–18 and its shortage of coal, which resulted in extensive curtailment of deliveries of natural gas for industrial use during the earlier weeks of the year.

Record of natural-gas industry in Pennsylvania, 1898–1917.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31
			Domestic.	Industrial.		Gas.	Dry.	
1898	232	$6,806,742	[a] 213,410	1,021	$6,064,477	373	74	2,840
1899	281	8,337,210	[a] 232,060	1,236	7,926,970	467	104	3,303
1900	266	10,215,412	[a] 229,730	1,296	9,812,615	513	142	3,776
1901	296	12,688,161	[a] 326,912	1,743	11,785,996	660	143	4,436
1902	379	14,352,183	185,678	2,448	13,942,783	775	232	5,211
1903	414	16,182,834	214,432	2,834	16,060,196	699	126	5,910
1904	414	18,139,914	238,481	2,929	17,205,804	701	174	6,352
1905	351	19,197,336	257,416	2,845	19,237,218	765	168	6,566
1906	309	18,558,245	273,184	3,307	21,085,077	603	153	7,300
1907	344	18,844,156	295,115	3,812	22,917,547	769	180	8,051
1908	[b] 572	19,104,944	307,585	4,577	20,678,161	571	147	[c] 8,831
1909	[b] 777	20,475,207	294,781	5,377	21,639,102	756	166	[c] 9,499
1910	[b] 819	21,057,211	321,430	4,102	23,934,691	857	161	[c] 10,337
1911	[b] 1,067	18,520,796	330,537	4,597	23,940,001	832	224	[c] 10,885
1912	[b] 1,104	18,539,672	345,765	3,442	26,486,302	993	219	[c] 11,543
1913	[b] 1,174	21,695,845	400,823	4,373	28,709,565	1,011	259	[c] 12,438
1914	[b] 1,325	20,839,869	415,644	4,307	28,439,324	998	236	[c] 13,073
1915	[b] 1,396	21,139,605	440,673	4,696	30,087,667	863	188	[c] 13,431
1916	[b] 1,586	24,513,119	463,264	4,676	35,015,695	1,009	252	[c] 13,921
1917	[b] 1,613	28,716,492	480,500	4,417	40,773,689	1,163	273	14,534

[a] Number of fires supplied.
[b] Includes 216 producers having shallow wells in Erie County for their own domestic consumption in 1908, 311 producers in 1909, 345 producers in 1910, 399 in 1911, and 401 in 1912, 1913, 1914, 1915, 1916, and 1917.
[c] Includes 350 shallow wells in Erie County in 1908, 429 in 1909 and 1910, 476 in 1911, and 492 in 1912, 1913, 1914, and 1915, 483 in 1916, and 450 in 1917.

Depth and rock pressure of wells in Pennsylvania, 1913–1917.

County.	Depth (feet).	Pressure (pounds).				
		1913	1914	1915	1916	1917
Allegheny	750-3,500	15-[a]1,000	10- 700	10- 900	10- 700	8-600
Armstrong	575-3,600	1- 500	1- 800	3- 500	3- 700	2-500
Beaver	700-2,000	30- 510	40- 560	30- 200	10- 125	25-125
Butler	700-3,384	4- 850	8- 450	8- [a]600	5-[a]800	2-800
Clarion	506-3,100	2- 800	0- 700	2- [a]850	10- 700	4-700
Elk	500-3,200	50- [a]980	60-[a]1,000	60- [a]900	50- 800	6-1,200
Crawford Erie	550-1,200 300-1,600	10- 50	5- 40	25- 30	....	....
Fayette Cambria	1,200-2,772 2,350-2,500	35- 700	35- 550	600	400- 570	300-400
Forest	370-3,165	17- 700	25- 600	3- 700	21-[a]900	5-600
Greene	680-3,600	39- 750	50- 650	30- 600	30-[a]700	28-540
Indiana	1,100-1,860	600	500	300	....	....
Jefferson	700-3,360	100- 960	15-[a]1,100	5- 800	10- 740	10-850
McKean	750-3,000	3- 800	2- 525	7- 900	4-[a]800	2-700
Mercer Lawrence	800-1,150 650- 850	51- 300	26- 450	150- 450	230- 280	60-280
Potter	750-2,400	20- 600	50- 385	20- 300	70- 250	30-150
Tioga	700-1,400	....	....	....	....	....
Venango	350-2,700	10- 200	24- 450	15- 400	10- 600	17-200
Warren	500-3,290	5- 280	5- 300	8- 80	0- 300	2-400
Washington	606-3,500	5- 400	5- 400	2- 400	10- 500	8-500
Westmoreland	1,200-3,800	6-[a]1,000	16-[a]1,000	1-[a]1,000	3-[a]900	2-800

[a] New well.

WEST VIRGINIA.

GENERAL STATEMENT.

The year 1917 was the ninth consecutive year in which West Virginia has led the gas-producing States of this country in volume of natural gas produced and the eighth in which it has led in value.

Natural gas has been utilized in West Virginia since 1841, when it was adopted as a fuel for evaporating brine in the salt industry that was then centered in the Great Kanawha Valley, near Charleston. As early as 1884 natural gas was supplied to domestic and industrial consumers in Wellsburg, Brooke County, but it was not until the nineties that the natural-gas industry in this State became important. Since 1896 the value of the annual production of natural gas in West Virginia has shown a steady increase, doubling once in 1898, again in 1900, again in 1903, and again in 1916. Since 1906, the first year for which an estimate of the volume of natural gas produced in West Virginia is available, the volume of the annual production has more than doubled and its value has considerably more than trebled. The volume of natural gas piped from West Virginia for consumption in other States in 1916 was greater by 78,000,000,000 cubic feet than the entire volume produced in that State in 1906.

The natural-gas fields of West Virginia are distributed over 32 counties of the State and lie west of the Appalachian Mountains in the maturely dissected Allegheny Plateau province. In this State natural gas is found more abundantly than in Pennsylvania, not only as "wet" gas in association with petroleum, but as "dry" gas accumulated under favorable conditions in the sandstone or limestone reservoirs that yield no oil. The gas fields of the State are broadly coincident with the oil fields, but, as in Pennsylvania, the eastern boundary of the gas belt lies a few miles in advance of the eastern limits of oil production.

Stratigraphically the oil and gas bearing rocks of West Virginia range in position from the base of beds that have been called Catskill (?) formation and assigned tentatively to the upper part of the Devonian system to the lower part of the Monongahela formation of the Pennsylvanian series, oil and gas being found in a great number of sandstones and one limestone (Greenbrier limestone or Big lime) between the Elizabeth or Seventh sand at the base and the Carroll sand or Uniontown sandstone member at the top. Of these the principal sources of natural gas are, in descending order, the Gas (Second Cow Run), Salt, Maxton, Big lime, Big Injun, Berea, and Gordon sands.

PRODUCTION.

The volume of natural gas produced and marketed in West Virginia in 1917 establishes a new record for production of gas in that State and is more than double the production credited to any other State in that year. It is estimated at 308,617,101,000 cubic feet, a volume that exceeded the former record of 299,318,907,000 cubic feet established in 1916, by 9,298,194,000 cubic feet, or 3 per cent.

The market value of this output, based on its retail selling price, also attained the record amount of $57,389,161, a gain of $9,785,765, or 20 per cent, over the market value of the output in 1916. A part of this gain was due of course to the augmented volume of gas involved in 1917, but the principal part of it was due to the substantial increase of 2.70 cents per thousand cubic feet in the average selling price, compared with that maintained in 1916. The average retail price of the production in 1917 was 18.60 cents a thousand cubic feet, as against 15.90 cents in 1916.

Activity in drilling for natural gas in West Virginia, though slightly less in 1917 than in 1916 was, nevertheless, greater than in normal years because of the unusual demands for gaseous fuel in the industrial districts that are dependent on the gas fields of that State.

The results of the quest for natural gas in West Virginia in 1917 included 1,040 gas wells and 138 barren wells, a total of 1,178 wells or only 38 less than the number drilled in 1916. Exclusive of the great number of wells that produced both gas and petroleum there were in West Virginia at the end of 1917 some 9,329 wells that produced gas exclusively, this number representing a net gain of 787 wells over the number in service at the beginning of the year.

Of the total volume of natural gas produced in West Virginia in 1917 it is estimated that 167,771,351,000 cubic feet, or about 54 per cent, compared with 104,664,536,000 cubic feet in 1916, representing 35 per cent of the output in that year, was subjected to treatment for the recovery of gasoline vapors, and that the motor-fuel supply of the country was augmented to the extent of nearly 33,000,000 gallons of raw-gas gasoline as a consequence.

New gas territory of promise was opened in 1917 by the Comet Oil & Gas Co., near Prunytown, Taylor County, the gas proving a welcome addition to the supply available for distribution in Prunytown and Grafton. Drilling was continued in 1917 in the deep test of the Hope Natural Gas Co., on the farm of Martha O. Goff, on Owens Fork, Simpson district, Harrison County, and at the end of the year the well was reported to have reached a depth of about 7,200 feet.

In addition to supplying the greater part of its own requirements of natural gas in 1917, West Virginia supplied a volume of gas estimated at 196,924,922,000 cubic feet, and having a market value of $47,745,196 to consumers in Pennsylvania, Ohio, Indiana, Kentucky, and Maryland.

CONSUMPTION.

Inclusive of the gas consumed in a few towns in western Maryland adjacent to the West Virginia boundary, the volume of natural gas consumed in West Virginia in 1917 is estimated at 115,488,192,000 cubic feet, or about 37 per cent of the total volume produced in the State. This volume is greater by about 10,384,184,000 cubic feet, or 10 per cent, than the volume consumed locally in 1916.

The average price paid by all consumers of natural gas in West Virginia in 1917 was 9.14 cents a thousand cubic feet, an increase of 0.95 cent compared with the average retail price in 1916. As a consequence of this increase and of the larger volume of gas consumed the market value ($10,558,612) of the entire volume consumed was greater by $1,948,528, or 23 per cent, than the market value of the gas consumed in 1916.

Of the total volume consumed in 1917, it is estimated that 21,258,009,000 cubic feet, or 18 per cent, valued at $3,999,833, was distributed to 129,297 domestic consumers at an average price of 18.82 cents a thousand cubic feet and that the remaining 82 per cent, valued at $6,558,779, was distributed to 2,047 industrial consumers at an average rate of 6.96 cents a thousand.

A comparison of these data with corresponding statistics for 1916 shows with regard to the consumption of natural gas for domestic purposes in 1917 gains of 2,478,138,000 cubic feet, or 13 per cent, in volume; of $610,433, or 18 per cent, in market value; of 5,437, or 4 per cent, in the number of consumers; and of only 0.17 cent, or about 1 per cent, in the average retail rate per thousand cubic feet.

The average monthly consumption of natural gas by each domestic consumer in West Virginia in 1917 was about 14,000 cubic feet, this volume being supplied at an average monthly cost of $2.55. In 1916 the average monthly consumption was 12,700 cubic feet and the average monthly cost was $2.30.

With regard to the consumption of natural gas in West Virginia and Maryland for industrial purposes a comparison of available statistics for 1916 and 1917 shows in 1917 gain of 9 per cent in volume, of 26 per cent in market value, of 4 per cent in the number of consumers, and of 0.91 cent, or 15 per cent, in the average rate per thousand cubic feet.

Of the total volume of natural gas consumed for industrial purposes in West Virginia in 1917, it is estimated that 28,392,707,000 cubic feet, or approximately 30 per cent, valued at $773,876, an average of 2.60 cents a thousand cubic feet, was consumed in the manufacture of carbon black.

It is estimated that in all about 70,771,137,000 cubic feet of natural gas, sold at an average rate of 6.98 cents a thousand cubic feet, was consumed for manufacturing purposes in West Virginia in 1917 and that 23,459,046,000 cubic feet, sold at an average rate of 6.91 cents a thousand, was consumed in the oil fields and in the direct development of power.

Of the total volume of natural gas consumed in West Virginia in 1917 a small proportion was piped into the State from Pennsylvania and Ohio as a matter of convenience to supply consumers adjacent to the State boundaries.

Record of natural-gas industry in West Virginia, 1898–1917.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1898	19	$1,334,023	a 28,652	125	$914,969	32	4	227
1899	30	2,335,864	a 28,137	305	1,310,675	78	6	300
1900	34	2,959,032	a 45,943	184	1,530,378	129	6	428
1901	44	3,954,472	a 55,808	266	2,244,758	177	8	604
1902	79	5,390,181	29,357	877	2,473,174	142	37	745
1903	88	6,882,359	36,179	1,122	3,125,061	242	43	987
1904	90	8,114,249	44,563	1,005	3,383,515	292	33	1,274
1905	76	10,075,804	45,588	1,417	3,586,608	385	28	1,579
1906	67	13,735,343	51,281	913	3,720,440	263	23	1,831
1907	105	16,670,962	53,807	1,000	b 3,757,977	377	59	2,169
1908	138	14,837,130	63,228	1,225	b 4,020,282	441	80	2,511
1909	183	17,538,565	70,853	1,907	b 5,183,054	801	65	3,232
1910	241	23,816,553	86,778	2,659	b 5,617,910	1,002	69	4,052
1911	340	28,435,907	87,438	1,566	b 6,240,152	905	117	4,790
1912	406	33,324,475	94,273	1,953	b 7,001,331	870	149	5,533
1913	451	34,164,850	101,234	1,834	b 7,333,956	1,038	128	6,534
1914	475	35,076,755	108,277	1,850	b 7,334,690	856	154	7,194
1915	506	36,424,263	115,908	1,910	b 7,451,003	779	97	7,718
1916	544	47,603,396	123,860	1,963	b 8,610,084	1,055	161	8,542
1917	521	57,389,161	129,297	2,047	b 10,558,612	1,040	138	9,329

a Number of fires supplied.

b Includes gas consumed in Maryland.

Depth and rock pressure of wells in West Virginia, 1913–1917.

County.	Depth (feet).	Pressure (pounds).				
		1913	1914	1915	1916	1917
Boone	1,060–3,900	400– 525	130– 550	200– 600	435	435
Braxton	1,200–3,000	....	400	800	550–650	214–675
Clay	1,400–2,800	200– 450	300– 500	250– 400	100–420	300–507
Taylor	1,453–2,800	400– 1,000	110– 800	135– 800	250–450	300–600
Brooke	1,200–1,950	0– 640	0– 80	0– 80	0–150	20–125
Cabell	900–2,800	350– 500	400	400	....	....
Calhoun	824–4,000	60– 400	10–[a]1,200	20– 650	50–540	100–500
Doddridge	1,400–3,100	75– 900	50– 465	50– 400	25–400	25–800
Gilmer	1,148–3,181	100– 180	100– 600	112– 700	160–650	225–650
Hancock	700–1,880	40– 100	20– 75	30	75	75
Harrison	700–4,500	50– 900	100– 900	70– 800	30–850	30–650
Kanawha	715–2,585	50– 500	225– 500	210– 480	90–490	90–600
Lewis	1,127–3,000	50–[a]1,100	20–[a]1,000	80–[a]900	85–800	50–225
Lincoln	900–2,720	400– 560	300– 540	220– 500	250–550	75–550
Logan	1,122–2,200	75– 540	75– 540	400– 450	300	400
Marion	1,280–3,478	40– 500	75– 600	30–[a]925	15–500	30–300
Marshall	1,000–3,500	125– 300	110– 300	110– 150	60–200	80–300
Mingo Wayne	1,600–2,600 1,300–2,000	250 600	200– 500	425– 580	50–550	110–500
Monongalia	1,250–3,500	60– 820	60– 800	37– 725	30–300	28–700
Nicholas Ohio Pocahontas	1,200–1,300 550–2,000 2,000–2,500	25– 350	15– 350	15– 525	20	20
Pleasants	900–2,150	30– 500	30– 250	125– 375	30–400	125–400
Putnam	900–2,400	....	....	....	....	....
Upshur	1,928–2,800	460	350– 360	240	100	....
Ritchie	600–3,000	30– 700	20– 600	20– 500	20–730	45–600
Roane	1,450–2,700	350– 750	240– 600	175– 500	200–400	40–340
Tyler	1,400–3,400	50– 650	150– 685	10– 500	25–450	100–110
Wetzel	1,000–3,560	5– 150	5– 150	50– 130	50–600	30–470
Wirt	500–1,875	18– 275	70– 125	30– 150	30–100	30– 40
Wood	1,030–1,900	150– 500	198– 400	40– 460	200–400	100–150

[a] New well.

OHIO.

GENERAL STATEMENT.

A decline of slightly more than 1 per cent in the volume of natural gas produced commercially in Ohio in 1917 was insufficient to affect the rank of this State, its position of fourth among the States that produce natural gas being maintained by a margin of 29 per cent over its nearest competitor, California.

Natural gas has been in use in Ohio since 1838, when it was employed as fuel in the residence of Daniel Foster in Findlay, Hancock County, the supply being derived from a well drilled for water. As early as 1860 oil-field gas was used in the manufacture of salt at East Liverpool, Columbiana County, but it was not until the early seventies that the drilling of wells specifically for gas was undertaken in Ohio. As an industry apart from the petroleum industry the natural-gas industry of Ohio was unimportant until the discovery of the great reservoirs of this fuel in the "Trenton" limestone, in Hancock County, in 1884–1886. In the decade 1885–1894 the value of the natural gas produced annually in Ohio increased from $100,000 to more than $1,000,000, and in the succeeding 10 years to more than $5,000,000. Since 1904 it has been in excess of $5,000,000 annually, and since 1911 it has been in excess of $10,000,000.

The natural-gas fields of Ohio are distributed over some 50 counties lying in the eastern half and the northwestern quarter of the State. The principal field, generally referred to as the central Ohio gas belt, is a little east of the central part of the State and extends from Vinton County on the south to Lake Erie on the north, the continuity of the field being broken by unproductive areas in southern Hocking, central Fairfield, southern Ashland, central Medina, and southern Cuyahoga counties.

In northeastern Ohio gas in small volume is obtained in shallow wells sunk in the black Ohio shale of the Devonian system, the yield of individual wells being rarely more than sufficient for the fuel needs of more than two families. Outside the central gas belt and the shale gas area the natural gas produced in Ohio is for the most part obtained from wells that also yield petroleum.

In southeastern Ohio natural gas is obtained from a number of productive sands in the succession of rocks between the Berea sandstone at the base of the Mississippian series, and the Goose Run sand, in the upper part of the Monongahela formation of the Pennsylvanian series. In the central gas belt production is obtained chiefly from the Clinton sand of the Silurian system. In the northwestern part of the State the principal source of natural gas is the "Trenton" limestone of the Ordovician system.

PRODUCTION.

The volume of natural gas produced profitably in Ohio in 1917 is estimated to have amounted to not less than 68,917,231,000 cubic feet, a decline of only 970,839,000 cubic feet, or 1.4 per cent, from 1916. Its market value ($18,434,814), on the other hand, was greater than the market value of the natural gas produced in the State in any preceding year and was greater than the value of the output in 1916 by $2,833,670, or 15 per cent. The average price received for this gas at the point of consumption was 26.75 cents a thousand cubic feet, a gain of 4.43 cents, or 20 per cent, over the average price received in 1916, which is accounted for in part by the fact that a larger proportion of the gas produced in 1917 was distributed to domestic consumers than of the gas produced in 1916 and in part by the fact that rates for industrial gas in Ohio in 1917 were considerably higher than in 1916.

No new gas fields of consequence were discovered in Ohio in 1917, the principal part of the production coming, as in other recent years, from the many pools of the central Ohio gas belt, which received an unusually active development during the year. In all 806 wells were drilled for gas in Ohio in 1917, a gain of 9 wells over 1916. Of these wells 552, or 68 per cent, were successful and 254, an average of about 1 in every 3 drilled, were failures.

Inclusive of 1,646 shale-gas wells in northeastern Ohio, but exclusive of the oil wells that contribute to the gas supply of the State, it is estimated that there were 5,979 gas wells in service in Ohio at the end of 1917, a net loss of 74 wells during the year.

The area reported held for natural-gas development in Ohio at the end of 1917 aggregated 2,260,028 acres, an increase of 701,797 acres during the year.

CONSUMPTION.

As a consumer of natural gas, Ohio is outranked only by Pennsylvania in the matter of volume. In the matter of the market value of the gas consumed, Ohio has led the other natural-gas consuming States since 1914. This circumstance is accounted for by the fact that more than one-half the volume of natural gas consumed in Ohio is piped in from other States, chiefly from West Virginia, and the cost of its transportation forms an integral part of the market value of the gas.

It is estimated that 165,782,369,000 cubic feet of natural gas was consumed in Ohio in 1917, a decrease of 3,697,642,000 cubic feet, or 2 per cent from 1915. As will be noted from subsequent figures this decrease lay wholly in the volume of gas consumed for industrial purposes, the curtailment in this regard being necessitated by the shortage of fuel during the winter months and the inability of the gas-distributing companies to secure an adequate supply of gas for both domestic and industrial demands. The average price per thousand cubic feet at which natural gas retailed in Ohio in 1917 was 26.99 cents, an increase of 4.93 cents over the price in 1916. As a consequence of this increase the market value of the gas consumed, which was $44,742,782, was greater than that of the gas consumed in 1916 by $7,348,372, or 16 per cent.

Of the total volume of natural gas consumed in Ohio in 1917 no less than 101,584,452,000 cubic feet, or 61 per cent, valued at $31,455,004, or 70 per cent of the total volume consumed, was distributed to 872,073 domestic consumers at an average price of 30.96 cents a thousand cubic feet. Compared with corresponding statistics for 1916 these data show increase of about 20 per cent in the volume of gas consumed, of 25 per cent in its market value, of 35,245 in the number of domestic consumers, but of only 1.18 cents in the average price per thousand cubic feet paid by that class of consumers.

Assuming that 854,450 domestic consumers in Ohio were favored with natural gas service the entire year, the average volume consumed monthly by each consumer was 9,900 cubic feet and its average monthly cost was $3.07. Average monthly consumption in 1916 was 8,500 cubic feet and average monthly cost was $2.53.

The remaining 39 per cent of the volume of natural gas consumed in Ohio in 1917, representing 30 per cent of the total value of the natural gas consumed in the State in that year, was supplied to 4,743 industrial consumers at an average price of 20.70 cents a thousand. Compared with 1916 these data show a loss in 1917 of 24 per cent in volume, but gains of 141 in the number of consumers supplied, of 10 per cent in market value, and of 6.33 cents, or 44 per cent, in the average rate for industrial service. Of the total volume of natural gas consumed in Ohio in 1916 approximately 50 per cent was distributed to industrial consumers.

It is estimated that the satisfaction of demands for natural gas in Ohio in 1917 required the piping into that State, mainly from West Virginia, of some 96,865,138,000 cubic feet of gas, a volume 27,947,907,000 cubic feet greater than the State's production of natural gas in that year.

Record of natural-gas industry in Ohio, 1898–1917.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1898	237	$1,488,308	a 68,211	349	$2,250,706	120	12	806
1899	359	1,866,271	a 77,787	691	3,207,286	134	17	929
1900	281	2,178,234	a 135,743	1,092	3,823,209	97	19	990
1901	305	2,147,215	a 149,709	949	4,119,059	113	35	1,099
1902	451	2,355,458	120,127	786	4,785,766	266	40	1,343
1903	515	4,479,040	197,710	1,786	7,200,867	290	62	1,523
1904	453	5,315,564	232,557	1,136	9,393,843	334	49	1,661
1905	425	5,721,462	274,585	2,955	10,396,633	342	58	1,705
1906	409	7,145,809	310,175	3,316	12,652,520	337	51	b 1,977
1907	468	8,718,562	380,489	5,476	15,227,780	431	90	2,942
1908	c 970	8,244,835	427,276	3,621	15,166,434	398	124	d 3,691
1909	c 1,534	9,966,938	450,973	5,260	18,884,312	548	149	d 4,260
1910	c 1,630	8,626,954	475,505	3,187	21,210,965	466	202	d 4,717
1911	c 1,900	9,367,347	577,263	3,634	22,792,270	450	191	d 4,999
1912	c 2,031	11,891,299	641,724	4,414	27,196,162	637	289	d 5,163
1913	c 2,056	10,521,930	685,956	5,010	27,055,824	408	235	d 5,308
1914	c 2,268	14,667,790	734,354	6,102	29,936,642	686	257	d 5,809
1915	c 2,499	17,391,060	773,548	5,621	31,900,764	800	260	d 6,064
1916	c 2,503	15,601,144	836,828	4,602	37,394,410	593	204	d 6,053
1917	c 2,320	18,434,814	872,073	4,743	44,742,782	552	254	5,979

a Number of fires supplied.
b Exclusive of complete report of shallow wells.
c Includes 735 producers in Ashtabula, Erie, Huron, Lake, Lorain, and Cuyahoga counties having shallow wells for their own domestic purposes in 1908, 1,239 in 1909, 1,289 in 1910, 1,476 in 1911, 1,579 in 1912, 1,600 in 1913, and 1,561 in 1914, 1915, and 1916, and 1,506 in 1917.
d Includes 901 shallow wells located in Ashtabula, Erie, Huron, Lake, Lorain, and Cuyahoga counties in 1908, 1,568 in 1909, 1,541 in 1910, 1,757 in 1911, 1,773 in 1912, 1,778 in 1913, and 1,733 in 1914, 1915, and 1916, and 1,646 in 1917.

Depth and rock pressure of wells in Ohio, 1913–1917.

County.	Depth (feet).	Pressure (pounds.)				
		1913	1914	1915	1916	1917
Allen	1,200–1,470	...	...	...	...	...
Ashland	2,400–3,000	90– 500	105– 300	80– 500	75– 400	80– 310
Ashtabula	400–2,200	...	30– 250	20– a 670	20– 740	525– 750
Athens	440–1,500	50– 350	10– 170	30– 170	20– 150	0– 160
Auglaize	1,100–1,300	3– 140	7– 70	5–	1– 5	5– 70
Belmont	778–2,200	60– 140	125	110– 125	100– 600	125– 200
Carroll	500–1,434	90– 150	...	...	...	...
Clermont	500– 513	...				
Clinton	715–	95	100	90	60	...
Columbiana	500–2,000	16– 300	16– 350	25– 300	12– 325	30– 350
Cuyahoga	337–3,200	0–a 1,000	0–a 1,200	0–a 1,100	0– 750	10–1,000
Darke	750–1,500	2– 200	2– 250	2– 300	0– 300	18– 200
Erie	350– 650	...	...	...	...	...
Fairfield	213–2,800	16– 320	25– 325	25– 150	15– 400	25– 350
Fulton	80– 150	...	...	...	0– 30	8– 20
Guernsey	700–1,500	300	300	30– 400	25– 400	0– 350
Muskingum	800–3,350					(1)
Hancock	800–1,800	2– 150	1– 200	1– a 400	0– 300	1– 200
Hardin	1,200–1,800	20– 300	20– 350	15– 425	10– 425	25– 350
Harrison	400–1,650	5– 225	8– 300	18– 200	2– 190	5– 450
Hocking	750–3,300	...	430	300	240	...
Huron	400– 800	...	...	...	...	...
Holmes	600–1,160	80– 165	80– 165	80– 180	80– 260	0– 200
Jefferson	600–2,026	15– 300	20– 250	15– 150	40– 200	10– 175
Knox	590–3,500	50– 300	75– 250	75– 300	75– 900	35– 880
Lake	360–1,700	...	...	...	...	...
Lawrence	1,600–1,834	750	425	500– 600	...	200– 500
Licking	1,950–3,000	30– 450	30– a 600	40– a 625	45– 625	40– 450
Logan	1,234–1,500	160	30– 120	125– 200	50– 150	15– 100
Lorain	338–2,590	0– 675	0– 150	0– 54	...	0– 54
Lucas	700–1,550	9– 30	5– 39	8– 35	18	10– 40

a New well.

Depth and rock pressure of wells in Ohio, 1913–1917—Continued.

County.	Depth (feet).	Pressure (pounds).				
		1913	1914	1915	1916	1917
Mahoning	500–2,000	150– 158	70– 187	85– 187	80– 160	60– 175
Medina	175–3,000	2– 500	3– 300	2– 50	2– 20	2– 25
Meigs	600–2,000	....	....	....	0– 115	....
Mercer	1,000–1,400	1– 105	5– 75	4– 180	4– 100	1– 40
Monroe	650–2,400	3– 100	20– 350	20– 160	474– 400	45– 400
Morgan	240–1,650	15– 450	20– 350	40– 500	40– *a* 570	....
Noble	484–2,000	150– 620	40– 380	40– 450	50– 500	40– 145
Ottawa	1,200–2,000	30– 350	125– 350	30– 450	100– 200	30– 100
Perry	650–3,620	150– 600	50– 80	....	200	....
Richland	1,950–2,800	....	....	....	80	....
Sandusky	400–1,451	5– 150	10– 160	1– 150	2– 150	1– 100
Sciota	1,535	....	....	....	....	....
Seneca	370–1,760	20– 140	20– 100	70– 90	25– 165	20– 80
Summit	900–3,550	....	....	....	....	....
Trumbull	370– 388	10	10	....	....	....
Tuscarawas	850–5,050	160– 475	120	78– 400	70– 800	35– 800
Van Wert	1,200–1,285	....	....	....	....	....
Vinton and Jackson	520–2,707	....	....	....	810	118– 810
Warren	275–1,000	....	....	....	....	....
Wayne	1,150–3,500	300–*a*1,120	200– 850	100– *a* 900	100–*a*1,000	300– 900
Washington	500–2,600	15– 500	10– 740	15– 400	30– 400	40– 300
Wood	1,170–1,500	10– 15	10– 35	10– 40	10– 40	10– 250

a New well.

KENTUCKY.

GENERAL STATEMENT.

Kentucky has been a regular through small contributor to the supply of natural gas in the United States since 1889, though its annual contribution is considerably less than 1 per cent of the total volume produced in the country. The natural-gas industry of Kentucky dates back to the completion of the Moreman well in 1863, on the Moreman farm, near Brandenburg, Meade County. In 1873 gas from this well was utilized at the Moreman salt works for the manufacture of salt from the brine that was associated with the gas in this and other wells in the Brandenburg district. Following the discoveries of gas near Findlay, Ohio, in 1885 and 1886 interest in the quest for gas was greatly stimulated, with the result that the Brandenburg district was extended areally and a sufficient volume of gas was developed to warrant the laying of an 8-inch pipe line from the field to Louisville, 30 miles distant.

The natural-gas fields of Kentucky, as now developed, are widely distributed but lie mainly in the eastern third of the State. The principal producing district is the Menifee gas field in Menifee County, where the gas produced is obtained from the "Corniferous" limestone of the Devonian system. In Morgan and Wolfe counties gas is produced commercially from oil wells tapping the same formation that yields gas in Menifee County. In Martin County gas is produced from the Big Injun sand of the Mississippian series. In the oil fields of Wayne and McCreary counties gas is obtained from the Beaver Creek "sand," a layer of cherty limestone near the base of the "Waverly" formation of the Mississippian series. In Knox County gas is obtained from impersistent sands in the Pottsville group of the Pennsylvanian series and in the upper part of the "Waverly" formation of the Mississippian series. In Estill County more or less gas accompanies the oil in the Irvine field, production being obtained from the "Corniferous" limestone of the Devonian system. In the western part of the State gas in small volume is found in shallow wells sunk in the black New Albany shale of the Devonian system, this formation being the source of the gas obtained in Meade County, where the natural-gas industry in Kentucky originated.

PRODUCTION.

It is estimated that not less than 2,802,079,000 cubic feet of natural gas was produced commercially in Kentucky in 1917. This volume exceeds that of the production in 1916 by 695,537,000 cubic feet, or 33 per cent.

This gain in output is ascribed chiefly to the increased conservation of natural gas in the oil fields of the State for the manufacture of natural-gas gasoline and, in part, to the increased demand for natural gas in the fields for drilling and pumping oil wells, the result of an unusually active campaign of drilling in 1917.

The average price received at the point of consumption for the natural gas produced in Kentucky in 1917 was 20.71 cents a thousand feet and the market value of the entire output was $580,380, a loss of 15.02 cents, or 42 per cent, in average unit selling price and of $172,255, or 23 per cent, in total market value, compared with 1916. The diminished value of the increased production of gas in Kentucky in 1917 is accounted for by the fact that the greater part of the gas produced within the State was consumed near the source of production either for drilling and pumping oil wells or for the manufacture of gasoline, for which services it commanded either a flat or a wholesale rate.

Activity in the quest for natural gas in Kentucky in 1917 resulted in the completion of 87 wells, of which 35, or 40 per cent, were successful, and 52, an average of 3 in every 5 drilled, were barren. Twelve exhausted gas wells were abandoned in Kentucky in 1917, and at the end of the year 286 gas wells were in service in the States, a net gain of 23 wells during the year.

CONSUMPTION.

The volume of natural gas consumed in Kentucky in 1917 amounted to not less than 12,053,445,000 cubic feet, an increase of 2,165,489,000 cubic feet, or 22 per cent, compared with 1916. The discrepancy of 9,251,366,000 cubic feet between the volume of gas produced and the volume consumed in Kentucky in 1917 was made up by importations from West Virginia and Ohio, the greater part from West Virginia. The average price paid by the consumers of natural gas in Kentucky in 1917 was 25.84 cents a thousand cubic feet and the total market value of the gas consumed was $3,114,402. Compared with 1916 the average price per thousand paid by all classes of natural-gas consumers in Kentucky in 1917 was higher by 2.26 cents, or nearly 10 per cent. Because of this advance in average price and of the greater volume of gas involved the market value of the gas consumed in 1917 exceeded that of the gas consumed in 1916 by $782,715, or 34 per cent.

Of the entire volume of natural gas consumed in Kentucky in 1917 some 7,354,153,000 cubic feet, or 61 per cent, valued at $2,496,814, or 80 per cent of the total market value of all the gas consumed, was supplied to 90,041 domestic consumers at an average price of 33.95 cents a thousand cubic feet. Compared with similar figures pertaining to domestic consumption of natural gas in Kentucky in 1916, these data show in 1917 gain of 1,493,918,000 cubic feet, or 26 per cent, in volume; of $530,922, or 27 per cent, in total market value; of 4,458 in the number of consumers served; and an advance of only 0.4 cent in the average domestic rate.

Assuming that an average of 87,812 consumers were supplied with natural gas the entire year the average monthly requirement of each consumer was about 7,000 cubic feet, which volume was supplied at an average monthly cost of $2.38. The average monthly requirement of the domestic consumer of natural gas in Kentucky in 1916 was 5,700 cubic feet, which was obtained at an average monthly cost of $1.91.

The remaining 39 per cent of the gas consumed in Kentucky in 1917, representing 20 per cent of the market value of the entire volume consumed, was supplied to 124 industrial consumers at an average price of 13.14 cents a thousand cubic feet. Compared with 1916, the volume of gas consumed industrially in 1917 was greater by 671,571,000 cubic feet, or 16 per cent; its market value was greater by $251,793, or 69 per cent; the number of consumers was less by 1; but the average price per thousand cubic feet was greater by 4.06 cents, or 45 per cent.

Record of natural-gas industry in Kentucky, 1906–1917.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consummers. Domestic.	Number of consummers. Industrial.	Value.	Drilled. Gas.	Drilled. Dry.	Productive Dec. 31.
1906	45	$287,501	17,216	18	$287,501	....	....	166
1907	38	380,176	19,279	239	380,176	31	14	179
1908	38	424,271	21,778	42	424,271	19	23	218
1909	38	485,192	25,639	137	695,577	26	7	212
1910	47	456,293	27,961	112	908,293	23	12	241
1911	74	407,689	41,201	70	901,759	19	8	255
1912	88	522,455	45,603	103	1,070,664	22	27	267
1913	93	509,846	54,446	146	1,225,116	23	7	274
1914	101	490,875	78,505	128	1,787,308	10	1	276
1915	86	614,998	84,666	117	1,942,423	6	1	262
1916	107	752,635	85,583	125	2,331,687	13	7	263
1917	118	580,380	90,041	124	3,114,402	35	52	286

TENNESSEE.

As a consequence mainly of activity in the quest for petroleum in Scott County, the production of natural gas in Tennessee increased from 2,000,000 cubic feet in 1916 to 10,900,000 cubic feet in 1917, a gain of 445 per cent. Its market value increased from $1,150, an average of 57.50 cents a thousand cubic feet, in 1916, to $2,450, an average of 22.48 cents a thousand, in 1917, a gain of $1,300, or 113 per cent, in total market value, but a loss of 35.02 cents, or 61 per cent, in average unit price.

All the gas produced in Tennessee in 1917 was consumed near the source of production. It is estimated that 750,000 cubic feet, or about 7 per cent, supplied the requirements for illumination and fuel of four families, at a price of 50 cents a thousand cubic feet, and the remaining 93 per cent, valued at an average price of 20.44 cents a thousand feet was consumed industrially, principally in oil-field operations. Twelve producers contributed to the output of natural gas credited to Tennessee in 1917. Four new gas wells were completed during the year and 2 exhausted wells were abandoned. At the end of the year 12 gas wells were in service in the State, a net gain of 2 wells during the year.

ALABAMA.

The small production of natural gas credited to Alabama in 1917 came from a few wells of small capacity in the Fayette gas field, Fayette County, and from a few wells in the Jasper district, Walker County. The beneficiaries of this production included 119 domestic and 3 industrial consumers.

The most significant development during the year was the discovery of a promising gas field, known as the "Dixie gas field" on a well-defined anticlinal structure a few miles south of the city of Birmingham. Activity in drilling near Mobile, in Mobile County, resulted in the development of no dependable supply of natural gas, though numerous pockets of gas were encountered in the course of the drilling.

In all 5 new gas wells were completed in Alabama in 1917, the State being credited with a total of 24 gas wells in service at the end of that year.

MICHIGAN.

The production of natural gas credited to Michigan in 1917 came from 6 gas wells and a few oil wells in St. Clair County, and from 3 gas wells, 1 each in Benzie, Oakland, and Wayne counties. Aside from a small volume utilized for drilling and pumping in the Port Huron oil district the consumption of this gas was for domestic purposes in nine households. The entire output is estimated at 1,184,000 cubic feet, valued at $1,013. One new gas well was drilled and one exhausted well was abandoned in St. Clair County in 1917.

INDIANA.

GENERAL STATEMENT.

As a contributor to the natural gas supply in the United States, Indiana is relatively unimportant, its rank among the States in which natural gas was produced in 1917 being thirteenth, both in volume and in market value of output.

In this State, as in the others of the Ohio Valley, the existence of natural gas had been demonstrated by discoveries in water wells and other borings many years before its presence in commercial quantities was proved. As early as 1876 natural gas in small volume was found in a well drilled for petroleum near Eaton, Delaware County, and there are records of similar discoveries in other localities. It was not, however, until the excitement following the discovery of gas in northwestern Ohio had started the drill anew in Indiana and not until after the successful completion in October, 1886, of well No. 1, at Kokomo, Howard County, credited with an initial open-flow capacity of 2,000,00 cubic feet of gas a day, that the natural-gas resources of Indiana began to be developed. Their subsequent development was rapid, the value of the annual production of natural gas increasing from $300,000 in 1886 to more than $2,000,000 in 1889, to more than $5,700,000 in 1893, and to more than $7,200,000 in 1900. In the succeeding six years it declined rapidly to $1,700,000, the value of the output in 1906, and in the decade since it has decreased slowly but steadily until it is now nearly $100,000 less than in 1887.

Natural gas in Indiana occurs in close association with petroleum. The gas fields of the State are coextensive with its oil fields and the small volume and low pressure of the gas recovered are but a reflection of the advanced stage of exhaustion of the fields both as to oil and as to gas.

The principal source of natural gas in Indiana is the "Trenton" limestone of the Ordovician system, which furnishes the gas produced in the eastern and northeastern parts of the State. In the southwestern part of Indiana natural gas derived from the "Corniferous" limestone of the Devonian system accompanies oil in Pike County and in parts of Gibson County, and gas from a sandstone layer in the Chester group of the Mississippian series is found with oil in the Princeton district, Gibson County.

PRODUCTION.

The volume of natural gas produced in Indiana in 1917 is estimated to have been not less than 1,711,454,000 cubic feet, a loss of 4,045,000 cubic feet, or about 0.25 per cent, compared with 1916. This slight decrease in volume, together with a loss of 2.85 cents in the average price per thousand cubic feet received for Indiana gas at the points of consumption, made the market value of the output in 1917 only $453,310, a loss of $50,063, or 10 per cent, compared with the market value of the output in 1916.

The production of natural gas credited to Indiana in 1917 was obtained from 2,188 wells, 42 of which were completed and 179 of which were abandoned during the year. Aside from the successful wells drilled in 1917 some 17 unsuccessful tests, an average of 2 in every 7 drilled, were also completed. In addition to the great number of oil wells that also yield natural gas there were 1,830 gas wells in service in Indiana at the end of 1917, a net loss of 137 wells, or 7 per cent, during the year.

Except for a small volume piped across the State boundary to supply the natural-gas requirements of Union County, Ohio, all the natural gas produced in Indiana in 1917 was consumed within the State.

CONSUMPTION.

The volume of natural gas consumed in Indiana in 1917 was not less than 5,766,466,000 cubic feet, an increase of 745,102,000 cubic feet, or 13 per cent, over the volume consumed in 1916.

The average price per thousand cubic feet paid for natural gas service by all classes of consumers in Indiana in 1917 was 34.19 cents, a decrease of 0.59 cent, or about 1.7 per cent, compared with the average rate for service in 1917. The total cost of natural gas service to its Indiana patrons in 1917 was $1,971,435, an increase of $225,150, or 11 per cent, over the total cost of similar service in 1916.

The discrepancy of 4,055,012,000 cubic feet between the volume of natural gas consumed in Indiana in 1917 and that produced in the State in that year was made up from West Virginia and Ohio, the former State supplying about 99 per cent of the total deficiency.

Of the entire volume of natural gas consumed in Indiana in 1917 it is estimated that 3,475,421,000 cubic feet, or about 60 per cent, was served to 42,322 domestic consumers at an average price of 37.55 cents a thousand cubic feet and a total charge of $1,305,137, or 66 per cent of the gross proceeds of all sales of natural gas in the State in 1917. Comparison of these data with corresponding figures for 1916 shows in 1917 gain of 117,549,000 cubic feet, or 3.5 per cent, in the volume of gas consumed for domestic purposes; of $45,892, or 3.5 per cent, in its total cost to the consumer; of 0.05 cent in its average cost per thousand cubic feet to the consumer; and a loss of 1,796, or 4 per cent, in the number of domestic consumers.

Assuming that 43,220 domestic consumers were supplied with natural gas the entire year the average monthly consumption of each patron was 6,700 cubic feet, this volume being obtained at an average monthly cost of $2.82. In 1916 the average monthly consumption per customer was 6,350 cubic feet, obtained at an average cost of $2.21.

The remaining 40 per cent of the natural gas consumed in Indiana in 1917 was supplied to 497 industrial consumers at an average price of 29.08 cents a thousand cubic feet and a total charge of $666,298, or 33 per cent, of the gross proceeds from sales of natural gas in Indiana in 1917. Comparison of the statistics of the consumption of natural gas for industrial purposes in Indiana in 1917 and 1916 shows in 1917, gain of 627,653,000 cubic feet, or 27 per cent, in volume; of $179,258, or 27 per cent, in total cost to the consumers; of 26, or 5 per cent, in the number of consumers; but decrease of 0.20 cent, or 0.7 per cent, in the average unit sale price of industrial gas. In 1916 the gas supplied to industrial consumers in Indiana was 33 per cent of the total volume consumed and in 1915 it was only 22 per cent of the volume consumed. Increased activity in industrial plants in 1916 and 1917 and the steady growth of the natural-gas gasoline industry in Indiana account in large part for this rather abnormal trend.

Record of natural-gas industry in Indiana, 1898–1917.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers. Domestic.	Number of consumers. Industrial.	Value.	Drilled. Gas.	Drilled. Dry.	Productive Dec. 31.
1898	533	$5,060,969	a 173,454	1,867	$4,682,401	706	111	3,325
1899	571	6,680,370	a 181,440	1,741	b 5,833,370	838	109	3,909
1900	670	7,254,539	a 181,751	2,751	b 6,412,307	861	156	4,546
1901	656	6,954,566	a 153,869	2,570	b 6,276,119	985	208	4,572
1902	929	7,081,344	101,481	3,282	b 6,710,080	1,331	205	5,820
1903	924	6,098,364	90,118	1,020	b 5,915,367	895	242	5,514
1904	846	4,342,409	84,862	390	b 4,282,409	706	153	4,684
1905	740	3,094,134	63,194	231	b 3,056,634	252	74	3,650
1906	578	1,750,715	47,368	156	b 1,750,755	159	46	3,523
1907	687	1,572,605	46,210	218	b 1,570,605	185	56	3,383
1908	823	1,312,507	42,054	216	b 1,312,507	187	41	3,226
1909	1,010	1,616,903	40,565	369	b 1,616,903	190	70	2,938
1910	1,027	1,473,403	36,054	282	b 1,473,403	69	33	2,955
1911	1,094	1,192,418	31,576	143	b 1,192,418	110	32	2,744
1912	1,140	1,014,295	27,165	140	b 1,014,295	96	39	2,547
1913	1,100	843,047	39,776	239	b 948,278	69	24	2,370
1914	1,029	755,407	43,410	344	b 1,422,880	68	19	2,224
1915	999	695,380	44,012	438	b 1,542,604	65	11	2,112
1916	995	503,373	44,118	471	1,746,285	43	14	1,967
1917	941	453,310	42,322	497	1,971,435	42	17	1,830

a Number of fires supplied. b Includes value of gas consumed in Chicago, Ill.

Depth and rock pressure of wells in Indiana, 1913–1917.

County.	Depth (feet).	Pressure (pounds). 1913	1914	1915	1916	1917
Adams	1,000–1,050	40– 50	6	10	5	....
Bartholomew	864– 999	85–165	80–150	75–160	75–150	100–150
Blackford	850–1,200	0– 8	0– 20	0– 7	0– 7	1–150
Clark	128– 244	....	....	....	....	....
Daviess } Martin	300–1,025	5–165	25– 40	30– 40	35– 60	9– 60
Martin			....	....	80	
Decatur	700–1,200	5–350	5–350	10–315	0–320	7–300
Delaware	728–1,500	0– 50	0– 60	0– 75	0–315	1–100
Franklin	728– 730	60	....	....	....	....
Grant	830–1,200	5–200	0– 50	0–100	0– 40	0– 5
Hamilton	800–1,280	8–225	0–230	0–235	0– 60	9–235
Hancock	700–1,100	8–125	6– 80	6– 60	4–200	2–190
Harrison	320–1,050	50	50	0– 45	0– 50	0– 40
Henry	800–1,200	5–150	4–100	5– 50	0–200	4–273
Howard	800–1,100	35–200	30–160	80–200	0–150	30– 80
Jay	800–1,800	0– 50	0– 40	0– 50	0– 60	2– 18
Jefferson	1,300–1,360	20	....	....	....	....
Madison	800–1,200	0–175	0–100	0– 80	0–185	3–170
Miami	900–1,000	....	....	....	....	....
Marion } Ripley	880–1,050	100–160	70–300	100–200	50–200	0–200
Pike	1,000–1,400	25–450	50–225	40– 50	....	....
Randolph	900–1,300	2–190	1–125	5–100	2–200	80–175
Rush	700–1,400	10–300	15–325	5–300	0–300	15–280
Shelby	650–1,020	15–300	20–300	8–300	0–300	13–850
Spencer	1,025	....	....	....	....	....
Sullivan	698– 795	30– 50	50–185	....	....	....
Tipton	750–1,100	5–125	3–100	2–100	3–100	0– 3
Wayne	800–1,150	45– 75	45	....	40– 60	30– 40

ILLINOIS.

GENERAL STATEMENT.

The natural-gas industry in Illinois dates from the discovery of natural gas in small volume in shallow wells at Champaign, Champaign County, in 1853. Though natural gas was known and was utilized on a small scale at several localities in the State prior to 1885, it did not assume the status of a public utility in Illinois until 1885, when gas was first piped into Litchfield, Montgomery County, from the small oil and gas field near that town. Not, however, until the opening of the oil fields in the southeastern part of the State in 1905 and 1906 did the natural-gas industry begin to make real headway in Illinois. Following the opening of these fields the consumption of natural gas in this State increased rapidly, the value of the annual production advancing abruptly from about $7,000 in 1905 to $87,000 in 1906, to $644,000 in 1909, and to a maximum of nearly $688,000 in 1911. In the four-year period 1912–1915, it decreased to nearly one-half the record value, but in 1916 this trend was overcome and reversed to the extent of a substantial gain over the value of the output in 1915. In 1917 the upward trend was strongly continued.

The principal areas of natural-gas production in Illinois are coincident with the oil fields and the relation between production of gas and activity in the quest for oil is close. In the southeastern part of the State natural gas is obtained from a number of productive sands in the Pennsylvanian series ("Coal Measures") and in the deeper-lying Chester group of the Missippian series. In western central Illinois sands of the Chester group yield gas in Bond County and sands lying near the base of the Pennsylvanian series yield gas in Macoupin County. At numerous localities in northeastern Illinois shallow wells yield gas that is believed to originate in the thick mantle of glacial drift that overlies the hard rocks in this part of the State.

PRODUCTION AND CONSUMPTION.

The volume of natural gas produced and consumed in Illinois in 1917 is estimated to have amounted to not less than 4,439,016,000 cubic feet, a gain of 905,315,000 cubic feet, or 26 per cent, over the volume produced and consumed in 1916. Much of this gain is credited to the Staunton district in Macoupin County, from which gas was piped to a number of municipalities in the western part of Illinois during the entire year 1917 as against only a few months in 1916.

The market value of the natural gas produced and consumed in Illinois in 1917 was $479,072, a gain of $82,715, or 21 per cent, over the market value of the output in 1916. The average price received for this gas at the point of consumption or, in other words, the average price paid by all classes of consumers for Illinois gas in 1917 was 10.79 cents a thousand cubic feet, a decrease of 0.43 cent, or about 4 per cent, compared with 1916. The reason for this decrease in average price is apparent from the statistics presented below which show in 1917, compared with 1916, a decided falling off in consumption for domestic purposes and a decided increase in consumption for industrial purposes.

Of the entire volume of natural gas consumed in Illinois in 1917 it is estimated that only 481,770,000 cubic feet, or 11 per cent, valued at $167,023, or 35 per cent of the gross value of the gas consumed, was supplied to 11,622 domestic consumers at an average price of 34.67 cents a thousand cubic feet. In 1916 the volume of domestic gas was 18 per cent of the total volume consumed and its market value was 43 per cent of the market value of all the natural gas consumed in the State in that year. Comparison of the principal items pertaining to domestic consumption in the two years designated shows in 1917 loss of 153,528,000 cubic feet, or 24 per cent, in the volume of gas consumed; of $2,706, or 1.5 per cent, in its market value; of 2,863, or 20 per cent, in the number of domestic consumers, but increase of 7.95 cents, or about 30 per cent in the unit cost to the consumer.

Assuming that an average of 13,053 domestic consumers were supplied with natural gas during the entire year, the average monthly consumption of each consumer was 3,075 cubic feet, for which the average monthly cost was $1.07. These figures indicate decided economies in the domestic utilization of natural gas in Illinois in 1917, compared with 1916 when the average volume used monthly by each consumer was 5,000 cubic feet and the average monthly cost was $1.34.

The remaining 89 per cent of the natural gas consumed in Illinois in 1917, representing 65 per cent of the market value of all the gas consumed in the State in 1917, was distributed to 118 industrial consumers at an average price of 7.89 cents a thousand cubic feet. In 1916 industrial consumers accounted for 82 per cent of the volume but for only 57 per cent of the gross market value of all the gas consumed in Illinois in that year. The volume of natural gas consumed for industrial purposes, including the manufacture of natural-gas gasoline, was greater by 1,058,843,000 cubic feet, or 37 per cent, than the volume so consumed in 1916, and its market value was greater by $85,421, or 38 per cent. The number of industrial consumers was 3 less than in 1916 and the average price per thousand for industrial gas was 0.07 cent higher than in 1916.

Activity in the quest for natural gas in Illinois in 1917 resulted in the drilling of 76 wells. Of these 18, or 24 per cent, were successful and 58, an average of 3 in every 4 drilled, were barren. A total of 72 exhausted gas wells were abandoned in 1917 and at the end of the year there were 287 gas wells in service in Illinois, a net loss of 54 wells, of 16 per cent, during the year.

The statistics of natural gas consumption in Illinois, presented in this chapter, include without differentiation the volume and value of such Illinois gas as is consumed in Vincennes, Ind.

Record of natural-gas industry in Illinois, 1906–1917.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1906	66	$87,211	1,429	2	$87,211	......	......	200
1907	128	143,577	2,126	61	143,577	94	41	283
1908	185	446,077	[a] 7,377	[a] 204	[a] 446,077	121	42	400
1909	194	644,401	[a] 8,458	[a] 518	[a] 644,401	56	11	423
1910	207	613,642	[a] 10,109	[a] 261	[a] 613,642	64	31	458
1911	225	687,726	[a] 10,078	[a] 293	[a] 687,726	69	78	458
1912	223	616,467	[a] 10,691	[a] 212	[a] 616,467	56	147	453
1913	231	574,015	[a] 10,423	[a] 279	[a] 574,015	60	119	455
1914	235	437,275	[a] 8,952	[a] 153	[a] 437,275	38	114	416
1915	226	350,371	[a] 8,610	[a] 134	[a] 350,371	28	67	372
1916	218	396,357	[a] 14,485	[a] 121	[a] 396,357	36	126	341
1917	225	479,072	[a] 11,622	118	[a] 479,072	18	58	287

[a] Includes number of consumers and value of gas consumed in Vincennes, Ind., and in 1916 includes some consumers who use mixed gas.

Depth and rock pressure of wells in Illinois, 1913–1917.

County.	Depth (feet).	Pressure (pounds).				
		1913	1914	1915	1916	1917
Bond, Lawrence	925–1,100; 700–1,900	35–355	40–350	100–350	75–325	60–275
Bureau	85– 357	0– 42	0– 35	0– 25	0– 42	2– 30
Champaign	80– 140	0– 30	0– 30	0– 45	0– 45	15– 45
Clark	250– 640	0– 30		20– 35	0– 30	10–225
Crawford	400–1,600	20–350	25–450	25–200	0– 30	50–275
Cumberland	500–1,000		65			
Dewitt	80– 180	0– 25	0– 20	0– 50	0– 20	0– 25
Edgar	230– 600	50–135	80–135	40–130	20–130	0– 60
Lee	126– 280	12– 20	15– 28	2– 28	1– 28	1– 28
Logan	84– 90					
McHenry, McLean	160– 372					
Macoupin	447– 505				157–170	75–160
Montgomery	55– 67	1– 2				
Morgan	224– 400	0– 96	0– 20	0– 35	0– 40	14– 35
Pike	88– 350	0– 9	0– 53	0– 10	0– 10	3– 12

MISSOURI.

The volume of natural gas produced commercially in Missouri in 1917 is estimated on the basis of meager reports to have amounted to at least 31,425,000 cubic feet, which at an average price of 26.19 cents a thousand cubic feet has been given a total market value of $8,230. Compared with 1916 these statistics show in 1917 decrease of 37,811,000 cubic feet, or 55 per cent, in volume; of $9,364, or 53 per cent, in gross market value; but increase of 0.78 cent in average price per thousand.

Outside Platte County, where natural gas produced locally is supplied to consumers in Parkville, the production of natural gas in Missouri in 1917 was restricted, so far as can be ascertained, to the output of scattered wells in Bates, Cass, Jackson, and Johnson counties, which furnished only enough gas to satisfy the requirements for fuel and light of from one to three households each.

Aside from the small volume of natural gas produced in this State, a large volume, accounted for in the statistics for Kansas and Oklahoma, is piped in from those States and consumed in the smelting of metals in the Joplin district in the southwestern part of Missouri and in the houses and industries in Kansas City and St. Joseph in the northwestern part.

KANSAS.

GENERAL STATEMENT.

The natural-gas industry in Kansas dates back to 1873, when gas from the Acers Mineral Well at Iola, Allen County, was used as an illuminant in a neighboring sanitarium erected for the primary purpose of exploiting the medicinal properties of the mineral water obtained from the same well. In 1882 gas was found in abundance in wells drilled 7 miles north of Paola, Miami County, and in 1884 mains were laid from this district to Paola and the distribution of gas to consumers in that town was begun. About 1887 natural gas from near-by wells was introduced into the town of Fort Scott, Bourbon County, and in 1892 the distribution of gas from wells of large capacity west and northwest of Coffeyville, Montgomery County, was begun in the latter town. In 1893 Cherrydale, in the northeastern part of the same county, was first supplied with natural gas from wells east of town, and Independence, near the center of the county, was supplied from wells 4 miles to the east. The adoption of natural gas as a fuel in the zinc smelters at Cherrydale in 1898 established the natural-gas industry of Kansas on a permanent basis, and its subsequent development was rapid. In 1905 natural gas mains were laid from the fields in Montgomery County to the Joplin lead and zinc district in southwestern Missouri, and in 1906 gas from the Allen and Neosho County fields was piped into Kansas City.

From only a few hundred dollars in 1882 the value of the gas produced annually in Kansas increased slowly to $50,000 in 1893, then rapidly to $112,000 in 1895, to $1,124,000 in 1903, and to a maximum of $8,294,000 in 1909, subsequent to which it declined steadily to $3,288,000 in 1913, since which year it has gradually increased with the development of prolific gas fields in Butler County, though it is still far below the maximum.

Natural gas was produced profitably in Kansas in 1917 in 23 counties, all in the eastern third of the State. Petroleum and natural gas in this State occur in sandstone or limestone layers in the Pennsylvanian series ("Coal Measures"), the most productive zone being that of the Cherokee shale, at the base of the series. Lenticular sandstone layers interbedded with the Cherokee shale constitute the principal reservoirs of oil and gas in the State.

PRODUCTION.

It is estimated that the volume of natural gas produced in Kansas in 1917 was 24,438,848,000 cubic feet, this volume being less by 7,271,590,000 cubic feet, or 23 per cent, than the volume credited to the State in 1916. This decrease is charged mainly to Butler County and is attributed to the normal decrease in yield of gas in the Eldorado and Augusta districts resulting from the extensive campaign of development that was centered there in 1916 and 1917.

The average price received for Kansas gas in 1917 at the point of consumption was 23.33 cents a thousand cubic feet, and the gross proceeds of the sales of that gas aggregated $5,701,436. Compared with corresponding items for 1916 these data show gain in 1917 of $846,047, or 17 per cent, in gross market value of gas sold, and of 8.02 cents, or 52 per cent, in the average unit price received for that gas at the point of consumption.

This output was obtained from 3,651 gas wells and from numerous additional wells that produced both gas and oil. Of these gas wells 554 were completed during 1917 and 536 were abandoned because of exhaustion. In all 924 wells were drilled for gas in Kansas in 1917, of which number 370, an average of about 2 in every 5 drilled, were unsuccessful. Compared with corresponding data for 1916 these figures show gain in 1917 of 270 wells, or 41 per cent, in total completions; of 93, or 20 per cent, in the number of gas wells brought in; of 177, or 92 per cent, in the number of failures completed; and of 145, or 37 per cent, in the number of exhausted wells abandoned. At the end of 1917 there were 2,579 gas wells, exclusive of those that yield both gas and oil, in service in Kansas, a net gain of 18 wells during the year.

CONSUMPTION.

Including the Kansas gas piped to Missouri and consumed in the smelter district adjacent to Joplin, the volume of natural gas consumed in Kansas in 1917 was about 37,962,857,000 cubic feet, a decrease of 22,601,255,000 cubic feet, or 37 per cent, from the volume consumed in 1916. This decrease which affected both domestic and industrial consumers is accounted for by the inability of the gas-distributing companies to procure a supply of gas adequate to the demands for it or equivalent to the supply available in 1916.

The discrepancy of 13,524,009,000 cubic feet between the volume of gas produced in Kansas in 1917 and the volume consumed in the State in that year was made up by Oklahoma, which was able to export some 28,853,674,000 cubic feet of gas to satisfy demands in Kansas.

The average price per thousand cubic feet paid by all classes of natural gas consumers in Kansas in 1917 was 22.29 cents and their total expenditures for natural-gas service amounted to $8,463,767, these data showing gain of 6.22 cents, or 39 per cent, in average unit price, but decrease of $1,267,751, or 13 per cent, in total cost to the consumers.

Of the total volume of natural gas consumed in Kansas in 1917 it is estimated that 8,928,425,000 cubic feet, or 23 per cent, valued at $5,235,274, was distributed to 188,043 domestic consumers at an average retail price of 58.64 cents a thousand cubic feet, and that the remaining 77 per cent, valued at $3,228,493, was distributed to 1,018 industrial consumers at an average wholesale rate of 11.12 cents a thousand.

With regard to domestic consumption of natural gas in Kansas comparison of these data with corresponding data for 1916 shows in 1917 decrease of 11,984,268,000 cubic feet, or 57 per cent, in the volume of gas consumed and of 14,179, or 7 per cent, in the number of consumers, but of only $78,737, or 1.5 per cent, in the total cost to domestic consumers of natural gas service because of an advance of 33.19 cents, or 130 per cent, in the average unit price paid for gas.

Assuming that an average of 195,132 domestic consumers in Kansas utilized natural gas the entire year the average volume consumed by each, in 1917, was 3,800 cubic feet, this volume being obtained at an average monthly cost of $2.23. The economies effected in consumption of natural gas for domestic purposes in 1917 are evident from the fact that the average monthly requirement of each domestic consumer in 1916 was 8,600 cubic feet, for which in those days of natural-gas abundance he paid $2.19.

With regard to the consumption of natural gas for industrial purposes in Kansas, comparison of the statistics for 1916 and 1917 shows in 1917 loss of 10,652,987,000 cubic feet, or 27 per cent, in volume; of $1,189,014, or 27 per cent, in total market value; of 336, or 25 per cent, in the number of industrial consumers; and of 0.01 cent in the average price per unit volume.

Analysis of the industrial consumption of natural gas in Kansas in 1917 shows that 14,094,485,000 cubic feet, or 49 per cent of all industrial gas sold, was utilized for manufacturing purposes by 84 consumers, who paid $1,459,626 for it, an average of 10.36 cents a thousand cubic feet, the remaining 51 per cent being utilized in the direct production of power by 934 consumers who paid $1,768, 867 for it, an average of 11.84 cents a thousand cubic feet.

Further analysis of the consumption of natural gas for manufacturing purposes in Kansas in 1917 shows that 9,079,410,000 cubic feet, valued at $938,721, was utilized in the smelting of metals, 1,696,183,000 cubic feet, valued at $188,960, was utilized in the manufacture of cement, and that 2,707,151,000 cubic feet, valued at $290,340, was utilized in the manufacture of brick, glass, and clay products.

Record of natural-gas industry in Kansas, 1898–1917.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1898	29	$174,640	a6,186	44	$174,640	34	18	121
1899	31	332,592	a10,071	71	332,592	44	22	160
1900	32	356,900	a9,703	65	356,900	54	15	209
1901	48	659,173	a10,227	72	659,173	71	35	276
1902	80	824,431	13,488	91	824,431	144	63	404
1903	120	1,123,849	15,918	143	1,123,849	295	66	666
1904	190	1,517,643	27,204	298	1,517,643	378	135	1,029
1905	171	2,261,836	46,852	601	2,265,945	340	157	1,142
1906	130	4,010,986	79,270	990	b4,023,566	331	99	1,495
1907	196	6,198,583	149,327	1,605	b6,208,862	361	163	1,760
1908	212	7,691,587	168,855	1,162	b7,691,587	403	208	1,917
1909	199	8,293,846	182,657	1,160	b8,356,076	452	214	2,138
1910	204	7,755,367	186,333	1,412	c9,335,027	392	195	2,149
1911	232	4,854,534	199,523	907	c9,493,701	301	152	2,033
1912	253	4,264,706	195,446	1,104	c8,521,858	435	200	2,106
1913	305	3,288,394	195,131	950	c6,983,802	506	253	2,297
1914	353	3,340,025	187,714	1,079	b7,163,746	445	219	2,261
1915	371	4,037,011	201,133	1,446	b8,174,289	554	194	2,443
1916	414	4,855,389	202,222	1,354	b9,731,518	461	193	2,561
1917	462	5,701,436	188,043	1,018	b8,463,767	554	370	2,579

a Number of fires supplied.
b Includes gas taken from Kansas and consumed in Missouri.
c Includes gas taken from Kansas to Missouri; also gas piped from Oklahoma to Kansas and Missouri.

Depth and rock pressure of wells in Kansas, 1913–1917.

County.	Depth (feet).	Pressure (pounds).				
		1913	1914	1915	1916	1917
Allen	500–1,500	5– 260	6– 240	5–300	4–270	4–300
Anderson	230–1,070	65– 250	65– 225	60–225	60–165	20– 70
Bourbon	150– 800	75	75	80	....	450
Chase	64–1,100	3– 95	10–a160	6–160	8–130	4–150
Crawford / Cowley	97– 680 / 575–1,500	40– 50	30– 90	40–176	25– 80	20– 40
Chautauqua	300–1,900	35– 410	40– 210	25–425	30–600	10–750
Douglas / Johnson	350– 550 / 130– 950	20– 60	10–a130	20–610	55– 80	60–255
Ellsworth	950–1,250	240– 270	160– 250	195–275	200–250	175–250
Elk	500–1,887	90– 100	75	40	100–550	150–400
Butler	1,330–2,650	550–a560	a400–a600	300–500	30–300	70–300
Woodson	650–1,430	....	90– 250	200	125	....
Greenwood	350– 400	....	....	....	....	....
Labette	320–1,000	20– 240	50– 200	42–195	50–300	50–250
Linn	85– 750	20– 100	20– 100	10–100	15–110	5–150
Franklin	300– 720	1– 500	50– 240	112	40–112	....
Miami	200–1,150		40– 120	45–100	50–100	40–211
Montgomery	160–1,600	5– 700	15– 400	15–175	8–150	10–315
Morris	600	....	....	250	300	....
Neosho	281–1,200	15– 325	25–a360	0–260	0–260	12–250
Wilson	250–1,725	15– 285	12–a350	30–475	7–600	12–340
Wyandotte	271– 800	30– 125	85	15– 75	0–140	60–150

a New wells.

OKLAHOMA.

GENERAL STATEMENT.

The natural-gas resources of Oklahoma are closely associated with petroleum and the development of the natural-gas industry in this State has closely paralleled the development of its vast resources of petroleum. The earliest recorded use of natural gas on a commercial scale in Oklahoma was at Red Fork, Tulsa County, where it was used as fuel for drilling and as a source of heat and light in a few houses in 1902. In 1903 natural gas was used for drilling near Lawton, Comanche County, near Pawhuska, Osage County, and near Newkirk, Kay County. In 1904 natural gas was distributed to domestic consumers in Tulsa, Bartlesville, Ochelata, Pawhuska, and Red Fork, and to brickworks near Red Fork. The subsequent growth of the natural-gas industry in Oklahoma has been rapid and has by no means spent its force. From 1911 to 1916 Oklahoma ranked third among the gas-producing States, on the basis of the volume of gas produced, but in 1917 it advanced to second rank by a margin of about 4,000,000,000 cubic feet over its closest competitor, Pennsylvania.

Natural gas was produced profitably in Oklahoma in 1917 in 31 counties lying in the eastern half of the State.

Petroleum and natural gas in Oklahoma are found in sandstone and, less commonly, in limestone layers of variable thickness occurring at numerous horizons in the succession of strata between the base of the Mississippian series (lower Carboniferous) below and the lower portion of the Permian series above. By far the greater part of the production, both of petroleum and of natural gas, is derived from "sands" in the intervening Pennsylvanian series (upper Carboniferous).

PRODUCTION.

The volume of natural gas produced in Oklahoma in 1917 is estimated to have amounted to not less than 137,384,154,000 cubic feet, a gain of 13,866,796,000 cubic feet, or 11 per cent, over the former record output in 1916. Practically all this gas was obtained from fields under development at the beginning of the year, the only new gas field of consequence discovered during the year being the Walters gas field in the eastern part of Cotton County, in the southern part of Oklahoma. Three or four gas wells of large volume were completed in this field before the end of 1917 and at the end of the year the Lone Star Gas Co. was extending its mains northward from Texas to connect this new source of gas supply with the gas markets in Dallas and Fort Worth.

The average price per thousand cubic feet received at the point of consumption for the natural gas produced in Oklahoma in 1917 was 10.18 cents, a gain of 0.45 cent, or 4.5 per cent, over the average price for which Oklahoma gas sold in 1916. The market value of all Oklahoma gas sold in 1917, irrespective of the place of its consumption, was $13,984,656, a gain of $1,969,950, or 15 per cent over the market value of the gas produced and sold in 1916.

Activity in drilling for natural gas in Oklahoma in 1917 resulted in the completion of 726 wells, a gain of 109 wells, or 18 per cent, over the number completed in 1916. Of these wells 350, or 48 per cent, were successful and 376, or 52 per cent, were failures. The number of exhausted gas wells abandoned in Oklahoma in 1917 was 261, as against 206 in 1916. At the end of 1917 there were 1,433 natural-gas wells, exclusive of oil wells that also produced gas, in service in Oklahoma, a net gain of 89 wells during the year.

The area held for purposes of natural-gas development in Oklahoma increased from 1,700,021 acres at the beginning of 1917 to 2,732,388 acres at the end of that year, a net gain of more than 1,000,000 acres.

CONSUMPTION.

It is estimated that, inclusive of the natural gas piped from Oklahoma and consumed in the lead and zinc district of southwestern Missouri, the volume of natural gas consumed in Oklahoma in 1917 was about 122,177,676,000 feet, a gain of 28,473,455,000 cubic feet, or 34 per cent, over the volume consumed in 1916.

The average price paid by all classes of consumers for this was 8.92 cents a thousand cubic feet, an advance of 1.38 cents, or 18 per cent, over the average retail price in 1916. The gross proceeds of all sales of natural gas in Oklahoma in 1917 were $10,900,827, a gain of $3,838,685, or 54 per cent, over the proceeds from sales of natural gas in this area in 1916.

Of the total volume of natural gas consumed in 1917, it is estimated that 12,873,023,000 cubic feet, or 10 per cent, with a market value of $2,612,468, was distributed to 94,605 domestic consumers at an average price of 20.29 cents a thousand feet. In 1916 the distribution to 79,724 domestic consumers amounted to 10,723,336,000 cubic feet, valued at $1,915,758, an average of 17.87 cents a thousand.

Assuming that an average of 87,165 domestic consumers were favored with natural gas service the entire year of 1917, the average monthly consumption of each was about 12,300 cubic feet, this volume being served at an average monthly cost of $2.50. In 1916 the average monthly requirement of each consumer was 11,200 cubic feet and the average monthly cost was $2.

The remaining 90 per cent of the natural gas consumed in 1917, valued at $8,288,359, was purchased by 2,183 industrial consumers at an average price of 7.58 cents a thousand cubic feet. Needs of natural gas for industrial fuel in 1916 amounted to 82,980,885,000 cubic feet, for which volume 2,327 consumers paid a total of $5,146,384, or an average of 6.20 cents a thousand cubic feet.

Analysis of the statistics of industrial gas consumed in the Oklahoma district in 1917 shows that 45 per cent was sold to 369 consumers for direct use in manufacturing industries, at an average price of 6.20 cents a thousand cubic feet and that the remaining 55 per cent was sold to 1,814 consumers for use in the generation of power at an average price of 8.69 cents a thousand.

Analysis of statistics of natural gas utilized for manufacturing purposes in Oklahoma in 1917 shows that about 26,877,080,000 cubic feet, valued at $1,545,849, was consumed in the smelting of metals; that about 1,176,537,000 cubic feet, valued at $84,397, was consumed in the manufacture of brick and clay products; that about 1,045,634,000 cubic feet, valued at $54,406, was consumed in the manufacture of glass; and that about 1,104,975,000 cubic feet, valued at $64,172, was consumed in the manufacture of cement.

Record of natural-gas industry in Oklahoma, 1906–1917.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1906	50	$259,862	8,391	202	$247,282	81	33	239
1907	107	417,221	11,038	277	406,942	99	41	344
1908	115	860,159	17,567	356	860,159	73	40	374
1909	131	1,806,193	32,907	1,527	1,743,963	97	35	454
1910	168	3,490,704	38,617	1,557	1,911,044	93	58	509
1911	204	6,731,770	44,854	1,507	2,092,603	303	143	732
1912	212	7,406,528	47,017	1,651	3,149,376	329	197	936
1913	347	7,436,389	49,308	1,793	3,740,981	423	298	1,052
1914	437	8,050,039	62,390	1,951	*a* 4,226,318	388	182	1,205
1915	434	9,195,804	67,874	1,551	*a* 5,058,526	209	118	1,229
1916	514	12,014,706	79,724	2,327	*a* 7,062,142	386	231	1,344
1917	565	13,984,656	94,605	2,183	*a* 10,900,827	350	376	1,433

a Includes some gas piped from Oklahoma to Missouri in 1914, 1915, 1916, and 1917, and from Arkansas to Oklahoma in 1917.

Depth and rock pressure of wells in Oklahoma, 1913–1917.

County.	Depth (feet).	Pressure (pounds).				
		1913	1914	1915	1916	1917
Cherokee	600– 650	......	......	......	......	......
Hughes	1,000–2,000	10– 350	......	500	400	......
Carter	590–2,000	......	30– 325	50– 370	300– 900	500– 700
Comanche	340–1,000		286–400	78	200– 250	......
Craig	500– 520					
Latimer	1,575–1,600	......	151– 400	......	......	......
Sequoyah	1,200					
Creek	400–2,900	20– 900	40– 800	40– 400	75– 690	50– 650
Garfield	1,150–1,170	......	......	......	......	......
Kay	400–3,400	40– 650	35– 450	50–*a*1,500	40–*a*1,200	24–1,250
Kiowa	350– 825	......	30	......	......	......
Le Flore	1,300–3,000	300– 375	385	140– 350	200– 350	120– 360
McIntosh	962–2,740	150– 400	*a*900	110–*a*1,200	500– 610	150– 610
Marshall	420– 600		150	135– 150	150– 225	
Mayes	102– 640	......	......	40– 80	5– 45	......
Muskogee	700–2,200	10– 350	20– 275	20	120– 805	125– 600
Nowata	450–1,700	25– 300	39– 150	85– 310	......	......
Okfuskee	1,450–2,460	......	*a*790	*a*790	700– 790	......
Okmulgee	600–2,600	80–*a*800	80–*a*840	300–*a*1,000	60– 710	50– 710
Osage	750–2,500	100– 700	150–*a*800	150– 680	50– 740	100– 627
Pawnee	1,000–3,150	......	......	*a*860	800	500– 700
Coal	400–3,300					
Pittsburg		......	110– 425	......	100– 550	175– 540
Pontotoc	1,000–3,000	......				
Greer	390– 565	......	......	......	......	......
Payne	2,940–3,150	......	*a*800	*a*900	400	320–1,050
Rogers	380–1,800	25– 500	145– 400	50– 350	30– 400	25– 375
Stephens	600–1,200	250– 330	240– 345	263	156	57– 268
Tulsa	580–2,200	100– 650	70– 525	40– 600	30– 500	55–1,000
Wagoner	550–1,700	......	165– 405	230– 325	206– 520	40– 450
Washington	315–2,260	19– 350	25–*a*635	30– 300	50– 400	80– 400

a New wells.

ARKANSAS.

PRODUCTION.

In fulfillment of the promise of increased yield of natural gas in Arkansas, implied in the success of activity in drilling in the Kibler field in 1916, the commercial production of natural gas in that State in 1917 was 5,609,484,000 cubic feet, a gain of 3,221,549,000 cubic feet, or 135 per cent over the output credited to the State in 1916.

The principal sources of natural gas in Arkansas are the relatively unimportant Massard Prairie district in Sebastian County and Hartford district in southern Sebastian and northern Scott counties, which have been productive for a number of years, and the important Kibler district in Crawford County, which was discovered near the end of 1915 and since that date has supported an active and successful development.

The average price realized for Arkansas gas at the point of consumption in 1917 was 5.63 cents a thousand cubic feet and the gross proceeds from sales of Arkansas gas amounted to $315,612, a net loss of 3.20 cents, or 36 per cent, in average unit price, but a gain, because of the large volume involved, of $104,648, or 50 per cent, in gross market value, compared with 1916. The diminished unit price in 1917 is accounted for by the greater proportion of the total volume delivered in that year at wholesale rates to industrial consumers than in 1916.

As a consequence of the gain in volume of gas produced Arkansas advanced from eleventh in rank among the gas-producing States in 1916, to tenth in 1917, exchanging places with Illinois. With regard to total market value of the gas produced no change in rank was made, Arkansas remaining in thirteenth place.

Activity in drilling for natural gas in Arkansas in 1917 was much less than in 1916, which was the year in which the Kibler field was most actively developed. In all 8 wells were completed, 5, or 63 per cent, being successful and 3 being failures. During 1917 eleven exhausted gas wells were abandoned and at the end of that year 113 active gas wells were in service, a net loss of 6 wells from the number in service at the end of 1916.

CONSUMPTION.

Exclusive of the natural gas piped into southern Arkansas from Louisiana, which is accounted for in the statistics of the latter State, the volume of gas consumed in Arkansas in 1917 was approximately 6,437,608,000 cubic feet, including the entire volume produced in the State during the year and a relatively small volume piped into the State from the Poteau gas field in eastern Oklahoma. This volume exceeds the volume consumed in Arkansas in 1917 by 3,090,210,000 cubic feet, or 92 per cent, the gain being due in large part to increased requirements of natural gas for the smelting of metals to satisfy war-time needs. The average price paid by all classes of consumers to whom this has was delivered, was 6.16 cents a thousand cubic feet and the gross proceeds of its sale were $396,612, a decrease of 2.43 cents in average unit price, but an increase of $109,213, or 38 per cent, over the total cost to all consumers, compared with 1916.

Of the entire volume consumed about 1,009,307,000 cubic feet, or 16 per cent, was utilized by 6,874 domestic consumers, who paid $153,807 for the privilege, the average price per thousand cubic feet being 15.24 cents. Compared with corresponding figures for 1916 these data show gain of 296,260,000 cubic feet, or 42 per cent, in volume; of $599, or 0.4 per cent, in total cost to all consumers; of 475, or 7.5 per cent, in the number of consumers; but decrease of 6.25 cents, or 29 per cent, in cost per unit of service.

Assuming that an average of 6,637 domestic consumers were favored with natural gas service throughout the entire year, the average monthly consumption of each was about 12,700 cubic feet, this volume being obtained at an average monthly cost of $1.94.

In 1916 the average monthly consumption per consumer was about 9,825 cubic feet but in that year the average monthly cost was $2.11.

The remaining 84 per cent of the gas consumed in Arkansas in 1917 was utilized by 125 industrial consumers, who paid $242,805 for it at an average price of 6.16 cents a thousand cubic feet. One hundred and thirty-five consumers in Arkansas in 1916 utilized 2,634,351,000 cubic feet of gas and paid for it a total of $134,191, an average price of 5.09 cents a thousand cubic feet.

LOUISIANA.

PRODUCTION.

The rank of Louisiana among the States in which natural gas is a commercial product was sixth in volume of gas produced in 1917, compared with fifth in 1916, but on the basis of the market value of the product the State advanced from eighth place in 1916 to seventh in 1917, exchanging places in this respect with its neighbor, Texas.

The volume of natural gas produced in Louisiana in 1917 is estimated to have amounted to 31,286,476,000 cubic feet, a decrease of 794,499,000 cubic feet, or a little more than 2 per cent, compared with 1916. At the point of consumption this gas sold for an average of 10.43 cents a thousand cubic feet, compared with 8.29 cents brought by the production in 1916, a gain of 2.14 cents, or 26 per cent. Despite the slight decrease in the volume sold, the total market value in 1917 was $3,262,987, exceeding the market value in 1916 by $602,542, or 23 per cent.

Activity in drilling for natural gas in Louisiana in 1917 resulted in the completion of 112 wells, of which 63, or 56 per cent, were successful and 49 were failures. Corresponding results in 1916 were 95 wells drilled, of which 48, or 50 per cent, were successful and 47 were failures. In all 54 exhausted gas wells were abandoned in 1917 and at the end of the year there were 269 active gas wells in service in the State, a net gain of 9 wells during that year. These wells were in addition to the large number of oil wells that also produce gas commercially in this State.

Development was continued successfully in 1917 in the Bastrop-Monroe district in Morehouse and Ouachita parishes in the northeastern part of the State and a number of carbon-black plants were erected in this district to take advantage of the abundance of natural gas available in a locality remote from other prospective markets. The usual number of gas wells of large initial volume was completed in the Harts Island and Elm Grove districts near Shreveport.

Late in 1917 two gas wells of unusually large volume and rock pressure were completed near Montegut, in Terrebonne Parish, in the southern part of the State, about 50 miles southwest of New Orleans, by the Hunter & McCormick interests of Shreveport. The possibilities of piping the product of these wells to New Orleans was receiving serious consideration at the end of 1917.

CONSUMPTION.

Including the gas piped to adjacent parts of southern Arkansas, the volume of natural gas consumed in Louisiana in 1917 was equivalent to the volume produced, as no gas from other States was consumed in Louisiana during the year.

Of the total volume consumed in 1917, it is estimated that 4,682,339,000 cubic feet, or 15 per cent, valued at $1,394,951, or 43 per cent of the market value of all Louisiana gas sold in that year, was distributed to 35,277 domestic consumers at an average price of 29.79 cents a thousand cubic feet. In 1916 some 32,257 domestic consumers used 3,890,552,000 cubic feet of Louisiana gas, paying therefor $1,149,336, an average price of 29.54 cents a thousand cubic feet. In that year the volume of gas distributed to domestic consumers was 12 per cent of the entire volume consumed but represented the same proportion of the total market value of all gas sold as the market value of the gas consumed in domestic use in 1917.

Assuming that 33,767 domestic consumers were supplied with Louisiana gas the entire year, the average monthly consumption of each in 1917 was 11,600 cubic feet obtained at an average monthly cost of $3.46. In 1916 the average monthly consumption was 10,400 cubic feet and the average monthly cost was $3.07.

The remaining 85 per cent of the Louisiana gas consumed in 1917, representing 57 per cent of the market value of the entire volume sold, was distributed to 703 industrial consumers at an average price of 7.02 cents a thousand cubic feet. In 1916 some 679 consumers paid $1,511,109, an average price of 5.36 cents a thousand cubic feet, for 28,190,423,000 cubic feet of Louisiana gas, comprising 88 per cent of the entire volume of gas sold that year and representing 57 per cent of the market value of that gas.

Record of natural-gas industry in Louisiana, 1909–1917.

Year.	Number of producers.	Number of consumers.		Total value of gas produced.	Wells.		
		Domestic.	Industrial.		Drilled.		Productive Dec. 31.
					Gas.	Dry.	
1909	11	4,034	164	[a] $326,245	26	10	85
1910	21	8,547	320	[a] 509,408	23	4	97
1911	27	[b] 17,964	442	[a] 858,145	36	18	119
1912	41	[b] 21,087	474	[a] 1,747,379	50	20	150
1913	57	[b] 26,424	550	[a] 2,119,948	53	24	111
1914	54	[b] 29,751	618	[a] 2,227,999	52	26	239
1915	57	[b] 30,144	597	2,163,934	35	10	253
1916	73	[b] 32,257	679	2,660,445	48	47	260
1917	95	[b] 35,277	703	3,262,987	63	49	269

[a] Includes the production of Alabama.
[b] Includes consumers supplied with gas piped from Louisiana to Arkansas and Texas.

Depth and rock pressure of wells in Louisiana, 1913–1917.

Parish.	Depth (feet).	Pressure (pounds).				
		1913	1914	1915	1916	1917
Bossier	800–2,463				300–1,000	360–1,000
Caddo	750–3,224	60–850	20–325	40–300	24–1,100	18– 616
De Soto	746– 905	350–450	338–716	[a] 466	100– 260	190–1,000
Lafourche	80– 100	20	5– 10	15		
Morehouse	2,232–2,266				1,000–1,140	1,000–1,200
Natchitoches	1,010				20	
Ouachita	1,200–3,210		Small.		1,050	1,050
Red River	904–2,668			[a] 400	100– 950	100– 600
Terrebonne	93– 126		50	34	18– 35	12–1,015

[a] New well.

TEXAS.

PRODUCTION.

Texas easily retained eighth rank among the natural-gas producing States on the basis of volume produced but dropped from seventh to eighth place on the basis of the total market value of gas produced, seventh place in 1917 being accorded by a small margin to Louisiana.

The volume of natural gas produced commercially in Texas in 1917 was 17,047,292,000 cubic feet. This production exceeded that of any preceding year and topped the former record established in 1916 by 1,237,713,000 cubic feet, or 8 per cent.

The average price obtained for Texas gas at the centers of consumption in 1917 was 18.73 cents a thousand cubic feet, and the market value of the entire volume produced was $3,192,625, a loss of 1.16 cents in average unit selling price, but a gain in market value of $48,754, or 1.5 per cent, compared with 1916.

Activity in the quest for natural gas in Texas in 1917 was considerably less than in 1916 and the results were less encouraging. In all 122 wells were drilled for gas in Texas in 1917. Of these only 35, or 29 per cent, were successful, the remaining 87, or 71 per cent, being failures. In 1916 a total of 190 wells was completed, of which 77, or 41 per cent, were successful. Some 34 exhausted gas wells in Texas were abandoned in 1917 and at the end of that year there were 250 gas wells in service in the State, exclusive of oil wells that also produce gas, a net gain of 1 well during the year.

Interest in Texas in 1917 was centered more in the quest for the limits of the new oil fields opened in that year in Eastland, Stephens, Palo Pinto, and Coleman counties than in the search for new sources of natural gas. Incidental to the primary quest natural gas in considerable volume was found associated with petroleum in the counties named. In other parts of the State the natural-gas industry received little impetus during the year. As noted in the discussion of Oklahoma the failing supply of gas in the Petrolia district, Clay County, Tex., impelled the Lone Star Gas Co. to seek, in the Loco-Duncan and Walters districts in southern Oklahoma, an adequate supply of gas for its customers in a score or more of the cities and towns in northern Texas. No progress was made on the project, noted in the chapter on natural gas in 1916, for piping gas from the White Point district in San Patricio County to the city of Corpus Christi, and in the White Point district itself development work was practically at a standstill.

CONSUMPTION.

The volume of natural gas consumed in Texas in 1917 was approximately 17,901,637,000 cubic feet. This volume exceeds that consumed in Texas in 1916 by 2,092,058,000 cubic feet, or 13 per cent, though a part of this gain is apparent, owing to the fact that the statistics for 1916 exclude the gas piped into Texas from Louisiana.

The average price paid for natural gas by all classes of consumers in Texas in 1917 was 19.18 cents a thousand cubic feet, a decrease of 0.71 cent from the average in 1916, and the gross market value of all the gas consumed was $3,433,123, compared with $3,143,871 in 1916.

Of the entire volume consumed in 1917, it is estimated that 7,194,724,000 cubic feet, or 40 per cent, having a market value of $2,464,099, was consumed by 73,706 domestic consumers, who paid an average of 34.25 cents a thousand cubic feet for it.

In 1916 the volume of natural gas consumed by 68,218 domestic consumers in Texas was about 5,423,295,000 cubic feet, for which volume they paid $2,112,893, or an average of 38.96 cents a thousand cubic feet.

On the assumption that an average of 70,962 domestic consumers were supplied throughout the entire year, the average volume of gas consumed monthly by each was about 8,500 cubic feet, for which the average monthly cost was $2.91. In 1916 the corresponding average monthly consumption was 7,100 cubic feet and the average monthly cost was $2.76.

The remaining 60 per cent of the natural gas consumed in Texas in 1917 was utilized by 854 industrial consumers, who paid for it a total of $969,024, or an average of 9.05 cents a thousand cubic feet. In 1916 the volume of industrial gas consumed in Texas, exclusive of that piped in from Louisiana, was 10,386,284,000 cubic feet and the 931 consumers utilizing it paid an average of 9.93 cents a thousand cubic feet for it, or a total of $1,841,582.

Record of natural-gas industry in Texas, 1909–1917.

Year.	Number of producers.	Number of consumers.		Total value of gas produced.	Wells.		
		Domestic.	Industrial.		Drilled.		Productive Dec. 31.
					Gas.	Dry.	
1909	17	5,035	130	$127,008	7	6	38
1910	19	14,719	133	447,275	22	5	52
1911	29	22,972	303	1,014,945	19	14	69
1912	41	27,226	329	1,405,077	21	23	87
1913	50	37,350	393	2,073,823	43	29	126
1914	75	48,547	468	2,469,770	89	23	197
1915	65	59,386	677	2,593,873	27	30	214
1916	83	68,218	931	3,143,871	77	113	249
1917	85	73,706	854	3,192,625	35	87	250

IOWA.

The production of natural gas in Iowa in 1917 came from two shallow wells in Louisa County and was consumed for domestic purposes in the homes of the owners of the wells. Three additional gas wells in Louisa County and 2 in Guthrie County, the latter near Herndon, were unused during the year.

NORTH DAKOTA.

The natural gas produced in North Dakota in 1917 was obtained in Bottineau, Lamoure, and Renville counties from water wells, which yielded only enough gas for the domestic needs of one or two families each.

Reports received from 11 owners of gas wells of this type show that in 1917 gas was utilized from 7 wells to supply the requirements of four families.

SOUTH DAKOTA.

The natural gas produced commercially in South Dakota in 1917 was obtained from a total of 30 scattered wells, practically all of which yield water as their primary product, in Corson, Hughes, Potter, Stanley, Sully, and Walworth counties. This gas was supplied by 26 producers and was utilized by 412 domestic and 5 industrial consumers.

MONTANA.

PRODUCTION AND CONSUMPTION.

Continued progress was made in 1917 in the utilization of the natural-gas resources of Montana. It is estimated that the volume of natural gas produced commercially in that State in 1917 was 334,421,000 cubic feet, a gain of 121,106,000 cubic feet, or 57 per cent, over the corresponding volume in 1916.

The average price received at the point of consumption for this gas was 24.34 cents a thousand cubic feet, and its total market value was $81,406, a gain of 6.13 cents, or 34 per cent, in average unit selling price and of $42,551, or 109 per cent, in total market value, compared with 1916.

The principal sources of natural gas in Montana are the Havre district adjacent to Havre, Hill County; the Cedar Creek district, Dawson County, a few miles west of Glendive; and the Baker district, Fallon County, adjacent to Baker. Sufficient gas to supply the domestic requirements of one household is also obtained from a well on the ranch of Charles M. Bair, near Hardin, Big Horn County, in the Crow Indian Reservation.

Of the entire volume of natural gas consumed in Montana in 1917 approximately 279,859,000 cubic feet, or 84 per cent, having a total market value of $75,205, was distributed to 1,216 domestic consumers, at an average price of 26.87 cents a thousand cubic feet. Compared with corresponding items in 1916, these figures show in 1917 a gain of 142, 244,000 cubic feet, or 103 per cent, in the volume consumed; of $43,705, or 139 per cent, in the market value of the gas consumed; of 489, or 67 per cent, in the number of consumers supplied; and of 3.98 cents, or 17 per cent, in the average unit cost of natural gas service.

Assuming that an average of 972 consumers were favored with natural-gas service the entire year 1917, the average monthly requirement of each was about 24,000 cubic feet, this volume being obtained at an average monthly cost of $6.45.

The remaining 16 per cent of the natural gas consumed in Montana in 1917, having a market value of $6,201, was utilized by 12 industrial consumers, who paid an average price of 11.37 cents a thousand cubic feet for it.

Of 5 wells drilled in 1917 for natural gas in Montana 3, or 60 per cent, were successful, and 2 were barren. One exhausted gas well was abandoned, and at the end of the year 15 gas wells were in service in the State, a net gain of 2 wells during 1917.

WYOMING AND COLORADO.

PRODUCTION AND CONSUMPTION.

The volume of natural gas produced commercially in Wyoming and Colorado in 1917 attained record proportions as far as those States were concerned. It amounted to about 1,223,136,000 cubic feet and was greater by 648,092,000 cubic feet, or 112 per cent, than the combined output of natural gas in the two States in 1916. It sold at the points of consumption for a total of $144,425, an average price of 11.81 cents a thousand cubic feet, a gain of $58,348, or 67 per cent, in gross market value, but a decrease of 3.16 cents, or 21 per cent, in average unit selling price, compared with 1916.

The low average price brought by the natural gas marketed in these States is accounted for by the fact that the greater part of the volume involved is consumed industrially, much of it comprising gas used in the oil fields for drilling and pumping oil wells. Despite the great supply of natural gas known to exist in Wyoming, only a small percentage of the total population of the State benefits by its presence. Outside Greybull, Basin, Byron, and Lovell, which municipalities are supplied with this ideal fuel from adjacent fields, the consumption of natural gas in Wyoming is almost exclusively oil-field consumption. In Colorado the production of natural gas is restricted to the oil fields, except for a small volume salvaged from water wells in Alamosa, Saguache, Las Animas, and Mesa counties, and represents only a small percentage of the volume credited to the two States.

The future of Colorado as a natural-gas producing State is not especially bright on the basis of evidence now at hand, though the State includes large areas of untested and not unpromising territory. The future of Wyoming in this respect is exceedingly bright, for, outside its proved oil fields, it is known to have vast reserves of natural gas in the Hidden Dome district, Washakie County; the Oregon Basin and Buffalo Basin district, Park County; the Pine Mountain-Iron Creek district, Natrona County; and the Sand Draw district, Fremont County, to say nothing of large areas of untested and not unpromising territory. The available supply of natural gas in Wyoming is far in excess of existing markets within feasible piping distance of the sources of supply.

Of the total volume of natural gas produced commercially in Wyoming and Colorado in 1917 about 198,993,000 cubic feet, or only 16 per cent, having a market value of $68,495, was utilized by 1,021 domestic consumers, who paid an average price of 34.42 cents a thousand cubic feet for the privilege. The remaining 84 per cent of the value produced, market value, $75,930, was utilized by 24 industrial consumers, who paid an average of 11.81 cents a thousand cubic feet for the privilege.

Compared with 1916, the volume of gas consumed for domestic purposes in the two States in 1917 was greater by 42,481,000 cubic feet, or 27 per cent; its market value was greater by $29,965, or 78 per cent; the number of its consumers was greater by 262, or 35 per cent; and its average retail price per thousand cubic feet was greater by 9.8 cents, or 40 per cent.

Assuming that an average of 890 domestic consumers utilized natural gas during the year, the average monthly consumption by each in 1917 was 18,630 cubic feet, at an average monthly cost of $6.85.

Of the total number of domestic consumers supplied in 1917, 1,014 were in Wyoming and 7 were in Colorado. Of the industrial consumers supplied 20 were in Wyoming and 5 were in Colorado.

At the end of 1917 Wyoming was credited with 35 natural-gas wells in service and Colorado with 13.

OREGON.

As far as can be ascertained from reports submitted to the Geological Survey the utilization of natural gas in Oregon in 1917 was restricted to two localities. Near Ontario, Malheur County, gas from a deep well drilled several years ago for oil supplied the domestic requirements of one household, and near McMinnville, Polk County, sufficient gas was obtained from a shallow well drilled for water on the farm of Cass Riggs to heat and light one residence. Gas from one deep well in Malheur County (at Ontario) and from one shallow well in Yamhill County (McMinnville district) was unused in 1917.

WASHINGTON.

So far as can be ascertained the use of natural gas in Washington in 1917 was restricted to Benton County, where 2 gas wells, less than 800 feet deep, supplied an overabundance of fuel for additional drilling near by. One well is credited with a daily capacity of 300,000 cubic feet and the other with a daily capacity of 4,500,000 cubic feet. Plans for piping the gas from this district, which is known as the Rattlesnake Hills field, to Spokane were under consideration at the end of 1917.

Concerning the possibilities of an important gas field in this locality, Calvert[1] says:

> Recent demonstration of a large volume of gas by a drilling test in Benton County, Wash., at a depth of 700 feet and under unusual conditions, affords an interesting theme for speculation by the oil fraternity, whether operator or geologist.
>
> In February, 1913, drilling was undertaken in sec. 20, T. 11 N., R. 26, by a Spokane land syndicate in the hope of developing artesian water, and at 700 feet a porous stratum was encountered that yielded considerable gas. The writer was informed of this discovery at the time, but assumed that the gas was methane (marsh gas) originating and occurring in sedimentary layers found occasionally intercalated in the thick basaltic sequence covering south-central Washington and adjoining areas. Apparently this view was held by others, as only a purely local interest was taken in the discovery. As an illustration, it may be cited that it was not for several years that the Washington State geologist, Prof. Henry Landes, could be persuaded to visit the area personally.
>
> As a result of a communication from Prof. Landes, the writer went to Benton County in 1917 and reached a conclusion corroborating that of Landes that conditions warranted a full drilling test. The main factors involved in this conclusion were (1) pronounced anticlinal structure; (2) the occurrence of various oil seeps associated with that structure; and (3) the demonstration of gas of the olefine series of considerable and undiminished volume after a long period of wastage.
>
> Regional study of the area with Prof. Landes likewise convinced the writer that only the basal portion of the basaltic sequence remains at the gas-well locality. This sequence approximates 3,500 feet in thickness in the foothills of the Cascade Range, some 60 miles to the west. Naturally, therefore, it would be futile to attempt drilling where the basalt is not eroded deeply, regardless of surface indications of oil or gas.
>
> The structure on which the gas well is located is known as the Rattlesnake Hills anticline and is marked by a high ridge extending from North Yakima to the vicinity

[1] Calvert, W. R., Possibilities of gas in State of Washington: Oil and Gas Jour., vol. 16, No. 39, p. 49, Feb. 28, 1918.

of Kennewick, a distance of about 60 miles. Throughout this extent the axis of the anticline rises westward, except where interrupted by several cross folds, thus forming several elongated domes. The greater portion of the basaltic sequence remains on the anticlinal area, but the area of local doming in the vicinity of the gas well has been subjected to exceptional erosional activity. During a former period of its history, Columbia River was directed against the north side of the uplift and meandered along that flank of the structure. As a result, the south limb remains as a hogback whose steep north front represents a difference in level between 1,200 feet at the base up to 3,500 feet at the crest. As the stratigraphic difference is even greater, on account of the southerly dip, it follows that the dome has been stripped of all but a relatively small amount of the original thickness of basalt and leads to the reasonable conclusion that the gas zone at 700 feet below the surface is near the bottom of the sequence and approaching the underlying sedimentaries. As to the geologic age and nature of such sedimentaries, there are no available data upon which to base assumptions, owing to lack of exposures due to the widespread flow of basalt, but there is some reason for belief that an embayment of the sea extended into this area from the southwest during the Eocene period.

Passing to the more strictly economic phase of the subject. At the time of the writer's first visit in 1917 to the area a local concern, the Walla Walla Oil, Gas & Pipe Line Co., had a small acreage under lease and had been endeavoring to drill to the horizon of the gas discovered in the attempted water well in 1913, in an adjoining section. In the interest of C. J. Wrightsman, a former oil operator of Tulsa, but now of 120 Broadway, New York, the writer obtained a large leasehold and took over the standard drilling equipment of the Walla Walla Co. Drilling was begun in late summer, the drill passing through about 60 feet of unconsolidated deposits, then basalt to 610 feet, next 90 feet of clay, immediately below which porous basalt was encountered yielding gas. The volume of this gas increased steadily for 33 feet, then remained constant, and according to a recent communication from Prof. Landes approximates 3,000,000 cubic feet daily. As yet the character of this gas has not been fully tested, but it presumably is similar to that of the old well, which is said to have shown the following analysis:

	Per cent.
Methane	76.60
Ethane	12.00
Propane	7.20
Butane	3.80
Oxygen	.40

It is asserted that 23 per cent of this gas was soluble in clairolene oil.

From present development there seems every reason to believe that a gas field of some importance is assured. However, the region is one of relatively sparse population, and unless a local industry of some sort is established market for the gas could be obtained only by piping to Spokane, Portland, or the Puget Sound country.

Naturally the question of greatest interest is in connection with the possible development of oil as well as gas, but here one enters the realm of pure speculation. It seems an unescapable conclusion that the gas has migrated into the basalt from an underlying source, but whether directly connected with oil, or whether in that event the petroliferous zone is within economic drilling reach is open to question. However, the occurrence of oil seepages associated with the anticline would tempt one to conclude that underlying oil is present in quantity, and the geologic history of the region, so far as possible to be deciphered, gives a basis for hope that continuance of the present drilling test will discover oil. If that should happen an entirely new source of supply would be opened up, as the area under discussion is far removed from present production.

CALIFORNIA.

PRODUCTION AND CONSUMPTION.

As a consequence of the large increase in the volume of natural gas produced, California advanced from seventh rank among the gas-yielding States in 1916 to fifth in 1917, at the expense of Louisiana and Kansas, retaining in both years fifth rank on the basis of the total market value of natural gas produced.

It is estimated that 49,427,331,000 cubic feet of natural gas was produced and marketed in California in 1917, a gain of 17,784,065,000 cubic feet, or 56 per cent, over the volume produced and marketed in 1916, and more than twice the output in 1915. The increase was due to the discovery of no new gas fields of importance, but to a more careful conservation of the supply available from the sources already developed, a conservation dictated by a country-wide scarcity of fuels and by an unsatisfied demand for the gasoline that it is possible to recover as a by-product from oil-field gas.

The market value of the natural gas produced commercially in California in 1917 was $6,816,524, a substantial contribution to the mineral wealth of the State, and the average price it brought at the point of consumption was 13.79 cents a thousand cubic feet. Compared with corresponding figures for 1916 these data show gain in 1917 of $1,376,247, or 25 per cent, in the market value of all gas sold, but a decrease of 3.4 cents, or 20 per cent, in the average unit price realized on its sale. The decrease in unit sale price is accounted for by the greater proportion of the entire volume utilized in 1917 for industrial purposes, including the manufacture of natural-gas gasoline, than in 1916.

Of the entire volume of natural gas consumed in California in 1917, it is estimated that 4,914,374,000 cubic feet, or 10 per cent, was utilized by 239,448 domestic consumers, who paid for it an average price of 68.03 cents a thousand cubic feet and a total of $3,343,443, or 49 per cent of the entire market value of all natural gas sold in the State during the year. Compared with statistics of natural gas consumed for domestic purposes in California in 1916, these data show loss in 1917 of 714,648,000 cubic feet, or 13 per cent, in the volume of gas involved; of 3,327, or 1.4 per cent, in the number of consumers; of $255,252, or 7 per cent, in the total market value of all gas sold for domestic purposes; but gain of 4.05 cents, or 6 per cent, in the average unit cost of domestic gas to the consumer.

Assuming that an average of 241,112 domestic consumers utilized natural gas the entire year, the average monthly consumption by each was 1,700 cubic feet and the average monthly cost to each was $1.16. In 1916 the average monthly consumption by each domestic consumer of natural gas in California was 2,100 cubic feet and the average monthly cost was $1.34.

The remaining 90 per cent of the natural gas consumed in California in 1917, representing 51 per cent of the market value of all gas consumed, was utilized by 1,038 industrial consumers who paid for it an average price of 7.80 cents a thousand cubic feet and a total of $3,473,081. In 1916 a total of 175 industrial consumers in California utilized 26,014,244,000 cubic feet of natural gas, or 82 per cent of the entire volume consumed in the State in that year, paying for it a total of $1,841,582, or 34 per cent of the entire market value of the gas sold that year, at an average unit price of 7.08 cents a thousand cubic feet. As already noted much of the increase in the consumption of natural gas for industrial purposes was due to expansion of the local natural-gas gasoline industry, statistics of which are presented on the subsequent pages of this report.

The quest for natural gas in California in 1917 resulted in the completion of 12 wells, 10 of which were successful. Nine exhausted gas wells were abandoned during the year, and at its end 111 gas wells, exclusive of the oil wells that yield gas, were in service in the State.

Record of natural-gas industry in California, 1909–1917.

Year.	Number of producers.	Number of consumers.		Total value of gas produced.	Wells.		
					Drilled.		Productive Dec. 31.
		Domestic.	Industrial.		Gas.	Dry.	
1909	35	7,612	104	$446,933	7	......	a 64
1910	30	8,292	217	476,697	3	2	a 65
1911	32	10,598	307	800,714	8	6	a 66
1912	43	18,171	232	1,134,456	6	1	a 71
1913	48	b 164,358	141	1,883,450	9	4	a 72
1914	57	b 205,163	172	2,910,784	8	1	a 75
1915	59	b 207,673	257	4,069,004	2	2	a 108
1916	87	b 242,775	175	5,440,277	7	......	a 110
1917	100	b 239,448	1,038	6,816,524	10	2	a 111

a Includes some artesian wells from which gas was used.
b Includes some consumers who are using mixed gas.

CITIES AND TOWNS SUPPLIED WITH NATURAL GAS.

The following list contains the names of cities and towns in the United States which were either wholly or in part supplied with natural gas in the year 1917:

ALABAMA.

Fayette.
Jasper.

ARKANSAS.

Argenta.
Arkadelphia.
Bauxite.
Benton.
Bierne.
Boughton.
Bryant.
Donaldson
Emmet.
Fort Smith.
Garland.
Gifford.
Gum Springs.
Gurdon.
Hope.
Hot Springs.
Huntington.
Kibler.
Little Rock.
Mabelvale.
Malvern.
Mansfield.
Perla.
Pine Bluff.
Prescott
Pulaska Heights.
Ravana.
Sheridan.
South Fort Smith.
Texarkana.
Van Buren.

CALIFORNIA.

Alhambra.
Anaheim.
Arkesia.
Arroyo Grande.
Athens.
Avila.
Bakersfield.
Bellflower.
Betteravia.
Beverly.
Burbank.
Cement.
Compton.
Cudahy.
Downey.
Eagle Rock.
Fairfield
Fellows.
Fullerton.
Gardena.
Garden Grove.
Glendale.
Guadalupe.
Hermosa Beach.
Huntington Park
Inglewood.
Lodi.
Long Beach.
Los Angeles.
Los Berros.
Lynwood.
McKittrick.
Manhattan Beach.
Maricopa.
Moneta.
Monterey Park.
Nipomo.
Norwalk.
Orange.
Orcutt.
Oxnard.
Pasadena.
Pismo.
Placentia.
Redondo Beach.
Sacramento.
San Fernando.
San Gabriel.
San Luis Obispo.
San Pedro.
Santa Ana.
Santa Maria.
Santa Monica.
Santa Paula.
Sawtelle
South Pasadena.
South Taft.
Stockton
Suisun City.
Summerland.
Taft.
Torrance.
Tustin.
Tropico.
Venice.
Ventura.
Vernon.
Watts.
Whittier
Wilmington.

ILLINOIS.

Annapolis.
Belleville.
Birds.
Bridgeport.
Carlinville.
Casey.
Collinsville.
Duncanville.
East Chicago.
Eaton.
Edwardsville.
Flat Rock.
Greenville.
Heyworth.
Hutsonville.
Lawrenceville.
Marshall.
Martinsville.
New Hebron.
Oblong.
Olney.
Palestine.
Pinkstaff.
Porterville.
Robinson.
Staunton.
Stoy.
Sumner.

INDIANA.

Adams.
Albany.
Alexandria.
Anderson.
Arcadia.
Atlanta.
Batesville.
Blue Ridge.
Cambridge.
Carmel.
Carthage.
Charlottesville.
Chesterfield.
Cicero.
Clarkesburg.
Connersville.
Converse.
Cowan.
Daleville.
Downeyville.
Dublin.
Dunkirk.
Dunreith.
Eaton.
Elwood.
Fairmount.
Fairview.
Falmouth.
Farmland.
Fortville.
Fountaintown.
Frankton.
Freeport.
Geneva.
Gentryville.
Germantown.
Gowdy.
Greenfield.
Greensburg.
Gwynneville.
Hagerstown.
Hartford City.
Herbst.
Homer.
Honey Creek.
Hope.
Hortonville.
Ingalls.
Kennard.
Knightstown.
Kokomo.
La Fontaine.
Letts.
Lewisville.
Loogootee.
Lynn.
McCordsville.
Mamilla.
Marion.
Markleville.
Maxwell.
Mays.
Middletown.
Mier.
Milford.
Millgrove.
Millhousen.
Milroy.
Milton.
Modoc.
Mohawk.
Montpelier.
Morristown.
Mount Auburn.
Mount Summit.
Muncie.
Newcastle.
New Lisbon.
New Point.
Noblesville.
Normal City.
Oakland City.
Oaklandon.
Oakville.
Ovid.
Pendleton.
Pennville.
Portland.
Powers.
Princeton.
Raleigh.
Raysville.
Redkey.
Richmond.
Ridgeville.
Riverside.
Rushville.
St. Paul.
Sandusky.
Sardinia.
Sharpsville.
Shelbyville.
Sheridan.
Shirley.
Spiceland.
Spring Grove.
Springport.
Straughn.
Sullivan.
Sweetsers.
Tipton.
Union City.
Vincennes.
Waldron.
Warrington.
West Liberty.
Westport.
Williamstown.
Winchester.
Windfall.
Winslow.

KANSAS.

Altamont.
Altoona.
Arkansas City.
Atchison.
Atlanta.
Augusta.
Baldwin City.
Bartlett.
Bassett.
Baxter Springs.
Belle Plaine.
Benedict.
Bentley.
Benton.
Bonner Springs.
Bronson.
Buffalo.
Buffville.
Burden.
Burlington.
Burrton.
Cambridge.
Caney.
Carlyle.
Chanute.
Chautauqua Springs.
Cherokee.
Cherryvale.
Chetopa.
Coffeyville.
Colony.
Columbus.
Cottonwood Falls.
Coyville.
Deerfield.
Derby.
Douglass.
Earleton.
Edgerton.
Edna.
Edwardsville.
Eldorado.
Elk City.
Elk Falls.
Elm.
Elmdale.
Elsmore.
Empire City.
Emporia.
Erie.
Eudora.
Eureka.
Fairhaven.
Fall River.
Fort Scott.
Fredonia.
Galena.
Gardner.
Garnett.
Gas.
Greeley.
Grenola.
Hackney.
Halstead.
Havana.
Haven.
Hepler.
Howard.
Humboldt.
Hunnewell.
Hutchinson.
Independence.
Iola.
Jefferson.
Kansas City.
Labette.
La Harpe.
Lawrence.
Leavenworth.
Lenexa.
Liberty.
Merriam.
Moline.
Moran.
Mound City.
Mound Valley.
Mount Hope.

KANSAS—continued.

Mulvane.
Neodesha.
New Albany.
New Salem.
Newton.
Niotaze.
North Altoona.
Olathe.
Osawatomie.
Oswego.
Ottawa.
Oxford.
Paola.
Parsons.
Peru.
Pittsburg.
Pleasanton.
Princeton.
Rantoul.
Richmond.
Roper.
Rose.
Savonburg.
Scammon.
Scipio.
Sedan.
Sedgwick.
Shawnee.
Spring Hill.
Stanley.
Strong.
Sycamore.
Thayer.
Tonganoxie.
Topeka.
Towanda.
Turner.
Tyro.
Udall.
Valley Center.
Vilas.
Weir.
Welda.
Wellington.
Wellsville.
Wichita.
Winfield.
Yates Center.

KENTUCKY.

Ashland.
Barbourville.
Bellevue.
Brooksville.
Buchanan.
Burning Springs.
Caney.
Cannel City.
Catlettsburg.
Central City.
Chinnville.
Clifton.
Clintonville.
Cloverport.
Cold Spring.
Covington.
Dayton.
Diamond.
Dover.
Estill.
Foster.
Frankfort.
Garrett.
Greenup.
Hazel Green.
Inez.
Kenner.
Kavanaugh.
Langley.
Lexington.
Louisa.
Louisville.
Ludlow.
Maysville.
Midway.
Monticello.
Mount Sterling.
Newport.
North Middletown.
Paintsville.
Paris.
Pollard.
Rothwell.
Russell.
Salyersville.
Versailles.
Warfield.
Wayland.
West Covington.
West Liberty.
West Point.
Wheelwright.
Williamsburg.
Winchester.
Worthington.

LOUISIANA.

Belcher.
Blanchard.
Bossier.
Cedar Grove.
Dixie.
Frierson.
Hosston.
Ida.
Lewis.
Mansfield.
Monroe.
Mooringsport.
Mystic.
Naborton.
Oil City.
Rodessa.
Shreveport.
South Highlands.
Thomason.
Vivian.

MARYLAND.

Barton.
Cumberland.
Deer Park.
Frostburg.
Kitzmillerville.
Klondike.
Loch Lynn.
Lonaconing.
Luke.
Midland.
Mountain Lake Park.
Mount Savage.
Oakland.
Western Port.

MISSOURI.

Carl Junction.
Carterville.
Carthage.
Deerfield.
Duenweg.
Joplin.
Kansas City.
Martin City.
Nevada.
Oronogo.
Parkville.
Prosperity.
St. Joseph.
Webb City.
Weston.

MONTANA.

Baker.
Glendive.
Havre.

NEW YORK.

Addison.
Akron.
Alden.
Alexander.
Alfred.
Alfred Station.
Allentown.
Almond.
Ambush.
Amherst.
Andover.
Angelica.
Angola.
Armor.
Attica.
Avon.
Baldwinsville.
Batavia.
Belfast.
Belmont.
Bergen.
Blasdell.
Blossom.
Bolivar.
Bowmansville.
Brant.
Bristol.
Bristol Center.
Brocton.
Buffalo.
Byron.
Caledonia.
Canisteo.
Cattaraugus.
Ceres.
Chautauqua.
Chipmonk.
Churchville.
Clarence.
Clarence Center.
Collins.
Collins Center.
Corfu.
Corning.
Crittenden.
Cuba.
Deer Creek.
Depew.
Dunkirk.
East Aurora.
East Bloomfield.
East Hamburg.

NEW YORK—continued.

East Pembroke.
Ebenezer.
Eden.
Ellicott.
Elma.
Elmira.
Evans.
Falconer.
Farnham.
Forestville.
Fredonia.
Friendship.
Gangloff.
Gardenville.
Genesee.
Getzville.
Gorham.
Gowanda.
Greenwood.
Hamburg.
Hanover.
Holcomb.
Holland.
Honeoye Falls.
Hornell.
Independence.
Irving.
Jamestown.
Jamieson Road.
Jewettville.
Lacona.
Lackawanna.
Lancaster.
Le Roy.
Lima.
Limestone.
Linwood.
Little Valley.
Mayville.
Millgrove.
Montour Falls.
Moscow.
Mount Morris.
Mumford.
Naples.
North Buffalo.
North Collins.
North Tonawanda.
Obi.
Olean.
Orchard Park.
Otto.
Pavilion.
Perry.
Petrolia.
Phoenix.
Pine City.
Pomfret.
Portland.
Portville.
Pulaski.
Reserve.
Rexville.
Richburg.
Riga.
Ripley.
Roanoke.
Rushville.
Salamanca.
Sandy Creek.
Scio.
Sheridan.
Silver Creek.
Southport.
Springville.
Stafford.
Stanards.
Stockton.
Tonawanda.
Town Line.
Versailles.
Warsaw.
Watkins.
Webb Mills.
Wellsville.
West Bloomfield.
West Clarksville.
Westfield.
West Phoenix.
West Seneca.
Wheatland.
Williamsville.
Wyoming.
York.
Zoar.

NORTH DAKOTA.

Lansford.

OHIO.

Academia.
Ada.
Adelphi.
Akron.
Alexandria.
Alger.
Allensville.
Alliance.
Amanda.
Amboy.
Amesville.
Amherst.
Amsterdam.
Andover.
Antioch.
Appleton.
Arcanum.
Arlington.
Ashland.
Ashtabula.
Ashville.
Athens.
Austinburg.
Avery.
Bairdstown.
Baltimore.
Bangs.
Barberton.
Barlow.
Barnesville.
Bartlett.
Basil.
Batesville.
Beach City.
Beallsville.
Beem City.
Bellaire.
Belle Valley.
Belleville.
Bellevue.
Belmont.
Beloit.
Belpre.
Berea.
Bergholz.
Berlin Heights.
Bethany.
Bethesda.
Bettsville.
Beverly.
Bexley.
Birmingham.
Bladensburg.
Bloomdale.
Bloomingburg.
Bloomington.
Bowerston.
Bowling Green.
Bradrick.
Brandon.
Bratenahl.
Bremen.
Bridgeport.
Brilliant.
BrinkHaven(Gann)
Brookfield.
Brook Park.
Brookville.
Brownsville.
Brunswick.
Buckeye City.
Buckeye Lake.
Buchtel.
Buckingham.
Bucyrus.
Buffalo.
Bullett Park.
Burbank.
Burgoon.
Butler.
Byesville.
Cadiz.
Caldwell.
Cambridge.
Canaanville.
Canal Dover.
Canal Winchester.
Canfield.
Canton.
Carbon Hill.
Cardington.
Carey.
Carroll.
Carrollton.
Castine.
Cedarville.
Celina.
Centerburg.
Chatham.
Chauncey.
Chesapeake.
Chester.
Chesterhill.
Chicago Junction.
Chillicothe.
Chippewa Lake.
Cincinnati.
Circleville.
Clarington.
Claysville.
Clearport.
Cleveland.
Cleveland Heights.
Clintonville.
Clyde.
Coal Grove.
Coal Ridge.
Coal Run.
Coalton.
Cochransville.
Coldwater.
Columbiana.
Columbus.
Conneaut.
Corning.
Corryville.
Coshocton.
Covington.
Crestline.
Creston.
Cridersville.
Crooksville.
Croton.
Cutler.
Cuyahoga Falls.
Cygnet.
Dakes.
Danville.
Dayton.
Deavertown.
Delaware.
Dennison.
Derwent.
Dexter City.
Dover.
Doylestown.
Drakes.
Dresden.

OHIO—continued.

Dudley.
Dunkirk.
East Cleveland.
East Columbus.
East Fultonham.
East Liverpool.
East Palestine.
East Richland.
East Richmond.
East View.
East Youngstown.
Eaton.
Edison.
Elba.
Eldorado.
Elmore.
Elyria.
Empire.
Enterprise.
Etna.
Euclid.
Euphemia.
Fairfield.
Fairview.
Findlay.
Florence.
Flushing.
Fly.
Forest.
Fort Recovery.
Fostoria.
Franklin.
Frazeysburg.
Fredericktown.
Fremont.
French Creek Avon.
Fulda.
Fultonham.
Gahanna.
Galena.
Galion.
Gallipolis.
Gambier.
Geneva.
Genoa.
Germantown.
Gibsonburg.
Girard.
Glenroy.
Glouster.
Gore.
Grandview.
Granville.
Graysville.
Greenville.
Grogan.
Groveport.
Guysville.
Hallsville.
Hamden.
Hamilton.
Hammondsville.
Hanging Rock.
Hannibal.
Hanover.
Hanoverton.
Harlem Springs.
Harpster.
Harriettsville.
Haydenville.
Hayesville.
Hebron.
Helena.
Hemlock.
Homer.
Homeworth.
Hooker.
Hopedale.
Horns Mills.
Howard.
Hubbard.
Huntsville.
Irondale.
Ironton.
Jackson.
Jackson Center.
Jacksontown.
Jacksonville.
Jefferson.
Jeromesville.
Jerusalem.
Jewett.
Johnstown.
Jolly.
Joy.
Junction City.
Kansas.
Kenmore.
Kenton.
Kilgore.
Kilbuck.
Kingston.
Kingsville.
Kirkersville.
Lakeside.
Lakeview.
Lakewood.
Lancaster.
Lathrop.
Laurelville.
Leesville.
Leetonia.
Leonard.
Leroy.
Lewisburg.
Lewisville.
Lexington.
Lima.
Linden.
Lisbon.
Litchfield.
Lock.
Lockville.
Lodi.
Logan.
London.
Lorain.
Lottasburg.
Loudonville.
Lowell.
Lowellville.
Lower Salem.
Ludington.
McArthur.
McConnellsville.
Macksburg.
Malaga.
Malta.
Mansfield.
Maple Heights.
Maria Stein.
Marietta.
Marion.
Martinsburg.
Martins Ferry.
Massillon.
Maumee.
Medina.
Mendon.
Miamisburg.
Middleport.
Middletown.
Miffin.
Milan.
Millersburg.
Millersport.
Millers Run.
Millertown.
Millwood.
Milo.
Miltonsburg.
Mineral City.
Mingo.
Minster.
Monroe.
Monroeville.
Montezuma.
Morral.
Morristown.
Mount Gilead.
Mount Liberty.
Mount Sterling.
Mount Vernon.
Mount Victory.
Moxahala.
Murray City.
Nashport.
Negley.
Nelsonville.
Neptune.
Nevada.
New Albany.
New Alexandria.
Newark.
New Athens.
New Berlin.
New Beverley.
New Boston.
New Bremen.
Newburgh.
Newburgh Heights.
New Carlisle.
New Castle.
Newcomerstown.
New Hagerstown.
New Knoxville.
New Lexington.
New Madison.
New Matamoras.
New Middletown.
New Paris.
New Philadelphia.
Newport.
New Riegel.
New Springfield.
New Straitsville.
Niles.
North Amherst.
North Baltimore.
North Canton.
North Georgetown.
North Hampton.
North Kingsville.
North Lima.
North Olmsted.
Norwalk.
Norwood.
Nottingham.
Oakfield.
Oakharbor.
Oakwood.
Oberlin.
Orrville.
Osborn.
Osgood.
Outville.
Ozark.
Pataskala.
Pennsville.
Perrysburg.
Perrysville.
Petersburg.
Pickerington.
Piqua.
Pleasant City.
Pleasantville.
Plymouth.
Point Pleasant.
Poland.
Polk.
Pomeroy.
Portage.
Portsmouth.
Proctorville.
Quaker City.
Ravenna.
Red Haw.
Reedurban.
Rendville.
Reno.
Rex Mills.
Reynoldsburg.
Richmond.
Rittman.
Rockbridge.
Rock Creek.
Rockyridge.
Rocky River.
Roseville.
Roxbury.
Rowsburg.
Rural.
Rushville.
Rutland.

OHIO—continued.

St. Clairsville.
St. Henry.
St. Louisville.
St. Marys.
Salem.
Salineville.
Saltpetre.
Sandusky.
Sarahsville.
Sardis.
Scio.
Sciotoville.
Sebring.
Selma.
Senecaville.
Seville.
Shadyside.
Shaker Heights.
Sharon.
Sharonville.
Sharpsburg.
Shawnee.
Shelby.
Shepard.
Sherodsville.
Shreve.
Sidney.
Simons.
Sómerset.
Somerton.
South Charleston.
South Newburgh.
South Olive.
South Pleasantville
South Zanesville.
Spencer.
Spencer Station.
Spencerville.
Springfield.
Stafford.
Sterling.
Steubenville.
Stewart.
Stockport.
Stoutsville.
Strasburg.
Struthers.
Sugar Creek.
Sugar Grove.
Summerfield.
Summerton.
Summit.
Sunbury.
Sycamore.
Tarlton.
Texas.
Thornville.
Thurston.
Tiffin.
Tippecanoe City.
Tiro.
Toledo.
Toronto.
Tremont City.
Trimble.
Trinway.
Troy.
Uhrichsville.
Union City.
Union Station.
Upper Sandusky.
Urbana.
Utica.
Vanburen.
Vanlue.
Vincent.
Wadsworth.
Wapakoneta.
Warner.
Warren.
Warrensville.
Warsaw.
Washington Court House.
Washingtonville.
Waterford.
Waterloo.
Watertown.
Waterville.
Wellington.
Wellston.
Wellsville.
West Alexandria.
West Bedford.
West Carrolton.
Westerville.
West Jefferson.
West Lafayette.
West Manchester.
West Millgrove.
West Park.
West Rushville.
West Salem.
Wheelersburg.
Whipple.
White Cottage.
Wilberforce.
Williamsport.
Woodsfield.
Wooster.
Worthington.
Yellow Springs.
Youngstown.
Xenia.
Zanesville.
Zenz City.

OKLAHOMA.

Ada.
Arcadia.
Ardmore.
Avant.
Bartlesville.
Bartlett.
Beggs.
Bigheart.
Bixby.
Blackwell.
Bluejacket.
Boynton.
Braman.
Bristow.
Broken Arrow.
Cameron.
Cathay.
Chandler.
Checotah.
Chelsea.
Choteau.
Claremore.
Cleveland.
Coalton.
Collinsville.
Commerce.
Copan.
Coweta.
Cross.
Cushing.
Davenport.
Dawson.
Delaware.
Depew.
Dewar.
Dewey.
Drumright.
Duncan.
Dustin.
Edmond.
El Reno.
Enid.
Eufaula.
Featherston.
Garnett.
Gotebo.
Guthrie.
Hallett.
Haskell.
Hattonville.
Healdton.
Henryetta.
Hominy.
Hunter.
Inola.
Jenks.
Jennings.
Kellyville.
Kiefer.
Kildare.
Lawton.
Lenapah.
Locust Grove.
Luther.
McAlester.
Markham.
Marlow.
Mazie.
Meeker.
Miami.
Midlothian.
Morris.
Mounds.
Muskogee.
Nardin.
Newkirk.
Nowata.
Ochelata
Oglesby.
Oilton.
Okewah.
Oklahoma.
Okmulgee.
Oologah.
Osage.
Owasso.
Pawhuska.
Ponca.
Pond Creek.
Porter.
Poteau.
Pryor.
Quinton.
Ramona.
Red Fork.
Red Oak.
Ringling.
Sand-Springs.
Sapulpa.
Schulter.
Shamrock.
Shawnee.
Skiatook.
South Coffeyville.
Spiro.
Stidham.
Stroud.
Terlton.
Tonkawa.
Tulsa.
Turley.
Vinita.
Wagoner.
Wainwright.
Wann.
Weleetka.
Welch.
Wellston.
Whiteagle.
Wilson.
Wirt.
Yale.

PENNSYLVANIA.

Adamsburg.
Aliquippa.
Allison Park.
Altoona.
Alum Rock.
Alverton.
Ambridge.
Apollo.
Ardmore.
Argentine.
Arnold.
Austin.
Avalon.
Avonmore.
Axelton.
Baden.
Bakerstown.
Baldwin.
Barkeyville.
Barnes.
Beallsville.
Beaver.
Beaver Falls.
Belle Vernon.
Bellevue.
Bentleyville.
Betula.
Bingham.
Blackstown.
Blacksville.
Blairs Corners.
Blairsville.
Bloomster.
Bluff.
Bolivar.
Boston.
Boughton.
Bowerton.
Boyers.
Bradford.
Bradys Bend.
Branchton.
Brockport.
Brockwayville.
Brookston.
Brookville.
Brownsville.
Bruceton.
Bruin.
Bryant.
Buena Vista.
Buffalo.
Bullion.
Bully Hill.
Burdette.
Burgettstown.
Burnsville.
Burtville.
Butler.
Cabot.
Caledonia.
California.
Callensburg.
Callery.
Campbelltown.
Candor.
Canonsburg.
Carbon Center.
Carlo.
Carnegie.
Carnot.
Carrick.
Carrolltown.
Castle Shannon.
Cecil.
Centerville.
Ceres.
Charleroi.
Chicora.
Church.
Clairton.
Clarendon.
Clarendon Boro.
Clarington.
Clarion.
Clarksburg.
Clarksville.
Claysville.
Clermont.
Clintonville.
Coal Hill.
Coal Valley.
Cochranton.
Colegrove.
Coleville.
Colona.
Connellsville.
Conoquenessing.
Conway.
Cooksburg.
Cooperstown.
Coraopolis.
Corry.
Corsica.
Coryville.
Costello.
Coudersport.
Courtney.
Cowanesque.
Cowansville.
Craigsville.
Cresson.
Crosby.
Curllsville.
Custer City.
Dahoga.
Darlington.
Davistown.
Dawson.
Dayton.
Deemston.
Delmont.
Dempseytown.
Derrick City.
Derry.
Donora.
Dorseyville.
Dubois.
Duke Center.
Dunbar.
Dunkard.
East Brady.
East Hickory.
East McKeesport.
Easton.
East Sharon.
East Springfield.
East Titusville.
Eclipse.
Edgewood.
Edgeworth.
Edinburg.
Eidenau.
Elbon.
Eldersville.
Eldora.
Eldorado.
Eldred.
Elizabeth.
Elkland.
Ellwood City.
Emlenton.
Emporium.
Emsworth.
Endeavor.
Enon Valley.
Enterprise.
Erie.
Evans City.
Export.
Fairhope.
Fairmount City.
Fairhaven.
Fairview.
Falls Creek.
Farrell.
Fayette City.
Fern.
Finleyville.
Fisher.
Florence.
Ford City.
Fosters Mills.
Foxburg.
Franklin.
Fredonia.
Freedom.
Freeport.
Frogtown.
Fryburg.
Gaines.
Galeton.
Garards Fort.
Garland.
Gastonville.
Genesee.
Geneva Hill.
Gibsonton.
Gill Hall.
Gilmore.
Ginger Hill.
Girard.
Glade Run.
Glassport.
Glendale.
Glenfield.
Glenhazel.
Glen Osborne.
Glenwillard.
Grand Valley.
Graysville.
Great Belt.
Greenfield.
Greenock.
Greensboro.
Greensburg.
Greenville.
Gresham.
Grove City.
Guffey.
Guitonville.
Hackett.
Hadley.
Haffey (Milltown)
Halsey.
Hamlin.
Harmony.
Harpers Corners.
Harrison City.
Harrison Valley.
Harrisville.
Hawthorn.
Haysville.
Hazel Hurst.
Heidelburg.
Hendersonville.
Henrys Bend.
Herman.
Hickory.
Highland.
Hilliards.
Hillsville.
Holbrook.
Hollidaysburg.
Homer.
Homer City.
Hooker.
Hopwood.
Houston.
Hydetown.
Imperial.
Indiana.
Industry.
Ingomar.
Instanter.
Irvineton.
Irwin.
Jackson Center.
Jacksonville.
James City.
Jamestown.
Jeannette.
Jefferson.
Johnetta.
Johnsonburg.
Johnstown.
Jollytown.
Juniata.
Kane.
Kane Boro.
Kane City.
Kanesholm.
Kaneville.
Karns City.

PENNSYLVANIA—continued.

Kaylor.
Keisters.
Kelletsville.
Khedive.
Kingsville.
Kinzua.
Kittanning.
Knox.
Knoxville.
Kushequa.
Lamartine.
Lamont.
Langloth.
Larabee.
Larimer.
Latrobe.
Lawrenceville.
Leechburg.
Leeper.
Leesburg.
Leetsdale.
Lewis Run.
Lickingville.
Ligonier.
Limestone.
Livermore.
Logans Ferry.
Loretta.
Lucinda.
Ludlow.
McClellandtown.
McClintockville.
McDonald.
McKeesport.
McKees Rocks.
McKinley.
Manor.
Manorville.
Mapleshade.
Mapletown.
Marble.
Marianna.
Marienville.
Mars.
Marvindale.
Marwood.
Masontown.
Matildaville.
Mayburg.
Mayport.
Meadow Lands.
Meadville.
Mechanicsville.
Mercer.
Middle Fork.
Midland.
Millers Eddy.
Millport.
Millstone.
Monaca.
Monaca Heights.
Monessen.
Monongahela.
Monroeville.
Monterey.
Mount Alton.
Mount Jewett.
Mount Joy.
Mount Morris.
Mount Oliver.
Mount Pleasant.
Murrysville.
Myonia.
Natrona.
Nedskey.
Nelson.
New Bethlehem.
New Brighton.
New Castle.
New Eagle.
New Florence.
New Freeport.
New Galilee.
New Kensington.
New Mayville.
New Salem.
New Sheffield.
New Stanton.
Newton.
Newton Mills.
New Wilmington.
Nickleville.
Noblestown.
North Bessemer.
North Blackville.
North East.
North Girard.
North Irwin.
North Warren.
Norwich.
Oakdale.
Oakland.
Oak Ridge.
Oil City.
Ormsby.
Osceola.
Osgood.
Oswayo.
Otto.
Parker.
Parkers Landing.
Petersville.
Petroleum Center.
Petrolia.
Philipston.
Pittsburgh.
Pittsfield.
Pleasantville.
Plummer.
Point Marion.
Polk.
Pollock.
Portage.
Port Allegany.
Port Barnett.
Porter.
Portersville.
Portland Mills.
Poseytown.
Potter Brook.
Prentice.
Primrose.
Prospect.
Punxsutawney.
Queen.
Queenstown.
Rankin.
Ratigan.
Raymilton.
Red Fork.
Redman.
Red Rock.
Reidsburg.
Renfrew.
Reno.
Reynoldsville.
Richmond.
Ridgway.
Rimer.
Rimer Hill.
Rimersburg.
Rixford.
Rochester.
Rockland.
Rockmere.
Rockygrove.
Rogersville.
Rolfe.
Roscoe.
Roseville.
Roulette.
Rouseville.
Rural Valley.
Russell.
Rynd Farm.
St. Marys.
St. Petersburg
Sabinsville.
Salem.
Salina, Venango County.
Salina, Westmoreland County.
Saltsburg.
Sandy Lake.
Sankertown.
Saxonburg.
Scottdale.
Semples.
Seneca.
Sergeant.
Sewickley.
Shamburg.
Sharon.
Sharon Center.
Sharpsville.
Shawmut.
Sheffield.
Shinglehouse.
Shinglehouse Boro.
Shippenville.
Sigel.
Sligo.
Slippery Rock.
Smethport.
Smiths Ferry.
Snowden.
South Brownsville.
South Heights.
South Jeannette.
South Sharon.
Spring Church.
Stoneboro.
Stoneham.
Straight.
Strattonville.
Sturgeon.
Sugar Creek.
Summerville.
Summit.
S. W. Greensburg.
Swissvale.
Tarentum.
Tarrs.
Taylorstown.
Tidal.
Tidioute.
Tiona.
Tionesta.
Titusville.
Townville.
Troutman.
Turkey.
Turtle Creek.
Tylersburg.
Ulysses.
Uniontown.
Unity.
Upper Middletown.
Utica.
Valencia.
Valley Station.
Van.
Vanderbilt.
Vandergrift.
Vanport.
Venango Station (P. R. R.).
Venetia.
Venus.
Verona.
Video.
Volant.
Walkers Mills.
Waltersburg.
Warren.
Warren Boro.
Washington.
Waters.
Waynesburg.
Webster.
West Alexander.
West Branch.
West Elizabeth.
West End Boro.
Westfield.
West Freedom.
West Hickory.
Westline.
West Middlesex.
West Middletown.
West Monongahela.
West Monterey.
Westmoreland City.

PENNSYLVANIA—continued.

West Newton.
West Reynoldsville.
West Sunbury.
West Winfield.
Wetmore.
Wheatland.
Whiskerville.
Whitetown.
Wick.
Widnoon.
Wilcox.
Wilkinsburg.
Wilson.
Wireton.
Woodlawn.
Worthington.
Youngsville.
Youngwood.
Zelienople.

SOUTH DAKOTA.

Fort Pierre.
Pierre.

TEXAS.

Abilene.
Albany.
Alvord.
Arlington.
Atlanta.
Baird.
Bangs.
Bellevue.
Bloomburg.
Bowie.
Bridgeport.
Byers.
Cass.
Cisco.
Clyde.
Corsicana.
Crowther.
Dallas.
Dalworth.
Decatur.
Denison.
Denton.
Eagle Ford.
Electra.
Fort Worth.
Fostepco Heights.
Gainesville.
Grand Prairie.
Groesbeck.
Henrietta.
Highland Park.
Irving.
Kirk.
Laredo.
Leigh.
McKinney.
Marshall.
Mart.
Mexia.
Moran.
Niles.
Petrolia.
Polytechnic.
Putnam.
Queen City.
Rhome.
Richland.
Riverside.
Santa Anna.
Sherman.
Sunset.
Teague.
Tehuacana.
Texarkana.
Thurber.
Trinity Heights.
Waco.
Whitesboro.
Wichita Falls.
Wortham.

WEST VIRGINIA.

Adamston.
Adrian.
Alma.
Alvord.
Amma.
Arvilla.
Auburn.
Bannister.
Barboursville.
Barrackville.
Bayard.
Belington.
Belmont.
Bens Run.
Benwood.
Benson.
Beraman.
Berea.
Bigbend.
Big Creek.
Big Isaac.
Big Springs.
Blacksville.
Blaine.
Blue Creek.
Blueville.
Boothsville.
Branchland.
Bridgeport.
Briscoe.
Bristol.
Broad Oaks.
Brookville.
Buckhannon.
Buffalo.
Burning Springs.
Burnsville.
Burton.
Cabin Creek Junction.
Cairo.
Calif Mines.
Cameron.
Cannelton.
Cedargrove.
Center Point.
Centerville.
Ceredo.
Charleston.
Chelyan.
Chester.
Clarington.
Clarksburg.
Clendenin.
Coalburg.
Coburns Creek.
Coger.
Colfax.
Colliers.
Columbia Mines.
Corinth.
Crawford.
Creston.
Crown Hill.
Culloden.
Danville.
Davis.
Davissons Run.
Daybrook.
Deanville.
Dobbin.
Dunbar.
Eastbank.
East Lynn.
Edgewood.
Elizabeth.
Elkins.
Elk Garden.
Elk View.
Ellenboro.
Elm Grove.
Elm Run.
Enterprise.
Eris.
Eureka.
Fairmont.
Fairview.
Farmington.
Farnum.
Finch.
Fink.
Flat Woods.
Flemington.
Follansbee.
Fort Gay.
French Creek.
Frenchton.
Friendly.
Fulton.
Gandeeville.
Gassaway.
Gaston.
Gay.
Glen Dale.
Glen Easton.
Glen Falls.
Glenova.
Glenwood.
Glenville.
Glovergap.
Goose Creek.
Gormania.
Gould.
Grafton.
Grantsville.
Grasselli.
Griffithsville.
Hamlin.
Handley.
Hannahdale.
Hansford.
Harrisville.
Hartley (Munday P. O.).
Haymond Heights.
Haywood.
Heaters.
Henry.
Hepzibah.
Horner.
Hundred.
Huntington.
Hurricane.
Hutchinson.
Industrial.
Ireland.
Jacksonburg.
Janelew.
Jarvisville.
Johnstown.
Jordan Creek.
Kelly Hill.
Kempton.
Kenova.
Kermit.
Keyser.
Kygar.
Leatherwood.
Lima.
Littleton.
Logan.
Longacre.

WEST VIRGINIA—continued.

Lost Creek.
Loudenville.
Loveland.
Lumberport.
McMechen.
Madison.
Mahone.
Mammoth.
Mannington.
Martha.
Meadowbrook.
Metz.
Middlebourne.
Miletus.
Milton.
Monongah.
Montgomery.
Montpelier.
Monticello Add.
Morgantown.
Moundsville.
Mount Clare.
Mount Zion.
Murphytown.
Myra.
Newark.
New Cumberland.
New Fairground.
New Martinsville.
North View.
Norwood Park.
Ogdin.
Ona.
Orlando.
Paden City.
Palestine.
Parkersburg.
Parsons.
Patterson.
Peel Tree.
Pennsboro.
Peoria.
Perry Mines.
Petroleum.
Peytona.
Philippi.
Piedmont.
Pine Grove.
Pleasant Valley.
Poca.
Point Comfort.
Point Pleasant.
Pratt.
Proctor.
Pruntytown.
Pullman.
Racine.
Ravenswood.
Reedy.
Ripley.
Riverside Addition.
Roanoke.
Rockcave.
Rockford.
Rowlesburg.
St. Albans.
St. Marys.
Salem.
Sandyville.
Schultz.
Sedalia.
Seth.
Sherrard.
Shiloh.
Shinnston.
Shirley.
Shrewsbury
Silverton.
Simpson.
Sistersville.
Smithburg.
Smithers.
Smithfield.
Smithville.
South Buckhannon.
Spencer.
Spring Hill.
Star City.
Stealey Heights.
Summit Park.
Sutton.
Tanner.
Terra Alta.
Thomas.
Thornton.
Three Mile.
Tin Plate.
Troy.
Tyler City.
Union Heights.
Volcano.
Walgrove.
Walkersville.
Wallace.
Walton.
Ward.
Warwood.
Waverly.
Wayne.
Wellsburg.
West Fork.
West Hamlin.
Weston.
West Union.
Wheeling.
Wileyville.
William.
Williamson.
Williamstown.
Wilsonburg.
Woodlawn.
Woodsdale.
Woodville.
Worthington.
Wyatt.

WYOMING.

Basin.
Byron.
Cowley.
Greybull.
Lovell.

NATURAL GAS IN FOREIGN COUNTRIES.

Statistics of natural gas in foreign countries for 1917 are very incomplete. Official data are available for Canada and the Dutch East Indies only. Small quantities of natural gas have been reported in previous years from Great Britain, Italy, Hungary, and Japan, but statistics are not available for 1917. Nearly all producing oil fields furnish also some natural gas.

CANADA.

The following data concerning natural gas produced in Canada is obtained from the reports on mineral production issued by the Canada Department of Mines:

Value of natural gas produced in Canada, 1909–1917.

Year.	New Brunswick.	Alberta.	Ontario.	Total Canada.
1909	....	$61,722	$1,145,307	$1,207,029
1910	....	75,168	1,271,303	1,346,471
1911	....	110,165	1,807,513	1,917,678
1912	$36,549	289,906	2,036,245	2,362,700
1913	174,147	1,079,466	2,055,768	3,309,381
1914	54,249	1,214,670	2,215,808	3,484,727
1915	60,383	1,022,814	2,622,838	3,706,035
1916	79,628	1,114,351	2,730,653	3,924,632
1917	103,735	1,299,976	3,641,587	5,045,298

The following table showing data concerning the natural-gas industry in the Province of Ontario is presented through the courtesy of Thos. W. Gibson, Deputy Minister of Mines, Toronto, Ontario:

Statistics of natural gas in the Province of Ontario, Canada, 1909–1917.

Year.	Wells bored in the year.		Producing wells, Dec. 31.	Miles of gas pipe.	Workmen employed.	Gas produced.		Wages for labor.
	Productive.	Nonproductive.				Quantity (cubic feet).	Value.	
1909			744	987	171	5,388,000,000	$1,145,307	$103,672
1910			828	982	186	7,263,427,000	1,271,303	118,785
1911	268	38	1,179	1,296	287	10,863,871,000	1,807,513	183,663
1912	178	41	1,247	1,448	277	12,529,463,000	2,036,245	184,351
1913	211	49	1,605	1,720	336	12,474,745,000	2,055,768	237,600
1914	120	28	1,665	1,389	392	14,094,521,000	2,215,808	224,492
1915	109	13	1,734	1,931	598	15,211,523,000	2,622,838	382,401
1916	135	38	1,802	2,233	653	17,838,318,000	2,730,653	404,039
1917	(a)	(a)	(a)	(a)	(a)	19,868,036,000	3,641,587	(a)

a Not stated.

DUTCH EAST INDIES.

Statistics for the years 1916 and 1917 concerning the production of natural gas in the Dutch East Indies have been furnished by the Hoofdbureau van het Mijwezen, Batavia, Java. The total production in 1917 was 200,118.7 metric tons, an increase of 108,997.5 tons, or 119.7 per cent, over the production for 1916. The production for 1917 was distributed as follows: Java, 30,674.9 metric tons; Sumatra, 112,942.9 metric tons; Borneo, 56,500.9 metric tons. The corresponding figures for 1916 were: Java, 24,371.3 metric tons; Sumatra, 66,122.8 metric tons; Borneo, 627.1 metric tons—total 91,121.2 metric tons.

GASOLINE FROM NATURAL GAS.

By John D. Northrop.

INTRODUCTION.

Of the few industries that may be considered direct offshoots of the natural-gas industry the recovery of gasoline from natural gas is the only one that has thus far attained special importance. Though scarcely a dozen years old and still in process of growth, the natural-gas gasoline industry has become a material contributor to the domestic supply of motor fuels from a source whose potentialities in the production of motor fuel are as yet only partly developed.

Although the foundations of this industry were laid in 1903 and 1904 by the experiments of Fasenmeyer near Titusville, Pa., of Tompsett Brothers near Tidioute, Pa., and of Sutton Brothers at Sistersville, W. Va., and were extended during the period between 1905 and 1908 by the experiments of Richards at Mayburg, Pa., of Hollingshead at Bradford, Pa., of McCarty at Bolivar, N. Y., of Gray at Kinzua, Pa., and of others, little headway was made until 1909 and 1910, when the researches of Peterson and his associates on the engineering staff of the Bessemer Gas Engine Co., of Grove City, Pa., transformed the industry from an experimental basis to a commercial one.

Its subsequent growth has been phenomenal. In 1911, the first year for which statistics on the subject are available, 176 plants in nine States produced 7,425,839 gallons of raw gasoline from natural gas. In 1917, only six years later, 886 plants in 12 States produced 217,884,104 gallons, a gain in that brief period of 403 per cent in the number of plants and of 2,834 per cent in the annual output of raw gasoline.

Prior to 1916 the greater portion of the gasoline recovered from natural gas was obtained from casing-head gas, oil-well gas, or "wet" natural gas by methods involving compression and condensation. Much of the output came, of course, from plants specially designed and installed to recover the gasoline vapors carried by gas of that type; but a fair proportion, particularly in the Appalachian oil field, was recovered incidentally by the use of simple and relatively inexpensive condensing apparatus connected with vacuum pumps installed to expedite the production of oil, and some was recovered as drips from gas transmission lines. Since 1913, however, a steadily increasing proportion of the annual output of natural-gas gasoline has been recovered by the absorption process. The development of this process that followed research work done in 1912 and 1913 by G. M. Sabolt, a chemical engineer of the Hope Natural Gas Co., has extended the scope of the natural-gas gasoline industry to include types of natural gas containing too little gasoline to warrant their successful treatment by compression methods—types that constitute about 50 per cent of the natural gas produced in the country. With the scope of the industry broadened to include practically every type of natural gas found in the United States, its growth since 1913 has been in the direction of increased capacity for production of gasoline rather than in a direction that would tend to determine what other products could be derived from natural gas by variations in the methods employed to recover gasoline. This phase of the industry is now receiving attention, and substantial progress has already been made in the recovery of liquid propane and butane from natural gas in conjunction with the recovery of gasoline. Experiments have demonstrated the feasibility of recovering these two substances at absorption gasoline plants at little additional cost for equipment and operation, and since May 31, 1917, an auxiliary plant of this kind, having a potential capacity of 2,000 gallons of liquid propane and 2,200 gallons of liquid butane a day, has been in operation in West Virginia.

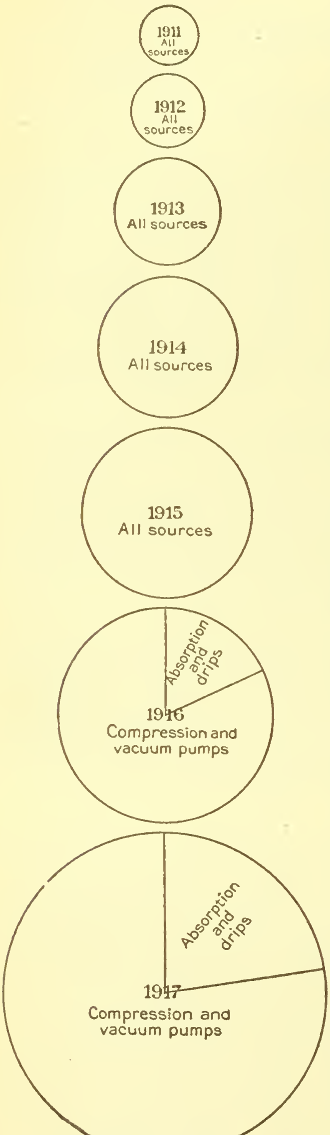


FIGURE 34.—Relative quantity of raw natural-gas gasoline sold in the United States annually, 1911-1917.

Liquid propane and liquid butane have fuel values 2.5 to 3 times that of natural gas and have been found suitable for use in cutting and welding metals, in heating and lighting dwellings, and, with the substitution of a gas mixer for the carburetor, as a source of power in internal-combustion engines, both stationary and automotive. Laboratory experiments have shown the possibility of obtaining from the gaseous forms of propane and butane, under certain conditions, as high as 27 and 38 pounds, respectively, of carbon black per thousand cubic feet of gas treated.

These are but the first results of scientific research made according to the principles of physics and chemistry utilized in the recovery of gasoline from natural gas. They are sufficient, however, to show that this research, if pursued to its conclusion, will give the resources of natural gas still remaining in the United States an increase in utility and value that may in some measure offset the loss by the notorious prodigality and waste that have heretofore marked our use of this valuable hydrocarbon.

The growth of the natural-gas gasoline industry in the United States is shown graphically in the accompanying diagram (fig. 1).

PRODUCTION.

GENERAL STATEMENT.

For the natural-gas gasoline industry in the United States the year 1917 was one of marked expansion in every phase. The quantity of raw gasoline recovered from natural gas in that year, including that produced by compression, by absorption, and by vacuum pumps, as well as that saved as drips from gas mains, was 217,884,104 gallons, a gain of 114,391,415 gallons, or 111 per cent, over the output in 1916. Of this quantity 168,866,555 gallons, or 77.5 per cent, was recovered by compression and by vacuum pumps and the remaining 49,017,549 gallons, or 22.5 per cent, by absorption and by salvage from gas mains. The combined gasoline obtained by compression and by vacuum pumps was greater than in 1916 by 83,943,768 gallons, or 99 per cent, and the gasoline obtained by absorption and from drips was greater by 30,447,647 gallons, or 164 per cent.

The quantity of commercial gasoline represented by the raw gasoline in 1917, though not susceptible of accurate determination, probably amounted to more than 300,000,000 gallons.

The average price received in 1917 for the raw gasoline at the sources of production was 18.45 cents a gallon, and the market value of the entire output was $40,188,956, a gain of 4.6 cents in average unit selling price and of $25,857,808, or 180 per cent, in gross market value, compared with 1916, which reflects the steadily appreciating value of motor fuels in the period under review.

The volume of natural gas from which the natural-gas gasoline was recovered in 1917 amounted to about 429,000,000,000 cubic feet, and the average recovery of gasoline per 1,000 cubic feet by all methods was about half a gallon.

The number of plants, including vacuum-pump plants, recovering gasoline from natural gas increased from 596 at the beginning of 1917 to 886 at the end of that year, a gain of 49 per cent, and the combined daily capacity of all plants increased during the same period from 495,448 gallons to 902,385 gallons, or about 82 per cent.

STATISTICS OF NATURAL-GAS GASOLINE.

Natural-gas gasoline marketed in the United States, 1911-1917.

State.	Number of operators.	Plants.		Gasoline produced.			Gas used.		
		Number.	Daily capacity.	Quantity.	Value.	Price per gallon.	Estimated volume.	Value.	Average yield in gasoline per thousand cubic feet.
1911.			*Gallons.*	*Gallons.*		*Cents.*	*Cubic feet.*		*Gallons.*
West Virginia	47	72	16,819	3,660,165	$262,661	7.18	1,252,900,600	$76,074	2.92
Ohio	26	39	6,454	1,678,985	118,161	7.04	469,672,000	37,574	3.57
Pennsylvania	43	50	5,669	1,467,043	109,649	7.47	526,152,663	52,615	2.79
Oklahoma	8	8	4,800	388,058	20,975	5.40	144,629,000	4,378	2.68
California Colorado Illinois New York Kentucky	8	7	3,358	[a] 231,588	20,258	8.75	82,343,000	6,320	2.81
	132	176	37,100	7,425,839	531,704	7.16	2,475,697,263	176,961	3.00

[a] Includes gasoline produced in Kentucky which came from natural condensation in gas mains.

Natural-gas gasoline marketed in the United States, 1911–1917—Continued.

State.	Number of operators.	Plants. Number.	Plants. Daily capacity.	Gasoline produced. Quantity.	Gasoline produced. Value.	Gasoline produced. Price per gallon.	Gas used. Estimated volume.	Gas used. Value.	Gas used. Average yield in gasoline per thousand cubic feet.
1912.			*Gallons.*	*Gallons.*		*Cents.*	*Cubic feet.*		*Gallons.*
West Virginia	66	97	22,366	5,318,136	$513,116	9.6	1,972,882,212	$163,749	2.8
Pennsylvania	69	83	10,524	2,041,109	217,016	10.6	722,730,117	62,010	2.8
Ohio	25	43	7,791	1,718,719	173,421	10.1	576,123,700	46,090	2.98
Oklahoma	11	13	11,910	1,575,644	99,626	6.3	701,044,300	24,901	2.25
California	7	7	6,669	1,040,695	112,502	10.8	600,743,000	25,573	1.7
Illinois	4	4							
Colorado	2	2							
New York	1	1	2,008	a 386,876	41,795	10.8	114,273,000	9,662	3.4
Kentucky	1	......							
	186	250	61,268	12,081,179	1,157,476	9.6	4,687,796,329	331,985	2.6
1913.									
West Virginia	63	115	31,930	7,662,493	807,406	10.54	2,981,119,000	181,337	2.57
Oklahoma	19	40	61,633	6,462,968	577,944	8.94	2,152,503,000	82,742	3.00
Pennsylvania	100	113	22,207	3,680,096	405,186	11.01	1,372,056,000	114,783	2.68
California	12	14	21,135	3,460,747	376,227	10.87	2,436,445,000	106,539	1.42
Ohio	25	41	8,142	2,072,687	212,404	10.25	744,226,000	63,233	2.79
Illinois	6	12							
Colorado	2	2							
New York	3	3	7,368	a 721,826	79,276	10.98	203,092,500	17,590	3.55
Kansas	1	1							
Kentucky	1	......							
	232	341	152,415	24,060,817	2,458,443	10.22	9,889,441,500	566,224	2.43
1914.									
Oklahoma	35	58	74,793	17,277,555	1,113,059	6.44	5,738,549,000	273,940	3.01
West Virginia	65	121	34,460	9,278,108	691,899	7.45	3,005,292,000	172,396	2.58
California	17	19	32,360	7,581,309	633,517	8.36	5,129,709,000	197,066	1.48
Pennsylvania	96	119	21,456	4,611,738	359,402	7.79	1,560,064,000	125,690	2.89
Ohio	25	47	9,319	2,440,171	184,097	7.54	852,277,000	68,935	2.86
Illinois	7	14	5,300	1,164,178	100,331	8.62	462,321,000	43,017	2.52
Kansas	3	3							
New York	3	3							
Colorado	2	2	1,665	a 299,573	23,604	7.88	146,345,000	8,862	2.03
Kentucky	1	......							
	254	386	179,353	42,652,632	3,105,909	7.28	16,894,557,000	889,906	2.43
1915.									
Oklahoma	36	63	111,463	31,665,991	2,361,029	7.46	8,791,881,000	435,512	3.60
California	18	20	40,755	12,835,126	975,397	7.60	8,006,888,000	288,669	1.60
West Virginia b	66	114	34,422	10,853,608	927,079	8.54	3,526,575,000	150,918	2.30
Pennsylvania b	116	139	22,754	5,898,597	569,873	9.66	1,838,034,000	186,325	2.73
Ohio	29	50	8,995	2,198,715	167,138	7.60	785,041,000	77,767	2.80
Illinois	8	16	8,500	1,035,204	80,049	7.73	451,663,000	34,405	2.29
Texas	1	1							
New York	4	4							
Louisiana	2	2	5,447	877,424	70,258	8.01	664,309,000	28,959	1.32
Kansas	3	2							
Colorado	2	2							
Kentucky b	2	1							
	287	414	232,336	65,364,665	5,150,823	7.88	24,064,391,000	1,202,555	2.57

a Includes gasoline produced in Kentucky which came from natural condensation in gas mains.
b Includes gasoline resulting from natural condensation in gas mains.

Natural-gas gasoline marketed in the United States in 1911–1917—Continued.

State.	Number of operators.	Plants. Number.	Plants. Daily capacity.	Gasoline produced. Quantity.	Gasoline produced. Value.	Gasoline produced. Price per gallon.	Estimated volume of gas treated.	Average yield of gasoline per thousand cubic feet of gas.
1916.			*Gallons.*	*Gallons.*		*Cents.*	*M cubic ft.*	*Gallons.*
Oklahoma	77	116	233,077	48,359,602	$5,865,145	12.13	24,749,454	1.954
West Virginia	105	147	98,659	18,765,056	3,025,293	16.12	104,664,536	0.179
California	28	26	54,060	17,158,754	2,293,822	13.37	24,826,354	0.691
Pennsylvania	167	195	46,487	9,714,926	1,726,173	17.77	38,490,621	0.252
Ohio	40	55	18,391	2,638,571	470,804	17.84	5,435,759	0.485
Illinois	17	32	12,070	2,260,288	262,664	11.58	1,338,594	1.688
Louisiana	7	7	10,661	2,113,159	269,564	12.76	907,153	2.329
Texas	3	4	6,688	1,292,811	201,023	15.55	948,485	1.363
Kentucky	5	5	11,300	725,467	141,347	19.48	5,614,613	0.129
Kansas	4	3	3,030	215,000	35,030	16.29	1,626,635	0.132
New York Colorado	7	6	1,025	249,055	40,283	16.17	102,819	2.422
	460	596	495,448	103,492,689	14,331,148	13.85	208,705,023	0.496
1917.								
Oklahoma	167	234	492,436	115,123,424	21,541,905	18.71	84,719,941	1.359
West Virginia	128	188	135,663	32,668,647	6,511,813	19.93	167,771,351	0.195
California	45	49	99,761	28,817,604	4,438,022	15.40	45,351,247	0.635
Pennsylvania	287	251	59,164	13,826,250	2,778,098	20.01	49,487,056	0.279
Texas	10	11	32,550	6,920,405	1,149,441	16.61	12,677,216	0.546
Ohio	49	61	25,137	5,439,560	1,051,376	19.33	30,062,141	0.181
Louisiana	15	20	20,118	4,979,754	814,747	16.36	2,233,511	2.229
Illinois	33	55	17,392	4,934,009	866,033	17.55	2,685,895	1.837
Kentucky	5	5	13,400	3,818,209	763,186	19.99	24,915,946	0.153
Kansas	4	6	4,642	1,174,980	241,219	20.53	9,315,339	0.126
New York Colorado	7	6	2,122	181,262	33,116	18.27	68,154	2.659
	750	886	902,385	217,884,104	40,188,956	18.45	429,287,797	0.508

Classification of natural-gas gasoline in 1916 and 1917 by principal methods of manufacture.

1916.

Gasoline produced by compression and by vacuum pumps.

State.	Plants. Number.	Plants. Daily capacity.	Gasoline produced. Quantity.	Gasoline produced. Value.	Gasoline produced. Price per gallon.	Gas used. Estimated volume.	Gas used. Average yield in gasoline per thousand cubic feet.
		Gallons.	*Gallons.*		*Cents.*	*Cubic feet.*	*Gallons.*
Oklahoma	104	215,377	45,827,325	$5,471,307	11.94	14,018,757	3.269
West Virginia	133	39,276	9,289,624	1,642,031	17.67	3,550,523	2.616
Pennsylvania	185	30,287	6,722,370	1,216,717	18.10	2,693,215	2.496
Louisiana	7	10,661	213,159	269,564	12.76	907,153	2.329
Texas	4	6,688	1,292,811	201,023	15.55	948,485	1.363
New York	5	1,025	249,055	40,283	16.17	102,819	2.422
Colorado	1						
California	24	72,251	19,428,443	2,652,776	13.65	14,492,463	....
Ohio	53						
Illinois	29						
Kentucky	3						
Kansas	2						
	550	375,565	84,922,787	11,493,701	13.53	36,713,415	....

Classification of natural-gas gasoline in 1916 and 1917 by principal methods of manufacture—Continued.

1916—Continued.

Gasoline produced by absorption.[a]

State.	Plants.		Gasoline produced.			Gas used.	
	Number.	Daily capacity.	Quantity.	Value.	Price per gallon.	Estimated volume.	Average yield in gasoline per thousand cubic feet.
		Gallons.	*Gallons.*		*Cents*	*Cubic feet.*	*Gallons.*
West Virginia	14	59,383	9,475,432	$1,383,262	14.60	101,114,013	0.094
Pennsylvania	10	16,200	2,992,556	509,456	17.02	35,797,406	.084
Oklahoma	12	17,700	2,532,277	393,838	15.55	10,730,697	.236
California	2						
Kentucky	2						
Illinois	3	26,600	3,569,637	550,891	15.43	24,349,492	....
Ohio	2						
Kansas	1						
	46	119,883	18,569,902	2,837,447	15.28	171,991,608	....
Grand total	596	495,448	103,492,689	14,331,148	13.85	208,705,023	.496

1917.

Gasoline produced by compression and by vacuum pumps.

State.	Number.	Daily capacity.	Quantity.	Value.	Price per gallon.	Estimated volume.	Average yield in gasoline per thousand cubic feet.
Oklahoma	207	456,632	108,728,213	$20,321,067	18.68	36,399,280	2.987
California	40	82,092	23,478,521	3,637,827	15.49	27,477,443	.854
West Virginia	159	44,348	12,276,784	2,211,494	18.01	4,845,648	2.534
Pennsylvania	234	32,564	9,011,199	1,792,430	19.89	3,572,356	2.522
Louisiana	18	17,915	4,459,920	719,758	16.14	1,558,346	2.862
Illinois	54	15,392	4,268,158	756,344	17.72	2,020,044	2.113
Texas	8	10,900	3,942,337	664,543	16.86	2,666,983	1.478
Ohio	54	8,337	2,331,498	423,106	18.15	836,639	2.787
New York	5						
Kansas	1	3,322	369,925	70,361	19.02	150,784	2.453
Kentucky	3						
Colorado	1						
	784	671,502	168,866,555	30,596,930	18.12	79,527,523	2.123

Gasoline produced by absorption.

State.	Number.	Daily capacity.	Quantity.	Value.	Price per gallon.	Estimated volume.	Average yield in gasoline per thousand cubic feet.
West Virginia	29	91,315	20,391,863	$4,300,319	21.09	162,925,703	0.125
Oklahoma	27	35,804	6,395,211	1,220,838	19.09	48,320,661	.132
California	9	17,669	5,339,083	800,195	14.99	17,873,804	.299
Pennsylvania	17	26,600	4 815,051	985,668	20.47	45,914,700	.105
Kentucky[a]	2	[b] 13,000	3 725,893	745,210	20.00	24,871,590	.150
Ohio	7	16,800	3,108,062	628,270	20.21	29,225,502	.106
Texas[c]	3	21,650	2,978,068	484,898	16.28	10,010,233	.298
Kansas	5	3,842	1,071,633	220,550	20.58	9,274,289	.116
Illinois[a]	1	2,000	665,851	109,689	16.47	665,851	1.000
Louisiana[a]	2	2,203	519,834	94,989	18.27	675,165	.770
New York[d]	......	....	7,000	1,400	20.00	2,776	....
	102	230,883	49,017,549	9,592,026	19.57	349,760,274	.140
Grand total	886	902,385	217,884,104	40,188,956	18.45	429,287,797	.508

[a] Includes drip gasoline.
[b] Includes gasoline produced in Kentucky from West Virginia gas.
[c] Includes some gasoline produced by compression.
[d] Drips only.

NATURAL-GAS GASOLINE INDUSTRY BY STATES.

OKLAHOMA.

The year 1917 was the fourth consecutive year in which Oklahoma has led all other States in the production of gasoline from natural gas. Its output constituted about 53 per cent of all the natural-gas gasoline produced in the United States in 1917 and was three and a half times the output of West Virginia, its nearest competitor for first place. It amounted to 115,123,424 gallons and exceeded the output in Oklahoma in 1916 by 66,763,822 gallons, or 138 per cent.

Of this record output 108,728,213 gallons, or 94 per cent, came from 207 compression plants and the remaining 6,395,211 gallons, or 6 per cent, came from 27 absorption plants, except a small quantity of gasoline recovered as drips from gas mains in Oklahoma.

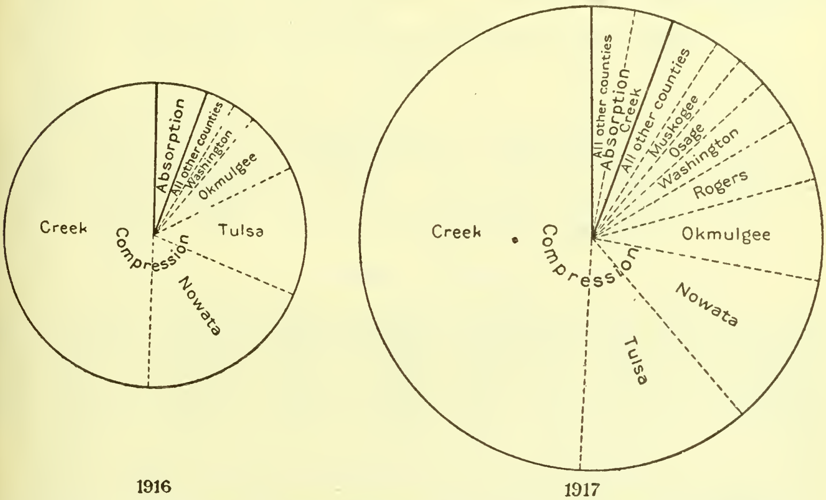


FIGURE 35.—Distribution by counties of natural-gas gasoline marketed in Oklahoma in 1916 and 1917.

The output of gasoline by compression plants in 1917 was greater than in 1916 by 62,900,888 gallons, or 137 per cent, and that by absorption plants, including drips, was greater by 3,862,934 gallons, or 153 per cent.

The average price received at the plants for the gasoline recovered from natural gas in Oklahoma in 1917 was 18.71 cents a gallon, and the market value of the entire output was $21,541,905, a gain of 6.58 cents in average unit selling price and of $15,676,760, or 267 per cent, in market value compared with 1916. The average selling price of the product of compressor plants in Oklahoma was 18.68 cents, and that of absorption plants was 19.09 cents, those prices constituting increases of 6.74 cents and 3.54 cents, respectively, over the corresponding prices in 1916.

The total number of plants actively engaged in the recovery of gasoline from natural gas in Oklahoma at the end of 1917 was 234, a net gain of 118 plants, or 102 per cent, over the number of active plants at the end of 1916. Plants utilizing methods of compression and refrigeration increased from 104 to 207 during the year, a gain of 100 per cent, and plants utilizing methods of absorption increased from 12 to 27, a gain of 125 per cent.

The volume of natural gas treated in the production of natural-gas gasoline in Oklahoma in 1917 is estimated at 84,719,941,000 cubic feet, a gain of 59,970,487,000 cubic feet, or 242 per cent, over the volume treated in 1916. Of this volume of gas, 36,399,280,000 cubic feet, or 43 per cent, yielded an average of 3 gallons of raw gasoline per thousand cubic feet by compression methods, the remaining 57 per cent yielding an average of 1 pint of gasoline per thousand cubic feet by absorption methods.

The accompanying diagram (fig. 2) and the following tables show the production of gasoline from natural gas in Oklahoma in 1916 and 1917 in such detail by counties as the policy of the Geological Survey of safeguarding the statistics of individual producers will permit:

Natural-gas gasoline marketed in Oklahoma in 1916 and 1917.

1916.

County.	Number of operators.	Plants.		Gasoline produced.		Estimated volume of gas treated.	Average yield of gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
		Number.	Daily capacity.	Quantity.	Value.			
			Gallons.	*Gallons.*		*M.cu.ft.*	*Gallons.*	*° Baumé.*
Creek	24	36	105,742	24,159,720	$2,500,218	6,032,636	1.4–7.8	72–96
Nowata	9	12	37,400	9,333,075	1,191,982	2,116,831	1.4–6.1	78–96
Tulsa	12	19	25,135	6,503,102	886,466	2,303,667	1.2–3.5	72–95
Okmulgee	13	18	20,100	3,082,438	431,409	2,080,671	.6–5.7	79–95
Washington	4	6	8,900	1,124,873	221,711	645,301	2.0–	82–89
Muskogee	8	9	6,000	1,086,536	158,211	616,791	1.3–3.5	64–90
Rogers	2	3	12,100	537,581	81,310	222,860	2.0–2.5	72–82
Pawnee	2	1					3.0	72
Kay	*a* 2							
Osage	*a* 1							
Total by compression		104	215,377	45,827,325	5,471,307	14,018,757	3.269	64–96
Total by absorption and drip		12	17,700	2,532,277	393,838	10,730,697	.236	68–80
Grand total	77	116	233,077	48,359,602	5,865,145	24,749,454	1.954	64–96

1917.

Gasoline produced by compression and by vacuum pumps.

County.	Number of operators.	Plants: Number.	Daily capacity.	Quantity.	Value.	Estimated volume of gas treated.	Average yield.	Average gravity.
Creek	38	72	244,747	57,365,695	$11,036,197	17,090,464	0.50–6.50	70–90
Tulsa	22	31	46,097	13,842,304	2,450,159	4,794,140	1.50–7.00	78–90
Nowata	14	17	48,190	12,379,140	2,300,282	3,544,339	1.06–7.45	74–90
Okmulgee	19	29	32,731	8,097,068	1,409,292	3,162,827	1.00–6.00	70–90
Rogers	5	10	15,256	4,805,265	783,811	1,902,294	1.75–3.98	75–85
Washington	12	15	19,275	3,761,253	757,135	1,918,941	.86–2.50	66–88
Osage	3	4	10,700	2,574,767	549,788	1,112,975	1.75–3.00	76–86
Muskogee	15	17	13,556	2,408,748	458,923	1,083,186	.85–3.98	68–87
Pawnee	5	5	7,880	1,809,746	232,249	1,217,560	1.30–2.52	72–85
Wagoner	3	3	12,100	1,508,236	307,873	513,634	1.58–3.50	80–90
Carter	1	2	1,100	175,991	35,358	58,920	....	78.8
Kay	1	2	5,000				3.00	80
	138	207	456,632	108,728,213	20,321,067	36,399,280	2.987	66–90

a Absorption plants and drip only.

Natural-gas gasoline marketed in Oklahoma in 1916 and 1917—Continued.

1917—Continued.

Gasoline produced by absorption.

County.	Number of operators.	Plants.		Gasoline produced.		Estimated volume of gas treated.	Average yield of gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
		Number.	Daily capacity.	Quantity.	Value.			
			Gallons.	*Gallons.*		*M cubic feet.*	*Gallons.*	*° Baumé.*
Creek	9	12	12,881	3,180,724	$584,897	20,088,076	0.086-1.500	45-76
Kay	3	4	9,720	915,613	181,801	4,666,230	.172- .190	62-76
Osage	2	3	3,501	397,850	82,486	6,335,195	.058-1.160	50-74
Pawnee	1	2	5,852				.370	....
Payne	1	1					.150	74
Lincoln	1	1	2,650				.045	74-76
Okmulgee	2	1					.10	70
Rogers [a]	1	......	....	1,901,024	371,654	17,231,160	....	70
Nowata [a]	3	......	....				....	63-72
Tulsa	3	1					2.00	54-76
Oklahoma	1	1	1,200				....	68
Muskogee	1	1					.50	60
Washington [a]	1	......	....				....	65
	29	27	35,804	6,395,211	1,220,838	48,320,661	.1323	45-76
Grand total	167	234	492,436	115,123,424	21,541,905	84,719,941	1.359	45-90

[a] Includes drips.

WEST VIRGINIA.

An output of 32,668,647 gallons of natural-gas gasoline in 1917 retained for West Virginia its rank of second among the contributing States. This quantity was 15 per cent of the output of natural-gas gasoline in the entire country in 1917; it exceeded the output of West Virginia in 1916 by 13,903,591 gallons, or 74 per cent, and was more than three times the output of that State in 1915.

Of the total quantity of natural-gas gasoline marketed from plants in West Virginia in 1917, some 12,276,784 gallons, or about 38 per cent, was the combined product of plants using methods of compression and vacuum pumps, the remaining 20,391,863 gallons, or 62 per cent, being the product of absorption plants plus a considerable quantity, in the aggregate, of gasoline recovered as drips from gas-transmission lines in the State. The quantity of gasoline recovered by compression and by vacuum methods in 1917 was 32 per cent greater and that recovered by absorption, including drips, was 115 per cent greater than in 1916.

The average price received at the plants for all types of natural-gas gasoline produced in West Virginia in 1917 was 19.93 cents a gallon and the market value of the entire output was $6,511,813, a gain of 3.81 cents in average unit selling price and of $3,486,520, or 115 per cent, in market value over 1916. The average price received in 1917 for the product of compression plants and of vacuum pumps was 18.01 cents a gallon, compared with 17.67 cents in 1916, a gain of about 2 per cent, whereas that received for the product of absorption plants, including drips, was 21.09 cents a gallon, compared with 14.60 cents in 1916, a gain of 44 per cent.

Although West Virginia ranks no higher than third among the States contributing to the natural-gas gasoline output of the United States from compression plants and vacuum pumps, it is the premier producer of gasoline by absorption methods. Its output of absorption gasoline 1917 comprised about 42 per cent of the output of absorption gasoline in the entire country in that year and exceeded the output of its nearest competitor for first honors, Oklahoma, by nearly 14,000,000 gallons.

The total number of gasoline plants in operation in West Virginia at the end of 1917 was 188, including 159 compression plants and 29 absorption plants. The net gain in plants during 1917 was 41, including 26 compression plants and 15 absorption plants. The rated capacity of all gasoline plants in operation in West Virginia at

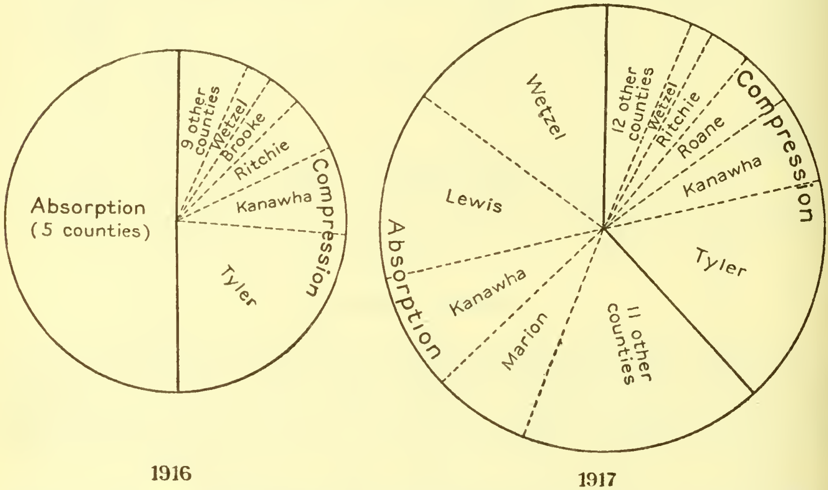


FIGURE 36.—Distribution by counties and by principal methods of manufacture of natural-gas gasoline marketed in West Virginia in 1916 and 1917.

the end of 1917 was 135,663 gallons of raw gasoline a day, a gain of 37,004 gallons, or about 38 per cent, in capacity in 1917, and an increase of 28 per cent in the number of plants.

The volume of gas treated at natural-gas gasoline plants in West Virginia in 1917 is estimated at 167,771,351,000 cubic feet, 3 per cent of which yielded an average of 2.5 gallons of gasoline per thousand cubic feet by compression methods and 97 per cent of which yielded an average of 1 pint of gasoline per thousand cubic feet by absorption methods.

The accompanying diagram (fig. 3) and the following tables show the quantity of natural-gas gasoline marketed in West Virginia in the last two years.

Natural-gas gasoline marketed in West Virginia in 1916 and 1917.

1916.

County.	Number of operators.	Plants. Number.	Plants. Daily capacity.	Gasoline produced. Quantity.	Gasoline produced. Value.	Estimated volume of gas treated.	Average yield of gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
			Gallons.	*Gallons.*		*M. cu. ft.*	*Gallons.*	*° Baumé.*
Tyler	19	53	14,430	4,424,890	$780,928	1,501,201	0.8- 6.0	75-94
Kanawha	8	7	9,287	1,566,461	287,856	469,887	2.5- 5.0	76-92
Ritchie	11	15	3,628	1,011,902	175,566	568,667	.8- 3.3	80-90
Brooke	11	11	2,689	626,464	111,893	193,029	2.0- 3.5	80-94
Wetzel	9	8	1,832	420,369	76,579	254,065	1.0- 2.0	70-86
Hancock	8	6	1,260	314,458	52,685	79,303	2.0-10.0	78-95
Pleasants	15	19	1,690	299,025	46,852	121,348	2.0- 3.0	72-90
Roane	3	3	970	261,940	44,850	124,891	1.3- 3.0	80-88
Wood	6	4	680	59,472	8,510	26,274	1.2- 3.0	80-86
Harrison		2					.5- 1.5	84-85
Doddridge		2					1.0- 2.5	81-88
Clay	a 15	1	2,810	304,643	56,312	211,858	2.0	82
Wirt		1					3.0	89
Calhoun		1					.5	92
Total by compression and vacuum	......	133	39,276	9,289,624	1,642,031	3,550,523	2.616	70-95
Total by absorption and drip	......	14	59,383	9,475,432	1,383,262	101,114,013	.094	68-86
Grand total	105	147	98,659	18,765,056	3,025,293	104,664,536	.179	68-95

1917.

Gasoline produced by compression and by vacuum pumps.

County.	Number of operators.	Plants. Number.	Plants. Daily capacity.	Gasoline produced. Quantity.	Gasoline produced. Value.	Estimated volume of gas treated.	Average yield of gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
Tyler	22	60	15,225	5,294,771	$935,133	1,517,753	0.75-6.00	75 -96
Kanawha	6	11	10,108	2,211,717	427,172	811,770	.50-3.75	72 -02
Roane	6	7	3,481	1,254,068	209,250	750,340	1.40-2.00	77.5-88
Ritchie	15	19	3,860	1,000,303	185,381	487,576	.25-3.30	76 -90
Wetzel	8	10	2,310	557,309	101,755	317,631	1.00-2.10	76 -86
Brooke	10	12	3,865	538,073	101,764	202,636	2.00-6.00	74 -92
Pleasants	13	19	1,372	410,531	67,080	215,029	1.50-3.00	70 -99
Hancock	7	6	1,211	382,247	69,692	102,670	1.50-6.00	78 -90
Wood	5	5	307	60,948	10,500	33,609	1.50-2.50	80 -86
Harrison	1	1	1,600				1.50	81
Clay	2	2					.94-2.00	73 -80
Doddridge	2	2	477				1.00-2.50	82 -88
Lewis	1	1	359	566,817	103,767	406,634	1.80	83
Calhoun	2	2					.75-1.00	78 -90
Marshall	1	......	......				......	80
Wirt	1	1	173				2.50	89
Marion	1	1					2.00	85
	103	159	44,348	12,276,784	2,211,494	4,845,648	2.53	70 -96

Gasoline produced by absorption.

County.	Number of operators.	Plants. Number.	Plants. Daily capacity.	Gasoline produced. Quantity.	Gasoline produced. Value.	Estimated volume of gas treated.	Average yield of gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
Wetzel	3	4	20,100	4,884,011	$1,065,021	46,555,910	0.1050	68-79
Lewis	2	4	23,000	4,428,527	962,063	31,261,900	0.1364- .1452	78
Kanawha	3	5	12,837	2,706,456	539,893	24,788,263	.0300- .1900	83-88.8
Marion	4	4	8,800	2,241,142	479,112	16,521,800	.1285- .1660	68-80
Cabell	1	1					.1600	83
Jackson	1	1					.1900	82
Wood	1	1					.0794	80
Harrison	1	1					.0964	80
Lincoln	1	1					.1000	85
Tyler	1	1	26,578	6,131,727	1,254,230	43,797,830	.2057	82
Clay	1	1					.0500	......
Ritchie	1	1					.0460	78
Monongalia	1	1					.9340	76
Putnam	1	1					.0800	88
Doddridge	1	2					.1250	......
Hancock b	2	......					......	75
	25	29	91,315	20,391,863	4,300,319	162,925,703	.1250	68-88.8
Grand total	128	188	135,663	32,668,647	6,511,813	167,771,351	.195	68-96

a Includes operators having absorption plants in Monongalia, Cabell, Jackson, Lewis, and Marion counties.
b Includes drip.

CALIFORNIA.

Third rank among the States in which the natural-gas gasoline industry has been developed was retained by a safe margin in 1917 by California. The quantity of gasoline recovered from natural gas in California in 1917 was 28,817,604 gallons, a gain of 11,658,850 gallons, or 68 per cent, over the output in 1916. This output, which establishes a new record for natural-gas gasoline in California, amounted, however, to only a little more than 13 per cent of the output in the entire country in 1917.

Included in the total output credited to California in 1917 are 23,478,521 gallons of gasoline produced at plants using methods of compression and 5,339,083 gallons produced at plants using methods of absorption, the latter total including an appreciable quantity of gasoline salvaged from gas mains in the State.

The average price received at the plants for natural-gas gasoline in California in 1917 was appreciably lower than the average received

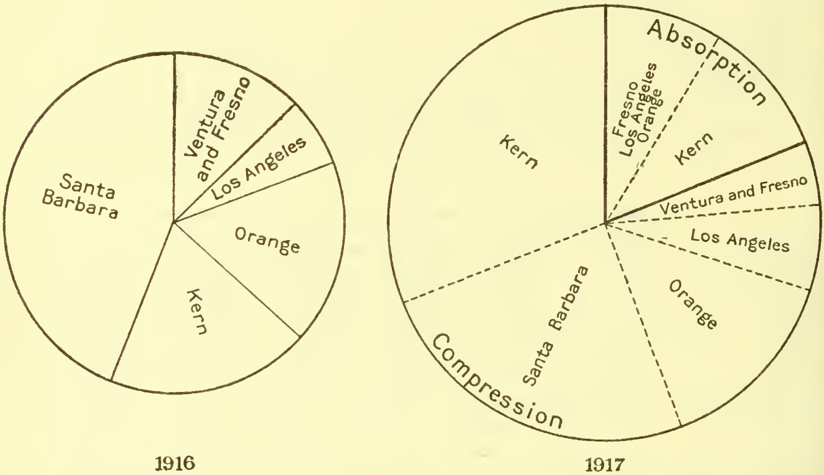


FIGURE 37.—Distribution by counties and (in 1917) by principal methods of manufacture of natural-gas gasoline marketed in California in 1916 and 1917.

in other parts of the United States. The average price was 15.40 cents a gallon, the compression product averaging 15.49 cents and the absorption product 14.99 cents, compared with an average for all types in 1916 of 13.37 cents a gallon. Because of the gain of 2.03 cents, or 15 per cent, in the unit selling price and the large gain in quantity of gasoline sold, the total market value in 1917 rose to $4,438,-022 and exceeded the market value in 1916 by $2,144,200, or 93 per cent.

The volume of natural gas from which gasoline was extracted in California in 1917 is estimated at 45,351,247,000 cubic feet, an increase of 20,500,000,000 cubic feet, or 83 per cent, over the volume treated in 1916. Of the volume of gas treated in 1917, about 60 per cent yielded an average of 7 pints of gasoline per thousand cubic feet by compression methods and the remaining 40 per cent yielded an average of 4.8 pints per thousand feet by absorption methods. At the end of 1917 there were 49 plants, having a combined daily capacity of 99,761 gallons of gasoline, in active operation in California, a net gain of 23 plants and of 45,701 gallons in daily capacity during the year. The average daily output of natural-gas gasoline in California in 1917 was 78,952 gallons.

The accompanying diagram (fig. 4) and the following tables show the progress of the natural-gas gasoline industry in California in the last two years.

Natural-gas gasoline marketed in California in 1916 and 1917.

1916.

County.	Number of operators.	Plants.		Gasoline produced.		Estimated volume of gas treated.	Average yield of gasoline per M cubic feet of gas.	Average gravity of gasoline as produced and before blending.
		Number.	Daily capacity.	Quantity.	Value.			
			Gallons.	*Gallons.*		*M cubic feet.*	*Gallons.*	*° Baumé.*
Santa Barbara	6	7	21,642	7,462,566	$1,046,308	4,806,583	1.0 –2.5	72–81
Kern	8	5	10,488	[a]3,353,438	483,729	11,916,940	.025–1.0	60–75
Orange	7	7	12,700	[b]3,026,652	368,785	2,592,613	.5 –3.0	67–81
Los Angeles	5	4	4,330	1,155,758	146,850	1,951,101	.3 –2.0	65–80
Ventura	1	1	4,900	[c]2,160,340	248,150	3,559,117	1.84	85.3
Fresno	1	2					.3 –1.2	62–75
	28	26	54,060	17,158,754	2,293,822	24,826,354	.691	60–85.3

1917.

Gasoline produced by compression and vacuum pumps.

County.	Number of operators.	Plants: Number.	Plants: Daily capacity.	Quantity.	Value.	Estimated volume of gas treated.	Average yield.	Average gravity.
Kern	9	13	26,773	9,165,898	$1,351,568	10,552,967	0.5 –1.8	64–79
Santa Barbara	6	8	30,429	7,056,616	1,129,813	4,485,648	1.0 –2.3	73–82
Orange	7	7	12,200	4,067,575	649,566	4,171,338	.17–3.0	65–81
Los Angeles	6	7	7,200	1,827,515	297,833	7,237,470	.11–2.0	62–80
Ventura	3	3	3,350	1,360,917	209,047	1,030,020	1.15–1.5	71.2–85
Fresno	2	2	2,140					
Total	33	40	82,092	23,478,521	3,637,827	27,477,443	.854	62–85

Gasoline produced by absorption.[a]

County.	Number of operators.	Plants: Number.	Plants: Daily capacity.	Quantity.	Value.	Estimated volume of gas treated.	Average yield.	Average gravity.
Kern	8	5	9,969	2,893,684	$416,429	13,090,177	0.02–1.07	45–70
Los Angeles	1	1	7,700	2,445,399	383,766	4,783,627	.50– .53	50–68
Orange	2	2						
Fresno	1	1						
Total	12	9	17,669	5,339,083	800,195	17,873,804	.2987	45–70
Grand total	45	49	99,761	28,817,604	4,438,022	45,351,247	.635	45–85

[a] Includes drips.
[b] Includes gasoline made by the absorption process at one plant.
[c] Includes Los Angeles County drips and gasoline made by absorption process at one plant in Fresno County.

PENNSYLVANIA.

Although Pennsylvania is the birthplace of the natural-gas gasoline industry and contains more plants for the recovery of gasoline from natural gas than any other State, its output in 1917 constituted only 6 per cent of the gasoline recovered from natural gas in the United States in that year and attained for it a rank no higher than fourth among the contributing States.

The quantity of gasoline obtained from natural gas in Pennsylvania in 1917 was 13,826,250 gallons, a gain of 4,111,324 gallons, or 42 per cent, over the output in 1916, and of 7,927,653 gallons, or 134 per cent, over the output in 1915. Of this record output 65 per cent was the combined yield of 234 compression plants and of numerous vacuum pump plants having an average capacity of only 140 gallons each a day, and the remaining 35 per cent was the product of

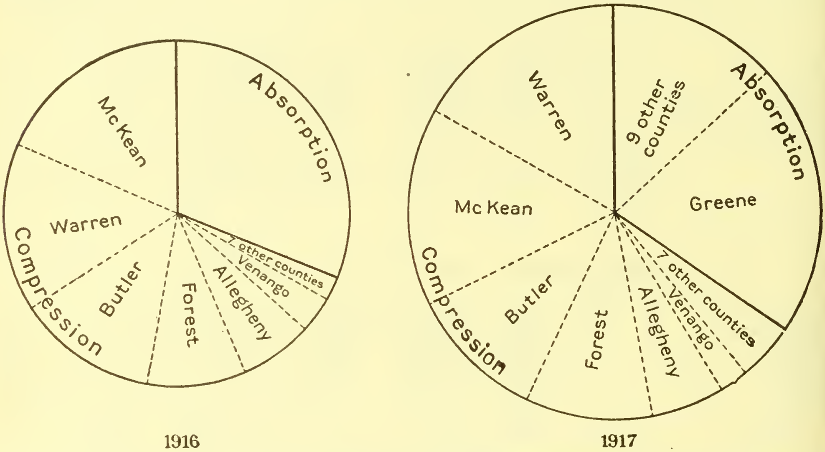


FIGURE 38.—Distribution by counties and by principal methods of manufacture of natural-gas gasoline marketed in Pennsylvania in 1916 and 1917.

17 absorption plants, having an average capacity of 1,565 gallons each a day, plus the product recovered as drips from gas mains in the States during the year. The output credited to compression and vacuum-pump plants in 1917 was 34 per cent greater than in 1916 and that credited to absorption plants and to drips was 61 per cent greater than in 1916.

The average price received at the plants for the natural-gas gasoline marketed in Pennsylvania in 1917 was 20.01 cents a gallon, the gasoline recovered by compression and by vacuum methods selling for an average of 19.89 cents a gallon and that recovered by absorption methods or salvaged from gas mains selling for an average of 20.47 cents a gallon. These prices show gain in 1917 of 2.24 cents, or 13 per cent, in the average sale price of all types of gas gasoline, of 1.79 cents, or 10 per cent, in the average sale price of the gasoline obtained by compression and by vacuum methods, and of 3.45 cents, or 20 per cent, in the average sale price of the gasoline obtained by absorption methods, including drips, compared with 1916. The market value of the entire output of natural-gas gasoline in Pennsylvania in 1917 was $2,778,098, a gain of $1,051,925, or 61 per cent, compared with 1916.

The volume of natural gas treated at gasoline plants in Pennsylvania increased from 38,490,621,000 cubic feet in 1916 to 49,487,-056,000 cubic feet in 1917, a gain of 28.6 per cent, and the average recovery of gasoline per thousand cubic feet of gas increased from 0.25 gallon in 1916 to 0.28 gallon in 1917, a gain of 12 per cent. The average recovery in 1917 by compression and by vacuum-pump methods was 2.5 gallons per thousand feet of gas treated, and by absorption methods was about 3.4 gills per thousand feet of gas treated.

The accompanying diagram (fig. 5) and the following tables show the progress of the natural-gas gasoline industry in Pennsylvania in the last two years.

Natural-gas gasoline marketed in Pennsylvania in 1916 and 1917.

1916.

County.	Number of operators.	Plants.		Gasoline produced.		Estimated volume of gas treated.	Average yield of gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
		Number.	Daily capacity.	Quantity.	Value.			
			Gallons.	*Gallons.*		*M. cu. ft.*	*Gallons.*	*°Baumé.*
McKean	11	12	9,085	1,780,159	$315,799	733,417	1.5-3.0	71-92
Warren	32	40	5,245	1,513,725	286,860	437,259	1.0-8.0	66-98
Butler	79	87	5,175	1,277,516	219,387	485,598	0.5-6.0	64-90
Forest	10	11	4,066	878,625	163,750	324,344	2.0-5.0	85-94
Allegheny	7	15	2,700	693,109	124,859	175,950	1.5-5.0	78-87
Venango	6	5	2,250	324,750	60,552	386,330	0.5-5.0	85-90
Washington	4	4	255	87,671	16,250	39,355	1.0-5.0	80-86
Beaver	3	3	120	26,700	4,986	9,200	2.5-5.0	80-86
Potter		1					1.0	90
Clarion		2					1.0-2.0	77-80
Crawford	a 15	1	1,391	140,115	24,274	101,762	1.0-5.0	85
Armstrong		2					0.5-4.5	76-85
Greene		2					2.5	....
Total by compression and vacuum	....	185	30,287	6,722,370	1,216,717	2,693,215	2.496	64-98
Total by absorption and drip	....	10	16,200	2,992,556	509,456	35,797,406	0.084	70-83
Grand total	167	195	46,487	9,714,926	1,726,173	38,490,621	0.252	64-98

1917.

Gasoline produced by compression and by vacuum pumps.

Warren	40	33	6,287	2,292,878	$453,012	765,503	0.75-7.00	66-100
McKean	13	14	8,804	2,186,192	502,284	997,282	0.75-3.00	85- 90
Butler	103	115	5,461	1,490,324	262,713	524,727	1.00-6.00	70- 90
Forest	20	21	5,113	1,398,486	259,210	462,646	2.00-5.00	72- 92
Allegheny	8	16	2,660	764,129	149,248	207,143	1.25-5.00	78- 96
Venango	5	5	1,520	276,660	51,754	363,191	2.50-3.95	82- 90
Beaver	8	8	830	209,465	41,635	73,725	2.00-5.00	78- 95
Crawford	3	3	422	135,447	25,011	49,071	2.00-5.00	82- 90
Clarion	8	7	627	103,747	18,924	65,806	1.00-4.00	75- 92
Washington	3	6	370	101,734	18,575	34,940	1.00-5.00	76- 84
Armstrong	3	4	120	38,950	7,367	15,847	1.00-5.00	72- 85
Potter	1	1	350	13,187	2,697	12,475	1.00-2.50	76- 95
Greene	1	1						
	216	234	32,564	9,011,199	1,792,430	3,572,356	2.522	66-100

a Includes one company operating an absorption plant in Elk County.

Natural-gas gasoline marketed in Pennsylvania in 1916 and 1917—Continued.

1917—Continued.

Gasoline produced by absorption. [a]

County.	Number of operators.	Plants. Number.	Plants. Daily capacity.	Gasoline produced. Quantity.	Gasoline produced. Value.	Estimated volume of gas treated.	Average yield of gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
			Gallons.	*Gallons.*		*M cubic feet.*	*Gallons.*	*°Baumé.*
Greene	3	3	12,150	2,936,893	$580,240	25,497,909	0.1031–0.1200	78–80
Warren	2	1	5,300 (Warren and Venango)	1,878,158 (Warren to Jefferson)	405,428 (Warren to Jefferson)	20,416,791 (Warren to Jefferson)	0.1195	71–82
Venango	4	1					0.123	65–80
Clarion	3	3	970				0.052–0.143	69–80
Potter	2	2	1,400				0.24–0.30	78–87
Elk	2	1	1,550 (Elk, Armstrong, and Allegheny)				0.0826	69–80
Armstrong	2	2					0.067	69–78
Allegheny	2	1					0.077	70–80
Washington	4	2	5,230 (Washington, Butler, and Forest)				0.1522–0.172	55–80
Butler [a]	43	....					....	52–88
Forest	2	1					....	71–80
McKean [a]	1	....	....				....	69
Jefferson [a]	1	....	....				....	69
	71	17	26,600	4,815,051	985,668	45,914,700	.105	52–88
Grand total.	287	251	59,164	13,826,250	2,778,098	49,487,056	0.279	52–100

[a] Includes drips.

TEXAS.

Fifth rank among the States contributing to the production of natural-gas gasoline in the United States in 1917 is accorded to Texas, which by increasing its output from 1,292,811 gallons in 1916 to 6,920,405 gallons in 1917, a gain of 435 per cent, outdistanced Ohio, Louisiana, and Illinois and advanced to that position from eighth place in 1916. The share of Texas in the output of natural-gas gasoline of the entire country was 3.2 per cent in 1917 compared with 1.2 per cent in 1916.

Because of the large gain in the quantity of gasoline marketed and of a gain of 7 per cent in the average price per gallon at which the product was sold, the market value of the gasoline output of Texas in 1917—$1,149,441—exceeded the market value of the output in 1916 by $948,418, or 472 per cent.

The production of gasoline from natural gas in Texas in 1916 was from 4 plants using compression and condensation. The output in 1917 was obtained from 9 plants of that type and from 2 plants, completed during the year, utilizing the absorption process. At the end of 1917 the facilities for the recovery of gasoline from natural gas in Texas included 7 compression plants and 1 vacuum-pump plant in Wichita County; 1 compression plant in Williamson County; 1 compression plant in Palo Pinto County; 1 absorption plant in Clay County; and 1 absorption plant in Shackelford County. At the end of 1917 one compression plant for the Nortex Gasoline Co. was under construction in Wichita County and 1 absorption plant for the Texas & Pacific Coal Co. was under construction in Eastland County. During 1917 the plant of the Petrolia Gas Co., in Clay County, was dismantled and rebuilt in Wichita County.

As a consequence of the construction work completed in 1917 the daily capacity of gasoline plants in Texas increased from 6,688 gallons at the end of 1916 to 32,550 gallons at the end of 1917, a net gain of 387 per cent The average daily output of natural-gas gasoline in Texas in 1917 was 18,960 gallons or about 58 per cent of the capacity available at the end of the year.

Because of the operation of absorption plants as well as new compression plants during a part of 1917, the volume of gas treated in the manufacture of gasoline in Texas was about 1,236 per cent greater than the volume treated in 1916, and the average recovery of gasoline per thousand cubic feet of gas treated decreased from 1.36 gallons in 1916 to 0.55 gallon in 1917.

Natural-gas gasoline marketed in Texas in 1917.

County.	Number of operators.	Plants.		Gasoline produced.		Gas used.		Average gravity of gasoline as produced and before blending.
		Number.	Daily capacity.	Quantity.	Value.	Estimated volume.	Average yield of gasoline per thousand cubic feet.	
			Gallons.	*Gallons.*		*M cubic feet.*	*Gallons.*	*° Baumé.*
Wichita	5	6	9,900	3,785,767	$633,516	2,517,346	1.0-6.5	79.9-90.0
Clay	2	2						
Williamson	1	1	22,650	3,134,638	515,925	10,159,870	0.1-4.0	76 -83
Shackelford	1	1						
Palo Pinto	1	1						
	10	11	[a] 32,550	6,920,405	1,149,441	12,677,216	0.546	76 -90
Total, 1916	3	4	6,688	1,292,811	201,023	948,485	1.363	87 -92

[a] Includes statistics of 1 operator in Clay County and 1 in Shackelford County using the absorption method.

OHIO.

Although the quantity of gasoline produced from natural gas and marketed in Ohio in 1917 exceeded the output in any preceding year, this State was relegated to sixth rank by reason of the more rapid growth of the industry in Texas.

The quantity of natural-gas gasoline produced in Ohio in 1917 was 5,439,560 gallons and although it was only 2.5 per cent of the production in the entire country in that year, it constituted a gain of 2,800,989 gallons, or 106 per cent, over the record output in 1916. Of this output 43 per cent was produced by 54 compression plants and numerous vacuum plants and was derived from some 836,639,000 cubic feet of natural gas at the average rate of 2.8 gallons to the thousand cubic feet of gas, and 57 per cent was the product of 7 absorption plants (plus the gasoline recovered as drips from gas mains) and was derived from 29,225,502,000 cubic feet of gas, at the average rate of 3.4 gills per thousand cubic feet of gas treated.

The average price received at the plants for all kinds of natural-gas gasoline marketed in Ohio in 1917 was 19.33 cents a gallon, compared with 17.84 cents in 1916, the product of the compression and the vacuum-pump plants selling for an average of 18.15 cents a gallon and that of the absorption plants (including drips) for an average of 20.21 cents a gallon.

As a result of betterments effected in 1917, including the enlargement of old plants and the construction of new plants, the daily capacity for natural-gas gasoline manufacture in Ohio increased from 18,391 gallons at the beginning of the year to 25,137 gallons, a net gain of 37 per cent, at its end. The average daily output of natural-gas gasoline in Ohio in 1917 was 14,902 gallons, or about 59 per cent of the capacity available at the end of that year. The trend of expansion of the natural-gas gasoline industry in Ohio is indicated by the fact that the net gain of 6 plants during 1917 includes 5 absorption plants and only 1 compression plant. Two compression plants operated in Morgan County in 1916 were inactive in 1917 and 3 new compression plants were installed during the year, 2 in Washington County and 1 in Monroe County. New absorption plants completed in 1917 include 1 each in Licking, Richland, Fairfield, Knox, and Jefferson counties—5 in all.

Natural-gas gasoline marketed in Ohio in 1916 and 1917.

1916.

County.	Number of operators.	Plants.		Gasoline produced.		Estimated volume of gas treated.	Average yield of gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
		Number.	Daily capacity.	Quantity.	Value.			
			Gallons.	*Gallons.*		*M cubic feet.*	*Gallons.*	*° Baumé.*
Monroe	14	28	4,562	1,446,917	$253,336	557,685	1.0–8.0	76–92
Jefferson	11	10	1,226	371,925	64,985	194,027	0.5–3.7	82–100
Washington	8	10	858	239,866	41,789	70,575	1.0–5.0	82–91
Richland	1	[a] 1					.1046	78–86
Columbiana	2	2					3.5000	85–90
Fairfield	1	1	11,745	[b] 579,863	110,694	4,613,472	3.0000	85
Licking	1	[a] 1					.1084	77
Morgan	2	2					2.5000	89
	40	55	18,391	2,638,571	470,804	5,435,759	0.4850	76–100

1917.

Gasoline produced by compression and by vacuum pumps.

County.	Number of operators.	Plants: Number.	Daily capacity.	Quantity.	Value.	Estimated volume of gas treated.	Average yield of gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
Monroe	14	29	5,235	1,689,541	$307,857	546,403	1.0 –6.0	76–92
Jefferson	11	10	1,312	293,554	53,672	122,060	1.5 –5.0	82–98
Washington	9	12	1,290	291,089	50,675	151,610	1.25–3.4	76–90
Columbiana	2	2	500	57,314	10,902	16,566	3.0 –3.5	85–89
Fairfield	1	1						
	37	54	8,337	2,331,498	423,106	836,639	2.79	76–98

Gasoline produced by absorption.

County.	Number of operators.	Plants: Number.	Daily capacity.	Quantity.	Value.	Estimated volume of gas treated.	Average yield of gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
Licking	2	2						
Richland	2	2	16,600	3,091,763	$625,004	29,062,512	0.10–0.229	78–86
Fairfield	2	1						
Knox	1	1						
Jefferson	1	1						
Noble [c]	1	......	200	16,299	3,266	162,990	0.10– .25	60–75
Washington [c]	2	......						
Monroe [c]	1	......						
	12	7	16,800	3,108,062	628,270	29,225,502	0.106	60–86
Grand total	49	61	25,137	5,439,560	1,051,376	30,062,141	0.181	60–98

[a] Absorption plants.
[b] Includes gasoline made by absorption process.
[c] Includes drips.

LOUISIANA.

By increasing its output of gasoline obtained from natural gas from 2,113,159 gallons in 1916 to 4,979,754 gallons in 1917, a gain of 136 per cent, Louisiana was enabled to retain seventh rank among the natural-gas gasoline producing States at the expense of Illinois and despite the advance of Texas from eighth to fifth place.

Of the total quantity of natural-gas gasoline marketed in Louisiana in 1917, approximately 4,459,920 gallons, or 90 per cent, was supplied by 18 plants employing the compression process, the remaining 10 per cent consisting of the product of 2 absorption plants and of the gasoline salvaged as drips from gas mains in the State in that year.

The volume of gas treated at gasoline plants in Louisiana in 1917 is estimated at 2,233,511,000 cubic feet, a gain of 146 per cent over the volume treated in 1916. Of this volume 70 per cent yielded an average of 2.86 gallons of gasoline per thousand cubic feet by compression methods and the remaining 30 per cent yielded an average of 3.1 quarts of gasoline per thousand cubic feet by absorption methods.

Activity in the construction of new gasoline plants in Louisiana in 1917 resulted in a net gain of 11 compression plants, 8 in Caddo Parish and 3 in De Soto Parish, and of 2 absorption plants, 1 each in Caddo and De Soto parishes, and in a gain of 9,457 gallons, or 89 per cent, in the daily capacity for gasoline production in the State. The average daily output of natural-gas gasoline in Louisiana in 1917 was 1,365 gallons, or 68 per cent of the capacity available at the end of the year.

Natural-gas gasoline marketed in Louisiana in 1916 and 1917.

Parish.	Number of operators.	Plants.		Gasoline produced.		Estimated volume of gas treated.	Average yield of gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
		Number.	Daily capacity.	Quantity.	Value.			
1916.								
			Gallons.	*Gallons.*		*M cubic feet.*	*Gallons.*	*° Baumé.*
Caddo	4	4	8,006	1,803,151	$227,067	813,750	1.5-3.3	64-80
De Soto	3	3	2,655	310,008	42,497	93,403	3.0-4.0	76-78
	7	7	10,661	2,113,159	269,564	907,153	2.329	64-80
1917.								
Caddo	8	12	13,950	3,447,424	$559,891	1,252,297	1.10-4.69	68-80
De Soto	4	6	3,965	1,012,496	159,867	306,049	2.05-4.69	72-78
Total by compression and vacuum	12	18	17,915	4,459,920	719,758	1,558,346	2.862	68-80
Total by absorption	3	2	[a] 2,203	519,834	94,989	675,165	0.77	69-92
Grand total	15	20	20,118	4,979,754	814,747	2,233,511	2.229	68-92

[a] Includes drip.

ILLINOIS.

Although the output of natural-gas gasoline in Illinois in 1917 was double the output in 1916, that State was only eighth in rank among the contributors because of the more rapid growth of the industry in Texas and in Louisiana.

The output credited to Illinois in 1917 was 4,934,009 gallons, a gain of 2,673,721 gallons, or 118 per cent, compared with 1916. This output was about 2.3 per cent of the total production in the entire United States in 1917 and constituted a new record for Illinois.

The average price received at the sources of production for this gasoline was 17.55 cents a gallon and the market value of the entire output was $866,033, a gain of 5.97 cents in average unit price and of $603,369, or 230 per cent, over the market value in 1916.

The natural-gas gasoline industry in Illinois is restricted to Lawrence, Crawford, and Clark counties, which at the end of 1917 contained 54 compression plants and 1 absorption plant besides numerous vacuum-pump plants and several conservers of drip gasoline. Activity in plant construction in 1917 resulted in a net gain of 23 compression plants, or 72 per cent, over the number in operation at the beginning of the year, and of 5,322 gallons, or 44 per cent, in the daily capacity of gasoline plants in the State.

The output of natural-gas gasoline credited to Illinois in 1917 was derived, exclusive of drips, from 2,685,895,000 cubic feet of gas, at the average rate of 1.84 gallons to the thousand cubic feet of gas treated. This volume of gas exceeded the volume treated in 1916 by 1,347,301,000 cubic feet, or 101 per cent, the recovery per unit volume of gas showing in 1917 an increase of 0.15 gallon (1.2 pints), or 9 per cent, over the average in 1916.

The average daily production of natural-gas gasoline in Illinois in 1917 was 13,520 gallons, or about 78 per cent of the capacity available at the end of the year.

Natural-gas gasoline marketed in Illinois in 1916 and 1917.

County.	Number of operators.	Plants.		Gasoline produced.		Estimated volume of gas treated.	Average yield of gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
		Number.	Daily capacity.	Quantity.	Value.			
1916.								
			Gallons.	*Gallons.*		*M cubic feet.*	*Gallons.*	*° Baumé.*
Lawrence[a]	8	22	9,300	1,928,974	$223,773	1,196,615	1.0–2.5	70–87
Crawford	8	} 10	2,770	331,314	38,891	141,979	1.5–4.0	60–88
Clark	1							
	17	32	12,070	2,260,288	262,664	1,338,594	1.688	60–88
1917.								
Lawrence[b]	10	27	10,762	3,529,712	$612,080	2,047,946	0.5–3.0	65–100
Crawford[c] } Clark	23	28	6,630	1,404,297	253,953	637,949	1.11–4.5	65–94
	33	55	17,392	4,934,009	866,033	2,685,895	1.837	65–100

[a] Includes statistics of one operator using absorption method.
[b] Includes statistics of one operator using absorption method and one which produced drip.
[c] Includes statistics of drip gasoline produced by six operators.

KENTUCKY.

Although the contribution of Kentucky was only 1.8 per cent of the natural-gas gasoline produced and marketed in the United States in 1917, that contribution amounted to 3,818,209 gallons and was 426 per cent greater than the State's output in 1916. This large gain is attributed chiefly to the absorption plants installed by the United Fuel Gas Co. in 1916, which, though located in Kentucky, operate to a considerable extent on natural gas from West Virginia. Other sources of natural-gas gasoline in Kentucky include compression plants operated by the Wood Oil Co. and by the New Domain Oil & Gas Co. in the oil fields of Wayne County, and by the Morgan County Heat & Light Co. in Morgan County, as well as the drip stations on the gas mains in the State.

The average selling price of natural-gas gasoline marketed in Kentucky in 1917 was 20 cents a gallon, and the market value of the entire output was $763,186, a gain of half a cent in average selling price and of $621,839, or 440 per cent, in total market value, compared with 1916.

The volume of gas treated in the production of the gasoline marketed in Kentucky in 1917 is estimated at 24,915,946,000 cubic feet, from which the recovery of gasoline per thousand cubic feet averaged 1.2 pints.

KANSAS.

As in practically every other State in which the natural-gas gasoline industry has been established, the year 1917 was one of marked expansion for the local industry in Kansas. The quantity of natural-gas gasoline produced and marketed from plants in Kansas in 1917 was 1,174,980 gallons, a gain of 959,980 gallons, or 447 per cent, the largest relative gain, compared with 1916, credited to any individual State during the year.

This output was obtained from 6 plants (5 absorption and 1 compression), 3 of which began operations in 1917.

Because the natural-gas gasoline product of Kansas consisted almost wholly of absorption gasoline, the average price received for it was higher than the average in any other State. The average price commanded by the natural-gas gasoline marketed in Kansas in 1917 was 20.53 cents a gallon, and the market value of the output was $241,219, a gain of 4.24 cents, or 30 per cent, in average unit selling price and of $206,189, or 589 per cent, in gross market value, compared with 1916.

The volume of natural gas from which this output and revenue were derived is estimated at 9,315,339,000 cubic feet, from which the average recovery of gasoline per thousand cubic feet was about 1 pint, valued on the basis of the average selling price per gallon at about 2.55 cents.

At the end of 1917 facilities for the recovery of gasoline from natural gas in Kansas included 1 compression plant in Chautauqua County operated by the Hi Grade Petroleum & Gasoline Co., 1 absorption plant in Wilson County operated by the Eureka Gasoline Co., 2 absorption plants in Montgomery County operated, respectively, by the Empire Gasoline Co. and the Tower Gasoline Co., and 2 absorption plants, 1 each in Butler and in Cowley counties, operated by the Empire Gasoline Co.

The daily output of natural-gas gasoline in Kansas in 1917 was 3,220 gallons, or 69 per cent of the capacity of all active plants in the State at the end of that year.

NEW YORK.

Five plants, all operating by compression and condensation methods, furnished the diminished output of natural-gas gasoline credited to New York in 1917. Two of these plants, operated, respectively, by the Pennsylvania Gasoline Co and the Power Gasoline Co., are located in Cattaraugus County, and the three remaining plants operated, respectively, by the Empire Gas & Fuel Co., the Ebenezer Oil Co., and E. J. Wilson, are located in Allegany County.

COLORADO.

As in other recent years the small production of natural-gas gasoline credited to Colorado came in 1917 from 1 plant operated by the Boulder-Greeley Oil Co. on casing-head gas from wells in the old Boulder oil field, Boulder County.

WYOMING.

Although no commercial production of natural gas gasoline was credited to Wyoming in 1917, compression plants for the treatment of casing-head gasoline were installed in that year in the Salt Creek field, Natrona County, by the Midwest Refining Co. and in the Byron field, Big Horn County, by the Eastern Fuel Co. Preparations for operations on a large scale in the Salt Creek field included the construction of a 4-inch welded pipe line from the gasoline plant in the field to the petroleum refinery of the Midwest Refining Co., at Casper, a distance of 42 miles.

COKE AND BY-PRODUCTS IN 1916 AND 1917.

By C. E. Lesher and W. T. Thom, Jr.

INTRODUCTION.

The manufacture of coke has always been regarded as one of the basic industries, but not until 1917 did the full importance of the coke and by-products industries become evident. The years 1916 and 1917 both saw new records established for the production of coke, but these increases in production were so far exceeded by the growing demand from the metal trades that coke became one of the important limiting factors in the Government's program after the United States entered into the war.

By-product coke ovens supply the raw material for the manufacture of explosives, as well as of dyes, and the great bulk of toluol and related bases used for making shell fillers and other high explosives was obtained from these ovens. The ammonia necessary both for making explosives and for refrigerating the meats and other perishable articles sent abroad to the Allies and to the American Expeditionary Forces was obtained largely from the country's by-product coke ovens, and from this same source came most of the coal-tar products used in building roads and roofs in the cantonments, and in other military construction both at home and abroad.

Other important products from the operation of by-product coke ovens are ammonium sulphate for fertilizer, coke for domestic use, artificial gas for both illumination and heat, oils for ore flotation, and possibly motor fuels which may prove to be satisfactory substitutes for gasoline.

ACKNOWLEDGMENTS.

The writers desire to express hearty thanks to the coke operators and others whose reports, voluntarily furnished, have made possible the statistics compiled in this report. The statistics were collected and compiled as presented by Helen L. Bennit, of the United States Geological Survey, under the direction of the senior author, and the text has been prepared by the junior author.

RELATION OF THE COKE INDUSTRY TO THE WAR.

By the fall of 1915 it was apparent that the outcome of the world war would depend fully as much upon the mobilization of industries as on the mobilization of armies and that the ability to produce steel and explosives in quantity would be the deciding factor in the struggle. The coke industry consequently sprang to the fore, as coke is essential to making iron and steel and modern high explosives are derived principally from the residues obtained in by-product coke oven operation.

By the beginning of 1916 the foreign demand for munitions had grown so strong that the resultant call for coke carried its production for the year to a new record in quantity. For the greater part of the year the demand for coke was the limiting factor in the production, but in the fall of 1916 traffic congestion, resulting from railroad embargoes and car shortage, began to cause a decline in the output of coke which attained serious proportions with the advent of winter weather.

The entry of the United States into the war on April 6, 1917, consequently found the ability of the coke industry to supply the demand a factor threatening to limit seriously the Government's war program. To meet this situation became part of the duty of the Committee on Coal Production of the Council of National Defense, which was created on April 27, 1917. Owing in part to the efforts of this body and in part to better weather, resulting in better transportation, the supply of coke increased during the spring and summer, principally through the greater production of by-product coke. As the car supply improved, labor shortage, which before had been largely concealed, became apparent, and by July, 1917, it was evident that lack of man power would make it impossible to produce more than 85 per cent of the rated capacity of the beehive ovens, even under the most favorable conditions.

As the summer progressed the need for more effective fuel regulation led to the passage of the food and fuel control act of August 10, 1917, which authorized the President to fix prices and to take such other steps in controlling supplies as the situation might warrant, and on August 23 he exercised the authority so conferred by appointing H. A. Garfield United States Fuel Administrator. The Fuel Administrator, early in November, requested that coke and coal consigned to by-product ovens be given priority on the railroads, and efforts were increased to obtain the greatest efficiency from the car supply available.

As the net result of the various influences outlined above, the total coke production was approximately 1,000,000 tons, or 2 per cent, larger in 1917 than in 1916. Traffic troubles and labor shortage cut the production of beehive coke approximately 2,300,000 net tons, but this was more than made up by the gain in by-product coke.

The Connellsville coke market, which may be taken as a barometer of the industry, showed little change in prices during the first nine months of 1916, but as a result of increasing demand and decreased supply, the market advanced steadily until the end of February, 1917. With the improved output resulting from better car supply, prices declined somewhat in March and April, but in May they began to rise again and during August they reached the highest average spot prices recorded in the history of the trade. Early in July rumors began to circulate that governmental price control might be expected, and on September 24 the price of coke was fixed by the President at $6 per net ton "Connellsville base." The question immediately arose as to what differentials in price if any were intended in favor of foundry coke, and of by-product coke made in New England and in other outlying districts. In answer to these queries the Fuel Administrator announced that Connellsville base prices of $6 per net ton for furnace coke, $7 per ton for foundry coke, and $7.30 per ton for crushed coke would take effect November 10, 1917, and a series of interpretations and local modifications of the prices for coke produced elsewhere were issued from time to time thereafter.

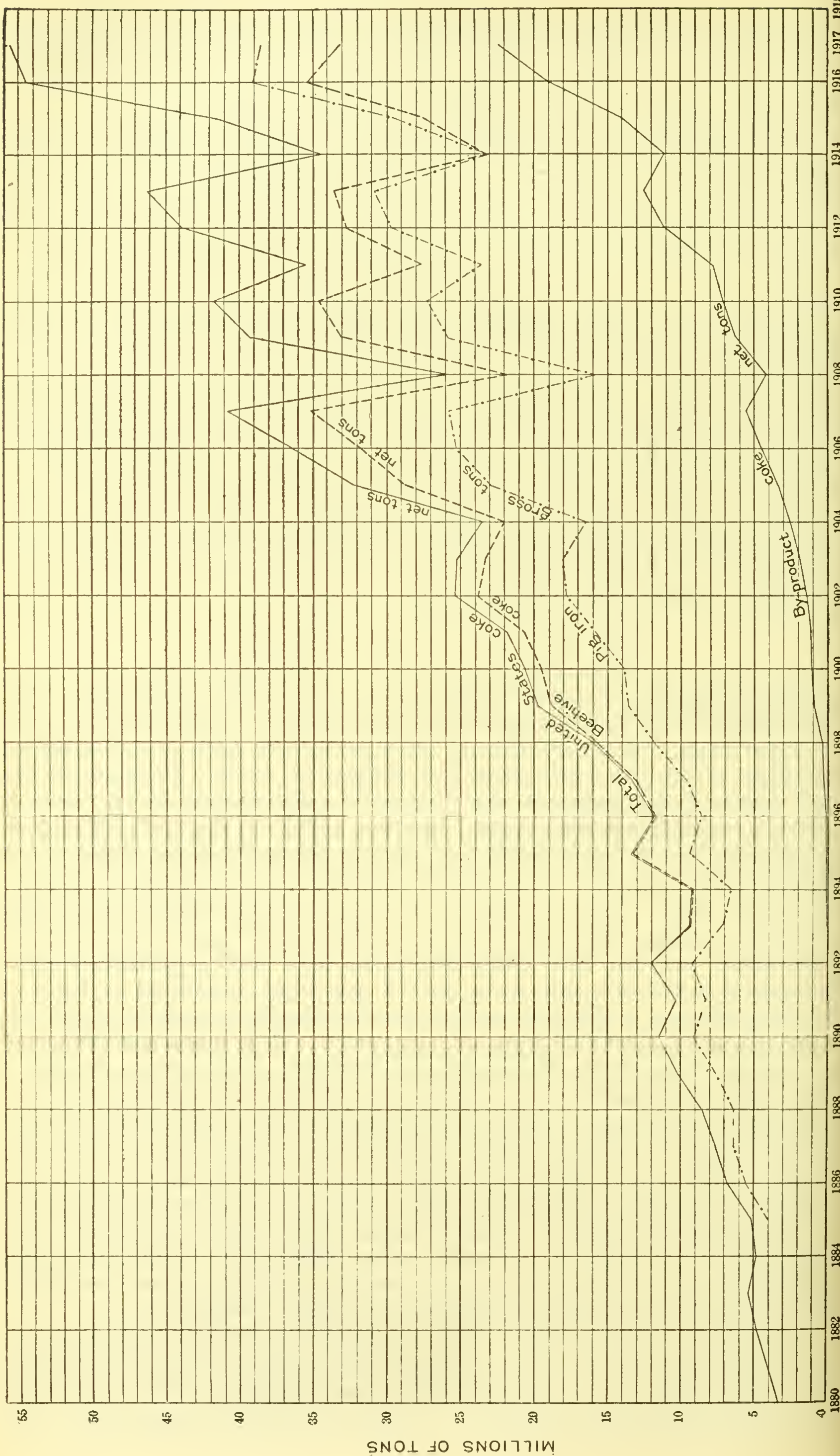
The by-products obtainable in coke manufacture played parts of great importance in the war. Among the endless number of coal-tar chemicals are many high-explosive bases, disinfectants, medicines, photographic materials, ammonia for cold storage, tar, paints, and road materials, all of which were of great value as war resources.

Prior to 1916 only 30 by-product plants in the country were equipped to recover the benzol and toluol contained in oven gas, owing to a lack of demand for these commodities, but in 1916 foreign demand for toluol for the manufacture of trinitrotoluol ("TNT") carried prices to unheard-of levels, and many more operators installed recovery plants. The entire supply of toluol was commandeered by the War Department late in 1917, in order that a maximum production might be obtained and that the supply available might be utilized most effectively. A maximum price much below the prevailing market price was set by a voluntary arrangement between the producers and the Government; consequently, in spite of a greater output in 1917, the value of the benzol products reported was noticeably less than in 1916.

REVIEW OF COKE INDUSTRY.

The quantity of coke produced in the United States in 1917 amounted to 55,606,828 net tons, exceeding by 1,073,243 net tons, or 2 per cent, the production in 1916, which, in turn, represented an increase of 31 per cent over the output in 1915. Because of the war demand the value of the output of coke gained 62 per cent in 1916, as compared with 1915, and the value of the output in 1917 exceeded that of 1916 by 75 per cent, reaching the large amount of $298,243,017. By-product coke continued to increase more rapidly in output than beehive coke, their relative gains for 1916 compared with 1915 being 36 per cent for by-product and 29 per cent for beehive coke; and for 1917 compared with 1916 the by-product output increased 3,369,919 net tons, or 18 per cent, reaching a total of 22,439,280 tons, while the beehive production decreased to 33,167,548 tons, a loss of 2,296,676 tons, or 6 per cent. This loss was due largely to car shortage in the Pennsylvania districts. About 90 per cent of the coke manufactured in the United States is used in the iron furnaces of the country, and the quantity of coke made under normal circumstances closely reflects the demand from the iron and steel trade. However, during 1916 and more especially during 1917 the supply of coke was short of the demand for it, and many iron furnaces were banked for longer or shorter periods during the winter of 1917 owing to their inability to obtain coke. Shortage of coal for coking, difficulties of transportation, and scarcity of labor were the factors limiting the production of coke to the output realized.

The interrelation between the production of coke and that of pig iron is clearly brought out by the curves in figure 42 (p. 1182), which shows by months for 1915, 1916, and 1917 the number of tons of beehive coke and of pig iron produced. A new record of production for the


MILLIONS OF TONS
Total
United
States
coke
net tons
Beehive
coke
net tons
Pig iron
gross
tons
By-product
coke
net
tons

Connellsville district was set in March, 1916, which contributed to carrying the total output of beehive coke for the month to the highest figure reached during 1915, 1916, and 1917. From this maximum increasing difficulties of transportation and, to some extent, the rising price of coal offered by operators of by-product ovens, caused the production of beehive coke in the Connellsville districts to decline to a minimum in February, 1917. In contrast with the Connellsville region, the remaining beehive districts showed a sharp recovery from the decline in July, 1916, and after some fluctuations their output attained its maximum for the three years in March, 1917, followed by a fairly well sustained output. Total production declined gradually from the March maximum, owing to the gradual recession from the early summer production registered in the Connellsville districts. December, 1917, was the first month in many years in which less than 50 per cent of the country's output of beehive coke came from the Connellsville region.

Every State producing beehive coke increased its output in 1916, and all save Georgia, Kentucky, Pennsylvania, Utah, and Washington recorded additional gains in 1917; the decrease in Pennsylvania, however, more than offset all gains made in other States.

By the fall of 1917 iron furnaces in the Pittsburgh districts were operating on a slender reserve of coke, and with the advent of bad weather the operators were forced to bank many stacks for lack of fuel, some large companies having 30 per cent of their furnaces idle during the weeks of greatest scarcity of coke. The insistent demand for coke and the high prices ruling during 1916 directed attention to the coke ash dumps, and the breeze recovered from this source amounted to 1,030,830 net tons in 1916 and to 1,495,545 tons in 1917.

Owing to the double demand for coke and for its by-products, special priority was given by the Government to shipments of coal for use in by-product ovens in order that maximum outputs might be obtained, and in consequence the year 1917 was one of unparalleled prosperity in the by-product coke industry. The resulting growth of the industry caused a change in the order of importance of several coke-producing States.

The number of plants equipped with apparatus for the recovery of benzol, toluol, and related oils increased from 30 in 1915 to 39 in 1916, and to 47 in 1917, and the value of the outputs of these oils was \$7,337,371, \$30,001,081, and \$28,655,204, respectively. The number of active by-product ovens increased from 6,036 in 1915 to 6,607 in 1916 and to 7,298 in 1917; and the output of by-product coke in 1917 exceeded that of 1915 by 59 per cent.

The shortage of coal-tar dyes which faced the country after the cessation of imports from Germany in 1915 was in some measure overcome by the growth of the domestic dye industry in 1916. However, in spite of the abundant raw materials for dye making afforded by the by-product coke ovens of the country, the situation was not made secure until German-owned patents covering manufacturing processes were released after the passage of the trading with the enemy act on October 6, 1917.

PRODUCTION.

STATISTICS OF PRODUCTION, 1915-1917.

In following tables the statistics of beehive and by-product coke are presented by States. Certain of the States have only one or two producers, and returns from these operators are given in combinations in order not to disclose individual figures. Permission was requested and has been granted to publish as State totals the returns for 1916 and 1917 for by-product coke in Kentucky, Maryland, Massachusetts, Minnesota, New York, Tennessee, Washington, and West Virginia and for beehive coke in Georgia. Additional permission has also been obtained to publish the total for 1917 of by-product coke in New Jersey. Thanks are due to the officials of the companies in these States for this courtesy.

Coke produced in beehive and by-product coke ovens in the United States, 1915–1917.

1915.

State.	Beehive coke.					By-product coke.					Total.			
	Active ovens.	Coal used (net tons).	Average yield (per cent).	Coke produced (net tons).	Value of coke at ovens.	Active ovens.	Coal used (net tons).	Average yield (per cent).	Coke produced (net tons).	Value of coke at ovens.	Coal used (net tons).	Coke produced (net tons).	Percentage to total production.	Value of coke at ovens.
Alabama	2,506	1,708,228	58.6	1,001,477	$3,086,656	732	2,987,710	69.3	2,070,334	$5,458,899	4,695,938	3,071,811	7.4	$8,545,555
Colorado	1,334	1,026,019	65.4	670,938	2,242,453						1,026,019	670,938	1.6	2,242,453
Georgia	62	35,377	56.6	20,039	81,170						35,377	20,039		81,170
Illinois						626	2,335,933	72.2	1,686,998	7,016,635	2,335,933	1,686,998	4.1	7,016,635
Indiana						787	3,685,774	75.1	2,768,099	11,604,588	3,685,774	2,768,099	6.7	11,604,588
Kentucky	733	462,168	61.6	284,516	536,352	108	337,679	71.5	241,581	593,417	799,847	526,097	1.3	1,129,769
Maryland						120	470,326	66.6	313,283	762,664	470,326	313,283	.8	762,664
Massachusetts						400	666,930	75.6	504,438	(a)	666,930	504,438	1.2	(a)
Minnesota						120	180,767	70.7	127,847	475,952	180,767	127,847	.3	475,952
New Mexico	600	732,830	53.1	389,411	1,265,268						732,830	389,411	.9	1,265,268
New York						555	975,656	70.2	684,461	2,459,463	975,656	684,461	1.6	2,459,463
Ohio	200	28,815	66.3	19,101	62,416	250	956,656	69.6	665,557	2,074,517	985,471	684,658	1.6	2,136,933
Pennsylvania	35,984	33,972,018	66.3	22,530,567	43,303,821	1,594	4,301,726	71.9	3,092,295	9,363,197	38,273,744	25,622,862	61.8	52,667,018
Tennessee	805	433,781	53.9	233,705	611,281	12	32,084	72.7	23,268	62,733	465,865	256,973	.6	674,014
Virginia	1,516	995,396	63.3	629,807	1,242,938						995,396	629,807	1.5	1,242,938
Washington	249	(a)		(a)	(a)	5	(a)		(a)	(a)	204,879	136,552	.3	700,832
West Virginia	4,270	2,071,001	60.4	1,250,235	2,348,468	120	202,762	72.5	141,211	412,337	2,273,763	1,391,446	3.3	2,760,805
Michigan						205								
Missouri						56								
New Jersey		b 812,883	58.9	b 478,459	b 2,164,720	150	b 2,420,379	72.4	b 1,753,523	b c 8,273,923	3,028,383	2,095,430	5.0	c 9,737,811
Utah	726													
Wisconsin						196								
	48,985	42,278,516	65.1	27,508,255	56,945,543	6,036	19,554,382	72.0	14,072,895	48,558,325	61,832,898	41,581,150	100.0	105,503,868

a Included in "Combined States."

b Includes Washington.

c Includes Massachusetts.

Coke produced in beehive and by-product coke ovens in the United States, 1915–1917—Continued.

1916.

State.	Beehive coke. Active ovens.	Beehive coke. Coal used (net tons).	Beehive coke. Average yield (per cent).	Beehive coke. Coke produced (net tons).	Beehive coke. Value of coke at ovens.	By-product coke. Active ovens.	By-product coke. Coal used (net tons).	By-product coke. Average yield (per cent).	By-product coke. Coke produced (net tons).	By-product coke. Value of coke at ovens.	Total. Coal used (net tons).	Total. Coke produced (net tons).	Total. Percentage to total production.	Total. Value of coke at ovens.
Alabama	4,269	3,158,417	57.9	1,828,067	$5,828,057	730	3,635,683	67.9	2,470,350	$9,191,082	6,794,100	4,298,417	7.9	$15,019,139
Colorado	2,089	1,674,096	62.9	1,053,553	3,736,467						1,674,096	1,053,553	1.9	3,736,467
Georgia	151	87,178	54.1	47,127	232,630						87,178	47,127	.1	232,630
Illinois						626	3,182,650	72.9	2,320,400	10,619,066	3,182,650	2,320,400	4.3	10,619,066
Indiana						794	4,626,204	75.4	3,489,660	16,096,479	4,626,204	3,489,660	6.4	16,096,479
Kentucky	827	590,187	61.4	362,164	932,533	108	614,922	71.6	440,362	1,292,653	1,205,109	802,526	1.5	2,225,186
Maryland						118	749,936	65.3	489,982	1,387,009	749,936	489,982	.9	1,387,009
Massachusetts						400	728,256	77.3	563,048	(a)	728,256	563,048	1.0	(a)
Minnesota						146	573,371	75.2	431,319	1,968,675	573,371	431,319	.8	1,968,675
New Mexico	966	843,814	59.6	502,812	1,718,976						843,814	502,812	.9	1,718,976
New York						555	1,098,249	70.6	775,014	3,033,276	1,098,249	775,014	1.4	3,033,276
Ohio	197	156,960	66.3	104,102	409,784	512	2,447,812	69.4	1,699,166	6,484,835	2,604,772	1,803,268	3.3	6,894,619
Pennsylvania	44,711	41,299,734	65.8	27,159,438	70,508,215	1,854	5,650,352	72.9	4,120,257	14,202,090	46,950,086	31,279,695	57.3	84,710,305
Tennessee	1,121	605,418	54.5	329,702	905,052	11	68,451	76.7	52,473	157,013	673,869	382,175	.7	1,062,065
Virginia	3,304	1,977,616	62.8	1,242,332	3,024,913						1,977,616	1,242,332	2.3	3,024,913
Washington	262	895,604	56.7	507,425	2,282,320	5	45,756	59.5	27,228	150,295	941,360	534,653	1.0	2,432,615
Utah	726													
West Virginia	6,982	3,795,934	61.3	2,327,502	5,889,180	120	276,481	70.1	193,807	678,325	4,072,415	2,521,309	4.6	6,567,505
Michigan						225								
Missouri						56	2,826,379	70.6	1,996,295	b10,112,272	2,826,379	1,996,295	3.7	b10,112,272
New Jersey						159								
Wisconsin						196								
	65,605	55,084,958	64.4	35,464,224	95,468,127	6,607	26,524,502	71.9	19,069,361	75,373,070	81,609,460	54,533,585	100.0	170,841,197

a Included in "Combined States."

Includes Massachusetts.

1917.

Alabama	5,493	3,658,598	58.8	2,151,828	$12,138,161	831	3,980,243	68.9	2,740,761	$16,256,111	7,638,841	4,892,589	8.8	$28,394,272
Colorado	2,867	1,784,631	62.3	1,112,449	5,479,734						1,784,631	1,112,449	2.0	5,479,734
Georgia	151	72,689	54.5	39,589	322,175						72,689	39,589	.1	322,175
Illinois						619	3,233,669	70.8	2,289,833	14,455,539	3,233,669	2,289,833	4.1	14,455,539
Indiana						861	4,817,942	73.5	3,540,718	21,831,302	4,817,942	3,540,718	6.4	21,831,302
Kentucky	801	599,626	55.3	331,532	1,794,315	108	742,162	71.6	531,539	2,324,948	1,341,788	863,071	1.6	4,119,263
Maryland						120	733,184	70.8	518,810	3,925,418	733,184	518,810	.9	3,925,418
Massachusetts						317	738,873	80.5	595,113	(a)	738,873	595,113	1.1	(a)
Minnesota						152	676,881	67.7	490,272	3,468,355	676,881	490,272	.9	3,468,355
New Jersey						260	621,699	68.1	423,361	(a)	621,699	423,361	.8	(a)
New Mexico	1,134	936,411	61.7	577,679	2,805,277						936,411	577,679	1.0	2,805,277
New York						615	1,401,458	70.9	993,184	6,889,424	1,401,458	993,184	1.8	6,889,424
Ohio	198	224,952	65.7	147,826	1,131,753	1,009	5,141,046	69.0	3,546,476	22,342,011	5,365,998	3,694,302	6.6	23,473,764
Pennsylvania	44,534	36,594,563	65.1	23,816,420	111,262,905	1,629	5,716,221	71.6	4,095,605	24,435,135	42,310,784	27,912,025	50.2	135,698,040
Tennessee	1,266	695,841	54.0	376,080	1,831,780	12	63,793	55.3	35,246	199,492	759,634	411,326	.7	2,031,272
Virginia	3,029	2,093,943	62.3	1,304,230	5,785,934						2,093,943	1,304,230	2.3	5,785,934
Washington	254	831,042	56.7	471,187	2,597,101	5	45,025	58.5	26,346	201,831	876,067	497,533	.9	2,798,932
Utah	726													
West Virginia	8,234	4,754,316	59.7	2,838,728	14,450,729	214	727,778	70.2	511,033	2,264,354	5,482,094	3,349,761	6.0	16,715,083
Michigan						258								
Missouri						56	2,865,785	73.3	2,100,983	b20,049,233	2,865,785	2,100,983	3.8	b20,049,233
Wisconsin						232								
	68,687	52,246,612	63.5	33,167,548	159,599,864	7,298	31,505,759	71.2	22,439,280	138,643,153	83,752,371	55,606,828	100.0	298,243,017

a Included in "Combined States."

b Includes Massachusetts and New Jersey.

Coke produced in the United States, 1913–1917, in net tons.

State.	1913	1914	1915	1916	1917	Increase or decrease, 1917. Quantity.	Percentage. Total.	Percentage. Beehive.	Percentage. By-product.
Alabama	3,323,664	3,084,149	3,071,811	4,298,417	4,892,589	+ 594,172	+ 13.8	+17.7	+ 10.9
Colorado	879,461	666,083	670,938	1,053,553	1,112,449	+ 58,896	+ 5.6	+ 5.6	....
Georgia	42,747	24,517	20,039	47,127	39,589	− 7,538	− 16.0	−16.0	....
Illinois	1,859,553	1,425,168	1,686,998	2,320,400	2,289,833	− 30,567	− 1.3	....	− 1.3
Indiana	2,727,025	2,276,652	2,768,099	3,489,660	3,540,718	+ 51,058	+ 1.5	....	+ 1.5
Kentucky	317,084	443,959	526,097	802,526	863,071	+ 60,545	+ 7.5	− 8.5	+ 20.7
Maryland	(a)	87,852	313,283	489,982	518,810	+ 28,828	+ 5.9	....	+ 5.9
Massachusetts	(a)	540,631	504,438	563,048	595,113	+ 32,065	+ 5.7	....	+ 5.7
Michigan	(a)	(a)	(a)	(a)	(a)	(a)	+ 13.9	....	+ 13.9
Minnesota	(a)	(a)	127,847	431,319	490,272	+ 58,953	+ 13.7	....	+ 13.7
Missouri	....	....	(a)	(a)	(a)	(a)	+ 9.1	....	+ 9.1
New Jersey	255,792	(a)	(a)	210,766	423,361	+ 212,595	+100.9	....	+100.9
New Mexico	467,945	362,572	389,411	502,812	577,679	+ 74,867	+ 14.9	+14.9	....
New York	758,486	457,370	684,461	775,014	993,184	+ 218,170	+ 28.2	....	+ 28.2
Ohio	351,846	521,638	684,658	1,803,268	3,694,302	+1,891,034	+104.9	+42.0	+108.7
Pennsylvania	28,753,444	20,258,393	25,622,862	31,279,695	27,912,025	−3,367,670	− 10.8	−12.3	− 0.6
Tennessee	364,578	264,127	256,973	382,175	411,326	+ 29,151	+ 7.6	+14.1	− 32.8
Utah	(a)	(a)	(a)	(b)	(b)	(b)	− 9.0	− 9.0	....
Virginia	1,303,603	780,984	629,807	1,242,332	1,304,230	+ 61,898	+ 5.0	+ 5.0	....
Washington	76,221	84,923	136,552	c 534,653	c 497,533	− c 37,120	− c 6.9	....	....
West Virginia	2,472,752	1,427,962	1,391,446	2,521,309	3,349,761	+ 828,452	+ 32.9	+22.0	+163.7
Wisconsin	(a)	(a)	(a)	(a)	(a)	(a)	+ 24.3	....	+ 24.3
Combined States	2,345,329	1,848,934	2,095,430	1,785,529	2,100,983	+ 315,454	+ 17.7	....	+ 17.7
	46,299,530	34,555,914	41,581,150	54,533,585	55,606,828	+1,073,243	+ 2.0	− 6.5	+ 17.7

a Included in "Combined States." b Included with Washington. c Includes Utah.

By-product coke produced in the United States, 1907–1917, in net tons.

State.	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917
Alabama	464,761	475,552	533,903	557,148	669,433	1,349,797	2,022,959	2,031,535	2,070,334	2,470,350	2,740,761
Illinois	368,730	360,776	1,276,404	1,513,126	1,610,212	1,764,944	1,859,553	1,425,168	1,686,998	2,320,400	2,289,833
Indiana				84,046	916,411	2,616,339	2,727,025	2,276,652	2,768,099	3,489,660	3,540,718
Kentucky							69,023	196,777	241,581	440,362	531,539
Maryland	332,253	270,916	315,587	335,373	343,451	304,715	236,423	87,852	313,283	489,982	518,810
Massachusetts	466,458	453,883	444,349	450,001	477,564	511,596	531,384	540,631	504,438	563,048	595,113
Michigan	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Minnesota	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	127,847	431,319	490,272
Missouri									(a)	(a)	(a)
New Jersey	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	423,361
New York	588,478	473,569	523,551	652,459	686,172	794,618	758,486	457,370	684,461	775,014	993,184
Ohio	146,011	72,356	83,114	163,487	202,298	241,725	236,032	453,800	665,557	1,699,166	3,546,476
Pennsylvania	2,045,599	1,133,039	1,849,391	2,052,973	1,493,509	1,974,619	2,628,680	2,184,336	3,092,295	4,120,257	4,095,605
Tennessee									23,268	52,473	35,246
Washington								(a)	(a)	27,228	26,346
West Virginia	153,003		86,393	77,977	165,099	188,373	136,152	46,287	141,211	193,807	511,033
Wisconsin	402,043	400,936	463,904	528,660	577,619	578,875	645,822	(a)	(a)	(a)	(a)
Combined States	640,563	560,199	678,048	723,484	706,077	789,563	863,161	1,519,535	1,753,523	1,996,295	2,100,983
	5,607,899	4,201,226	6,254,644	7,138,734	7,847,845	11,115,164	12,714,700	11,219,943	14,072,895	19,069,361	22,439,280

a Included in "Combined States."

Beehive coke produced in the United States, 1908–1917, in net tons.

State.	1908	1909	1910	1911	1912
Alabama	1,887,114	2,551,921	2,691,879	2,092,088	1,625,692
Colorado	845,669	1,072,562	1,199,248	951,748	972,941
Georgia	39,422	46,385	43,814	37,553	43,158
Illinois	(a)	(a)	(a)	....	....
Indiana	(a)	(a)	....	....	....
Kansas	(a)	....	(a)	(a)	(a)
Kentucky	37,827	46,371	53,857	66,099	191,555
Montana	(a)	(a)	(a)	....	....
New Mexico	274,565	373,967	401,646	381,927	413,906
Ohio	87,222	139,597	118,828	109,084	146,944
Oklahoma	(a)	....	(a)	....	....
Pennsylvania	14,378,595	23,056,134	24,262,634	20,430,426	25,464,074
Tennessee	214,528	261,808	322,756	330,418	370,076
Utah	(a)	(a)	(a)	(a)	(a)
Virginia	1,162,051	1,347,478	1,493,655	910,411	967,947
Washington	38,889	42,981	59,337	40,180	(a)
West Virginia	2,637,123	3,857,555	3,725,873	2,125,950	2,277,613
Wisconsin	(a)	(a)	(a)	(a)	....
Combined States	229,287	263,662	196,549	227,760	394,529
	21,832,292	33,060,421	34,570,076	27,703,644	32,868,435

	1913	1914	1915	1916	1917
Alabama	1,300,705	1,052,614	1,001,477	1,828,067	2,151,828
Colorado	879,461	666,083	670,938	1,053,553	1,112,449
Georgia	42,747	24,517	20,039	47,127	39,589
Illinois	....	....	....	....	....
Indiana	....	....	....	....	....
Kansas	....	....	....	....	....
Kentucky	248,061	247,182	284,516	362,164	331,532
Montana	....	....	....	....	....
New Mexico	467,945	362,572	389,411	502,812	577,679
Ohio	115,814	67,838	19,101	104,102	147,826
Oklahoma	....	....	....	....	....
Pennsylvania	26,124,764	18,074,057	22,530,567	27,159,438	23,816,420
Tennessee	364,578	264,127	233,705	329,702	376,080
Utah	(a)	(a)	(a)	(a)	(a)
Virginia	1,303,603	780,984	629,807	1,242,332	1,304,230
Washington	(a)	(a)	(a)	(a)	(a)
West Virginia	2,336,600	1,381,675	1,250,235	2,327,502	2,838,728
Wisconsin	....	....	....	....	....
Combined States	400,552	414,322	478,459	507,425	471,187
	33,584,830	23,335,971	27,508,255	35,464,224	33,167,548

a Included in "Combined States."

Beehive coke produced in the United States, 1915–1917, net tons, by months.

[Estimated.]

Month.	1915	1916	1917
January	1,445,691	2,919,002	2,923,056
February	1,583,992	2,887,349	2,489,888
March	1,864,922	3,263,196	3,138,977
April	1,841,369	2,875,600	2,813,935
May	1,936,414	3,043,940	2,861,364
June	2,209,666	2,917,543	2,754,897
July	2,345,271	2,721,323	2,753,902
August	2,553,055	2,999,220	2,649,755
September	2,581,708	3,015,848	2,727,367
October	3,029,077	3,079,332	2,780,436
November	3,024,698	2,933,921	2,677,284
December	3,092,392	2,807,950	2,596,687
	27,508,255	35,464,224	33,167,548

Beehive coke produced in the United States in 1917, in net tons, by States and weeks.
[Estimated.]

Week ended—	Weekly production.	Alabama.	Washington.	Georgia.	Utah.	Virginia.	Colorado.	Kentucky.	Tennessee.	New Mexico.	West Virginia.	Pennsylvania.	Ohio.
Jan. 6[a]	568,149	40,592	1,562	612	6,731	22,393	32,947	7,054	6,093	9,694	38,823	398,248	3,400
Jan. 13	681,743	48,897	1,885	737	8,107	26.972	36,206	8,498	7,339	11,679	48,287	480,208	2,928
Jan. 20	681,743	48,899	1,884	737	8,107	26.972	36,207	8,498	7,339	11,677	48,285	480,213	2,925
Jan. 27	681,743	48,901	1,885	738	8,107	26,972	28,766	8,498	7,339	11,679	55,728	480,205	2,925
Feb. 3	641,915	47,767	1,911	677	7,374	26,120	28,398	8,121	6,565	11,785	52,943	447,435	2,819
Feb. 10	607,469	49,672	2,164	597	6,317	26,591	28,929	7,996	5,336	13,200	51,339	412,491	2,837
Feb. 17	607,469	49,639	2,162	597	6,311	26,575	29,327	7,992	5,332	13,191	51,305	412,203	2,835
Feb. 24	607,469	49,629	2,162	596	6,310	26,569	29,323	7,990	5,331	13,188	51,419	412,118	2,834
Mar. 3	670,319	50,850	2,290	681	7,304	28,050	30,630	8,214	6,156	13,391	56,778	462,979	2,996
Mar. 10	729,383	46,070	2,272	787	8,747	27,501	30,757	7,515	7,354	11,833	62,156	521,444	2,947
Mar. 17	729,383	46,070	1,896	653	6,642	22,764	35,326	5,553	6,383	9,304	62,157	531,025	1,610
Mar. 24	729,383	46,070	2,272	787	8,748	27,499	21,176	7,516	7,354	11,832	62,157	531,025	2,947
Mar. 31	729,383	46,070	2,272	787	8,748	27,499	21,176	7,516	7,354	11,832	62,157	531,025	2,947
Apr. 7	651,404	42,329	1,639	596	7,591	24,062	19,901	6,336	7,451	11,110	50,791	476,839	2,759
Apr. 14	651,404	42,523	1,569	693	7,549	23,972	20,076	6,269	7,601	11,204	49,951	477,216	2,781
Apr. 21	651,404	42,522	1,570	693	7,550	23,972	20,074	6,269	7,601	11,204	49,955	477,213	2,781
Apr. 28	651,404	42,522	1,570	693	7,550	23,972	20,074	6,269	7,601	11,203	49,952	477,217	2,781
May 5	633,734	40,358	1,680	893	8,163	24,945	19,621	6,522	7,577	10,814	52,101	458,318	2,742
May 12	632,742	39,543	1,795	891	8,782	26,165	19,670	6,668	7,712	10,737	54,732	453,280	2,767
May 19	632,742	39,542	1,795	891	8,782	26,165	19,669	6,668	7,712	10,735	54,735	453,281	2,767
May 26	632,742	39,542	1,795	891	8,781	26,166	19,670	6,668	7,712	10,737	54,732	453,281	2,767
June 2	642,660	39,986	1,810	890	8,752	26,108	20,100	6,633	7,819	10,970	55,234	461,545	2,813
June 9	654,167	39,592	1,759	819	7,878	23,678	21,243	5,875	7,898	11,565	54,049	476,930	2,881
June 16	654,167	39,592	1,759	819	7,878	23,678	21,243	5,875	7,898	11,565	54,049	476,930	2,881
June 23	654,167	39,592	1,759	819	7,878	23,678	21,243	5,875	7,898	11,565	54,049	476,930	2,881
June 30	687,458	41,607	1,848	861	8,279	24,882	22,321	6,174	8,300	12,156	56,804	501,199	3,027
July 7	571,972	36,514	1,572	686	5,527	20,900	16,167	4,822	7,057	9,362	44,866	421,917	2,582
July 14	635,647	40,936	1,754	758	5,883	23,263	17,506	5,298	7,866	10,262	49,405	469,835	2,881
July 21	643,437	41,763	1,789	773	6,001	23,733	18,421	5,405	8,025	10,469	50,404	473,715	2,939
July 28	620,897	39,986	1,713	740	5,746	22,724	17,100	5,175	7,683	10,025	48,259	458,932	2,814
Aug. 4	565,784	34,461	1,731	731	5,522	21,427	15,628	4,760	7,139	9,363	45,191	417,236	2,595
Aug. 11	587,930	32,994	2,043	838	6,146	23,292	16,304	5,007	7,612	10,054	48,694	432,205	2,741
Aug. 18	574,009	32,213	1,995	818	6,000	22,740	15,919	4,890	7,432	9,817	47,539	421,970	2,676
Aug. 25	553,783	31,077	1,924	789	5,788	21,938	15,357	4,717	7,170	9,470	45,865	407,106	2,582
Sept. 1	650,198	36,487	2,260	927	6,796	25,757	18,029	5,540	8,419	11,120	53,850	477,982	3,031
Sept. 8	640,523	36,562	1,930	884	8,654	23,210	18,906	5,432	6,936	10,972	51,835	472,330	2,872
Sept. 15	648,984	37,043	1,955	896	8,768	23,517	19,155	5,504	7,027	11,117	52,522	478,570	2,910
Sept. 22	648,984	37,043	1,955	896	8,768	23,517	19,155	5,504	7,027	11,117	52,522	478,570	2,910
Sept. 29	679,866	38,806	2,049	939	9,185	24,636	20.067	5,765	7,361	11,647	55,021	501,342	3,048
Oct. 6	637,940	43,194	1,809	716	7,177	25,242	18,163	6,269	7,646	10,959	56,883	456,993	2,889

[a] To be omitted from 1917 total.

Beehive coke produced in the United States in 1917, in net tons, by States and weeks—Continued.

Week ended—	Weekly production.	Alabama.	Washington.	Georgia.	Utah.	Virginia.	Colorado.	Kentucky.	Tennessee.	New Mexico.	West Virginia.	Pennsylvania.	Ohio.
Oct. 13	660,477	47,568	1,826	674	6,827	27,012	18,531	6,855	8,224	11,362	61,112	467,483	3,003
Oct. 20	605,944	43,640	1,675	619	6,263	24,781	17,002	6,289	7,545	10,423	56,067	428,885	2,755
Oct. 27	603,336	43,452	1,668	616	6,236	24,675	16,928	6,262	7,513	10,378	55,826	427,039	2,743
Nov. 3	580,643	40,268	1,675	687	6,052	23,778	16,441	5,877	6,985	9,906	53,106	413,222	2,646
Nov. 10	575,473	36,061	1,837	912	6,129	23,649	16,668	5,459	6,314	9,618	51,107	415,080	2,639
Nov. 17	623,493	39,070	1,990	988	6,641	25,623	18,059	5,914	6,841	10,421	55,369	449,717	2,860
Nov. 24	642,707	40,274	2,052	1,020	6,845	26,413	18,615	6,096	7,052	10,735	57,076	463,581	2,948
Dec. 1	636,717	39,898	2,033	1,009	6,781	26,166	18,442	6,040	6,986	10,642	56,545	459,255	2,920
Dec. 8	694,655	45,735	1,730	624	6,708	31,298	20,011	7,130	7,848	13,492	82,202	474,460	3,417
Dec. 15	573,941	37,786	1,431	515	5,543	25,859	16,534	5,893	6,484	11,148	67,918	392,006	2,824
Dec. 22	657,230	43,270	1,637	590	6,347	29,612	18,933	6,746	7,426	12,765	77,774	448,897	3,233
Dec. 29	567,040	37,331	1,414	509	5,476	25,548	18,335	5,821	6,407	11,013	67,102	387,294	2,790
	33,167,548	2,151,828	96,412	39,589	374,775	1,304,230	1,112,449	331,532	376,080	577,679	2,838,728	23,816,420	147,826
Portion of week of Jan. 6, 1917, to be included in totals for 1917	452,657	30,612	1,250	490	5,385	17,914	26,358	5,643	4,874	7,755	31,058	318,598	2,720
Portion of week of Jan. 5, 1918, to be included in totals for 1917	105,684	....	312	122	1,346	4,479	6,589	1,411	1,219	2,111	7,765	79,650	680

STATISTICS OF PRODUCTION OF COKE, 1880–1917.

Coke produced in the United States, 1880–1917.

Year.	By-product coke.				Beehive coke.				Total.	
	Quantity (net tons).	Percentage to total.	Value.	Percentage to total.	Quantity (net tons).	Percentage to total.	Value.	Percentage to total.	Quantity (net tons).	Value.
1880	0	0	0	0	3,338,300	100.0	$6,631,267	100.0	3,338,300	$6,631,267
1885	0	0	0	0	5,106,696	100.0	7,629,118	100.0	5,106,696	7,629,118
1890	0	0	0	0	11,508,021	100.0	23,215,302	100.0	11,508,021	23,215,302
1893	12,850	0.1	....	......	9,464,730	99.9	....	......	9,477,580	16,523,714
1900	1,075,727	5.2	$2,635,531	5.6	19,457,621	94.8	44,807,800	94.4	20,533,348	47,443,331
1905	3,462,348	10.7	10,851,730	15.0	28,768,781	89.3	61,624,466	85.0	32,231,129	72,476,196
1910	7,138,734	17.1	24,793,016	24.9	34,570,076	82.9	74,949,685	75.1	41,708,810	99,742,701
1911	7,847,845	22.1	27,297,897	32.4	27,703,644	77.9	56,832,952	67.6	35,551,489	84,130,849
1912	11,115,164	25.3	42,632,930	38.1	32,868,435	74.7	69,172,183	61.9	43,983,599	111,805,113
1913	12,714,700	27.5	48,637,852	37.7	33,584,830	72.5	80,284,421	62.3	46,299,530	128,922,273
1914	11,219,943	32.5	38,080,167	43.1	23,335,971	67.5	50,254,050	56.9	34,555,914	88,334,217
1915	14,072,895	33.8	48,558,325	46.0	27,508,255	66.2	56,945,543	54.0	41,581,150	105,503,868
1916	19,069,361	35.0	75,373,070	44.1	35,464,224	65.0	95,468,127	55.9	54,533,585	170,841,197
1917	22,439,280	40.4	138,643,153	46.5	33,167,548	59.6	159,599,864	53.5	55,606,828	298,243,017

Statistics of the manufacture of coke in the United States, 1880–1917.

Year.	In operation.		Coal used (net tons).	Percentage yield of coke from coal.	Coke produced (net tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.
	Establishments.	Ovens.					
1880	a 186	a 12,372	5,237,741	63.7	3,338,300	$6,631,267	$1.99
1890	a 253	a 37,158	18,005,209	64.9	11,508,021	23,215,302	2.02
1900	345	43,039	32,113,553	63.9	20,533,348	47,443,331	2.31
1910	478	96,067	63,088,327	66.1	41,708,810	99,742,701	2.39
1911	391	63,480	53,278,248	66.7	35,551,489	84,130,849	2.37
1912	439	73,058	65,577,862	67.1	43,983,599	111,805,113	2.54
1913	444	72,008	69,239,190	66.9	46,299,530	128,922,273	2.78
1914	359	54,638	51,623,750	66.9	34,555,914	88,334,217	2.56
1915	354	54,967	61,832,898	67.2	41,581,150	105,503,868	2.54
1916	389	72,888	81,609,460	66.8	54,533,585	170,841,197	3.13
1917	398	75,985	83,752,371	66.4	55,606,828	298,243,017	5.36

a Total in existence. No statistics available showing idle establishments.

YIELD OF COKE FROM COAL.

The yield of coke from coal—that is, the percentage of coke obtained to the coal used—is higher in by-product ovens than in beehive ovens. It was formerly considered good practice to obtain a yield of 50 to 60 per cent in beehive ovens and of 70 per cent in by-product ovens. The yield from beehive ovens in 1917 was 63.5 per cent and from by-product ovens 71.2 per cent; the average of both was 66 per cent. Only beehive plants reported yields below 50 per cent, and several beehive operations showed records above 75 per cent. Some of the by-product coke ovens had yields above 77 per cent; some had less than 60 per cent.

The yield of coke from by-product ovens may be decreased or increased within certain limits by changing the relative proportions of high-volatile and low-volatile coals used in preparing the coking mixture. It is therefore possible so to operate a by-product plant that a maximum yield of coke or of by-products may be obtained, the choice of methods being dependent upon the relative market prices prevailing.

A given quantity of coal will, on the average, produce about 11 per cent less coke in a beehive oven than in a by-product oven, owing to the partial burning of the coal which takes place in beehive ovens. It is probable, therefore, that the coal coked in 1917 would have yielded 3,900,000 more tons of coke than was produced if it had all been coked in by-product ovens.

Percentage yield of coke from coal in beehive and by-product ovens, 1913–1917.

State.	1913		1914		1915		1916		1917	
	Beehive.	By-product.	Beehive.	By-product.	Beehive.	By-product.	Beehive.	By-product.	Beehive.	By-product.
Alabama	54.5	71.4	59.5	69.8	58.6	69.3	57.9	67.9	58.9	68.9
Colorado	65.1		63.5		65.4		62.9		62.3	
Georgia	51.5		54.1		56.6		54.1		54.5	
Illinois		74.9		73.8		72.2		72.9		70.8
Indiana		77.1		72.8		75.1		75.4		73.5
Kentucky	60.0	69.8	63.0	70.2	61.6	71.5	61.4	71.6	55.3	71.6
Maryland		69.4		67.6		66.7		65.3		70.8
Massachusetts		76.3		76.4		75.6		77.3		80.5
Michigan		76.2		74.1		72.0		71.9		72.7
Minnesota		66.9		68.4		70.7		75.2		72.4
Missouri						77.0		76.9		76.9
New Jersey		75.4		77.6		77.0		61.4		68.1
New Mexico	59.4		54.9		53.1		59.6		61.7	
New York		71.1		69.3		70.2		70.6		70.9
Ohio	64.4	72.0	66.6	70.6	66.3	69.6	66.3	69.4	65.7	69.0
Pennsylvania	65.8	75.3	66.2	73.7	66.3	71.9	65.8	72 9	65.1	71.6
Tennessee	52.5		54.2		53.9	72.5	54.5	76.7	54.0	55.3
Utah	56.9		55.9		57.3		55.0		55.9	
Virginia	64.7		59.2		63.3		62.8		62.3	
Washington	64.2		63.4	66.9	65.4	70.0	62.1	59.5	60.1	58.5
West Virginia	60.8	70.8	61.4	72.0	60.4	69.6	61.3	70.0	59.7	70.2
Wisconsin		76.2		70.8		70.3		70.5		72.9
Average	64.4	74.4	64.6	72.4	65.1	72.0	64.4	71.9	63.5	71.2

COKE IN PENNSYLVANIA.

1916.—Pennsylvania continued to dominate the coke industry in 1916, with a production of 57 per cent of the total for the United States, compared with 62 per cent in 1915. As in the past, the three Connellsville districts in Fayette, Westmoreland, and Indiana counties continued to produce approximately 80 per cent of the State total of beehive coke. In spite of the decrease in the relative importance of Pennsylvania's production of coke, her output in 1916 increased 5,656,833 tons, or 22 per cent, amounting to 31,279,695 net tons.

Beehive coke ovens still continued to produce the great bulk of the State's output. In 1916 these ovens yielded 27,159,438 net tons of coke, a gain of 4,628,871 tons, or 20.5 per cent, compared with 1915. The Connellsville district proper recorded an increase of 2,447,051 net tons, or 25.1 per cent; the Upper Connellsville district, 59,301 tons, or 9.3 per cent; and the Lower Connellsville, 1,590,353 tons, or 19.9 per cent.

There was a decrease of 20 in the number of establishments operating beehive ovens—242 in 1916 against 262 in 1915—and a corresponding decrease in the number of ovens from 53,112 to 52,416. Ten rectangular ovens and no beehive ovens were under construction at the end of 1916, compared with 440 rectangular and 100 beehive ovens building on December 31, 1915.

By-product ovens produced 4,120,257 net tons of coke in 1916, or 13.2 per cent of the State's output, an increase over 1915 of 1,027,962 tons, or 33.2 per cent. The Pittsburgh district increased its output by 336,103 net tons, or 23.3 per cent, and the remainder of the State gained 691,859 tons, or 42 per cent.

The number of by-product plants in operation during 1916 remained stationary at 9, but the number of ovens increased from 1,744 to 1,956, and the number under construction rose from 212 at the end of 1915 to 700 on December 31, 1916.

1917.—In 1917 Pennsylvania produced 27,912,025 net tons of coke, or 50 per cent of the country's output, compared with 57 per cent in 1916. In spite of the war demand for coke, railway congestion, scarcity of labor, and coal shortage reduced the State's production 3,367,670 tons, or 11 per cent.

Beehive ovens produced 23,816,420 net tons, or 85.3 per cent of the State's output, a loss, compared with 1916, of 3,343,018 tons, or 12 per cent. Production in the Connellsville district proper declined 1,979,819 tons, or 16.2 per cent; the Upper Connellsville district increased 32,086 tons, or 4.6 per cent; and the Lower Connellsville district declined 1,231,488 tons, or 12.9 per cent.

Establishments operating beehive ovens decreased from 242 in 1916 to 232 in 1917, with a corresponding reduction in the number of ovens from 52,416 to 49,949, a decrease of 2,467. In spite of the great demand for coke only 3 beehive ovens were under construction at the end of 1917, compared with 10 rectangular ovens building a year previous.

By-product ovens produced 4,095,605 net tons of coke in 1917, or 14.7 per cent of the State's output, a decrease from 1916 of 24,652 tons, or 0.6 per cent. The Pittsburgh district decreased 9,863 tons, or 0.6 per cent, and the remainder of the State 14,789 tons, or 0.6 per cent.

The 9 by-product plants that were active in 1916 were also in operation throughout 1917, with a total of 1,956 active ovens. The 700 ovens under construction December 31, 1916, had not been put in blast before the end of 1917.

Coke produced in Pennsylvania, 1880–1917.

Year.	Establishments.	Ovens.		Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Total value of coke at ovens.	Value of coke at ovens per ton.
		Built.	Under construction.					
1880	124	2,501	836	4,347,558	....	2,821,384	$5,255,042	$1.86
1890	106	23,430	74	13,046,143	65.6	8,560,245	16,333,674	1.91
1900	177	32,548	2,310	20,239,966	66.0	13,357,295	29,692,258	2.22
1910	288	55,656	1,334	39,455,785	66.7	26,315,607	55,254,599	2.10
1911	279	54,904	1,271	32,875,655	66.7	21,923,935	43,053,367	1.96
1912	277	53,756	1,887	41,268,532	66.5	27,438,693	56,336,255	2.05
1913	276	55,058	582	43,195,801	66.6	28,753,444	67,929,864	2.36
1914	274	54,075	867	30,286,961	66.9	20,258,393	42,447,886	2.10
1915	273	54,856	752	38,273,744	66.9	25,622,862	52,667,018	2.06
1916	251	54,372	710	46,950,086	66.6	31,279,695	84,710,305	2.71
1917	240	[a] 51,905	[b] 703	42,310,784	66.0	27,912,025	135,698,040	4.86

[a] Includes 903 United-Otto, 516 Koppers, 360 Semet-Solvay, 150 Didier, 27 Gas Machinery, and 5,687 rectangular ovens.
[b] Includes 700 Koppers ovens.

Coke produced in the Connellsville region, Pa., 1880–1917.

Year.	Establishments.	Ovens. Built.	Ovens. Under construction.	Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Total value of coke at ovens.	Value of coke at ovens per ton.
1880	67	7,211	731	3,367,856	65.5	2,205,946	$3,948,643	$1.79
1890	28	15,865	30	9,748,449	66.3	6,464,156	11,537,370	1.94
1900	98	20,981	686	14,946,659	67.0	10,020,907	22,383,432	2.23
1910	118	24,481	206	17,205,615	66.6	11,459,601	23,121,556	2.02
1911	112	23,879	227	14,420,328	66.3	9,565,013	18,471,506	1.93
1912	109	22,219	148	17,772,202	66.5	11,814,588	22,463,602	1.90
1913	106	22,189	60	17,379,314	66.6	11,566,778	25,830,382	2.23
1914	105	21,343	160	11,789,842	66.6	7,850,813	15,078,667	1.92
1915 [a]	102	21,389	100	14,540,251	67.1	9,763,677	18,213,750	1.87
1916 [a]	101	21,129	10	18,274,300	66.8	12,210,728	29,559,601	2.42
1917 [a]	100	20,974	0	15,388,687	66.5	10,230,909	40,392,051	3.95

[a] Beehive only.

Beehive coke produced in Pennsylvania in 1915, 1916, and 1917.

1915.

District.	Establishments.	Ovens. Built.	Ovens. Under construction.	Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Total value of coke at ovens.	Value of coke per ton
Allegheny Mountain and Allegheny Valley	25	2,100	0	272,559	62.1	169,186	$436,954	$2.58
Connellsville	102	21,389	100	14,540,251	67.1	9,763,677	18,213,750	1.87
Lower Connellsville	76	16,400	440	11,930,691	67.0	7,989,862	14,359,435	1.80
Pittsburgh	12	4,208	0	3,183,972	63.2	2,013,418	4,665,235	2.32
Upper Connellsville	21	2,746	0	966,580	66.1	638,812	1,217,544	1.91
Other districts [a]	26	6,269	0	3,077,965	63.5	1,955,612	4,410,903	2.26
	262	53,112	540	33,972,018	66.3	22,530,567	43,303,821	1.92

1916.

District.	Establishments.	Ovens. Built.	Ovens. Under construction.	Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Total value of coke at ovens.	Value of coke per ton
Allegheny Mountain and Allegheny Valley	14	1,887	0	377,102	65.8	248,117	$684,715	$2.76
Connellsville	101	21,129	10	18,274,300	66.8	12,210,728	29,559,601	2.42
Lower Connellsville	73	16,360	0	14,472,277	66.2	9,580,215	24,942,032	2.60
Pittsburgh	12	4,208	0	3,886,368	61.2	2,378,636	7,994,931	3.36
Upper Connellsville	19	2,631	0	1,045,679	66.8	698,113	1,819,849	2.61
Other districts [a]	23	6,201	0	3,244,008	63	2,043,629	5,507,087	2.69
	242	52,416	10	41,299,734	65.8	27,159,438	70,508,215	2.60

1917.

District.	Establishments.	Ovens. Built.	Ovens. Under construction.	Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Total value of coke at ovens.	Value of coke per ton
Allegheny Mountain and Allegheny Valley	8	810	3	349,858	66.5	232,703	$1,034,200	$4.44
Connellsville	100	20,974	0	15,388,687	66.5	10,230,909	40,392,051	3.95
Lower Connellsville	74	16,420	0	12,785,016	65.3	8,348,727	40,499,332	4.85
Pittsburgh	11	3,951	0	4,098,668	60.3	2,471,587	15,034,944	6.08
Upper Connellsville	15	2,314	0	1,117,491	65.3	730,199	4,243,797	5.81
Other districts [a]	24	5,480	0	2,854,843	63.1	1,802,295	10,058,581	5.58
	232	49,949	3	36,594,563	65.1	23,816,420	111,262,905	4.67

[a] Includes Bedford, Cameron, Clearfield, Elk, Huntingdon, and Jefferson counties, and part of Allegheny, Indiana, and Westmoreland counties.

By-product coke produced in Pennsylvania in 1915, 1916, and 1917.

District.	Establishments.	Ovens.		Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Total value of coke at ovens.	Value of coke per ton.
		Built.	Under construction.					
1915.								
Pittsburgh [a]	3	794	0	2,049,019	70.5	1,444,228	$4,172,984	$2.89
Other districts [b]	6	950	212	2,252,707	73.2	1,648,067	5,190,213	3.15
	9	1,744	212	4,301,726	71.9	3,092,295	9,363,197	3.03
1916.								
Pittsburgh [a]	3	794	640	2,491,056	71.5	1,780,331	5,759,162	3.23
Other districts [b]	6	1,162	60	3,159,296	74.1	2,339,926	8,442,928	3.61
	9	1,956	700	5,650,352	72.9	4,120,257	14,202,090	3.45
1917.								
Pittsburgh [a]	3	794	640	2,516,433	70.4	1,770,468	9,872,057	5.58
Other districts [b]	6	1,162	60	3,199,788	72.7	2,325,137	14,563,078	6.26
	9	1,956	700	5,716,221	71.6	4,095,605	24,435,135	5.97

[a] Includes plants at Farrell, Glassport, and Johnstown in 1915, with Clairton additional in 1916 and 1917.
[b] Includes plants at Chester, Dunbar, Lebanon, South Bethlehem, and Steelton.

COKE IN WEST VIRGINIA.

Statistics of the manufacture of coke in the several districts of West Virginia for the years 1916 and 1917 are given in the following table, with comparable tabulation for 1915.

1916.—Every district showed an increase in production in 1916 compared with 1915, and the increase for the State amounted to 81 per cent in quantity and 138 per cent in value. The number of beehive ovens built decreased by 832, and the number of active by-product ovens was increased by the completion of 94 Koppers ovens at Follansbee.

1917.—In 1917, as in 1916, every district showed an increase in both quantity and value of its output of coke, the total gain for the State amounting to 33 per cent in quantity and 155 per cent in value. There was a decrease from 1916 to 1917 of 11 in the number of establishments—from 103 to 92—and of 1,082 in the number of ovens, which was in a small measure offset by the building during 1917 of 20 ovens in the Flat Top district, the first beehive ovens to be erected in the State since 1913.

Coke produced in West Virginia in 1915, 1916, and 1917.

District.	Establishments.	Ovens.		Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Total value of coke at ovens.	Value of coke at ovens per ton.
		Built.	Under construction.					
1915.								
Flat Top	41	7,695	....	1,245,551	58.3	726,545	$1,317,892	$1.81
Kanawha	8	1,453	....	259,863	57.7	149,899	371,427	2.48
New River	16	1,403	....					
Tug River [a]	7	2,151	....	....	....	....	....	....
Upper Monongahela	33	[b] 2,868	[c] 94	584,757	66.4	388,105	873,180	2.25
Upper Potomac and Tygarts Valley	8	778	....	183,592	69.1	126,897	198,306	1.56
	113	16,348	94	2,273,763	61.2	1,391,446	2,760,805	1.98
1916.								
Flat Top	37	6,927	....	2,511,215	59.9	1,505,400	$3,608,166	$2.40
Tug River	1	2,151	....					
Kanawha	8	1,453	....	188,215	58.9	110,801	288,682	2.61
New River	15	1,351	....	335,379	59.1	198,375	654,332	3.30
Upper Monongahela	34	[d] 2,962	....	773,531	67.8	524,434	1,598,687	3.05
Upper Potomac and Tygarts Valley	8	766	....	264,075	69.0	182,299	417,638	2.29
	103	15,610	....	4,072,415	61.9	2,521,309	6,567,505	2.60
1917.								
Flat Top	37	6,399	20	2,881,167	58.0	1,672,407	$7,606,190	$4.55
Tug River	1	2,151	....					
Kanawha	7	1,374	....	390,895	59.0	230,671	1,169,160	5.07
New River	13	1,297	....	345,587	59.5	205,688	1,464,116	7.12
Upper Monongahela	26	[e] 2,542	....	1,570,455	66.3	1,041,382	5,280,790	5.07
Upper Potomac and Tygarts Valley	8	765	....	293,990	67.9	199,613	1,194,827	5.99
	92	14,528	20	5,482,094	61.1	3,349,761	16,715,083	4.99

[a] Tug River district was idle in 1915.
[b] Includes 120 Semet-Solvay ovens.
[c] Koppers ovens.
[d] Includes 120 Semet-Solvay and 94 Koppers ovens built but not operated.
[e] Includes 120 Semet-Solvay and 94 Koppers ovens.

BY-PRODUCT COKE IN OHIO.

The statistics of the by-product coke industry of Ohio for 1916 and 1917 are given in the following tables, which have been arranged to show production by principal districts, in so far as that is possible without the disclosure of individual operations. All three districts showed marked increase in production in 1917, compared with 1916, with an aggregate gain of 109 per cent for the State.

Operating establishments increased from 8 in 1916 to 10 in 1917, with a corresponding increase from 916 to 1,108 in the number of ovens. Ovens under construction at the end of 1917 numbered 760, compared with 472 at the end of 1916.

By-product coke produced in Ohio in 1916 and 1917.

District.	Establishments.	Ovens.		Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Total value of coke at ovens.	Value of coke at ovens per ton.
		Built.	Under construction.					
1916.								
Canton and Cleveland....	3	351	180	602,827	68.0	410,218	$1,655,236	$4.04
Youngstown..............	2	347	84	1,337,758	68.7	919,367	3,436,613	3.74
Other districts [a]..........	3	218	208	507,227	72.9	369,581	1,392,986	3.77
	8	916	472	2,447,812	69.4	1,699,166	6,484,835	3.82
1917.								
Canton and Cleveland....	3	351	180	1,883,796	70.1	1,320,146	9,410,502	7.13
Youngstown..............	3	431	312	2,520,027	68.7	1,730,942	9,866,747	5.70
Other districts [a]..........	4	326	268	737,223	67.2	495,388	3,064,762	6.19
	10	1,108	760	5,141,046	69.0	3,546,476	22,342,011	6.30

[a] Includes plants at Canal Dover, Hamilton, Lorain, and Toledo in 1916, with Ironton and Portsmouth additional in 1917.

RANK OF COKE-PRODUCING STATES.

1916.—Coke was produced in 22 States in 1916. In five States only beehive ovens were used, in 10 by-product ovens furnished the whole output, and in seven both methods of coke making were employed. In total output Pennsylvania led the list, with Alabama, Indiana, West Virginia, and Illinois following in order; in production of by-product coke the order was Pennsylvania, Indiana, Alabama, Illinois, and Ohio.

1917.—In 1917, as in 1916, coke was produced in 22 States, of which five produced beehive coke only, 10 produced by-product coke, and seven produced coke from both types of ovens. Pennsylvania's relative importance as a coke producer again declined slightly in 1917, but it still maintained a commanding lead as the most important producing State. Because of the war boom in the production of by-product coke, Ohio moved from sixth to third place in point of total output, and Kentucky dropped from ninth to twelfth place. The rank of the coke-producing States with reference to total and to by-product output for the years 1913 to 1917 is shown in the following table:

Rank of the States in the production of coke, 1913–1917.

State.	1913		1914		1915		1916		1917	
	Total.	By-product.	Total.	By-product.	Total.	By-product.	Total.	By-product.	Total.	By-product.
Pennsylvania	1	1	1	1	1	1	1	1	1	1
Alabama	2	3	2	3	2	3	2	3	2	4
Ohio	14	11	11	9	7	7	6	5	3	2
Indiana	3	2	3	2	3	2	3	2	4	3
West Virginia	4	12	5	14	5	13	4	15	5	12
Illinois	5	4	4	4	4	4	5	4	6	5
Virginia	6	....	6	....	10	....	7	....	7	....
Colorado	7	....	7	....	9	....	8	....	8	....
New York	8	5	12	8	8	6	11	7	9	6
Wisconsin	9	6	8	5	11	8	12	8	10	7
Michigan	11	8	9	6	6	5	10	6	11	8
Kentucky	16	14	13	11	12	12	9	12	12	10
Massachusetts	10	7	10	7	13	9	13	9	13	9
New Mexico	12	....	14	....	14	....	14	....	14	....
Maryland	18	10	19	13	16	10	15	10	15	11
Minnesota	19	13	18	12	21	15	16	11	16	13
New Jersey	17	9	17	10	17	11	20	14	17	14
Tennessee	13	....	16	....	18	17	18	16	18	16
Utah	15	....	15	....	15	....	17	....	19	....
Missouri	....	....	....	....	20	14	19	13	20	15
Washington	20	....	20	15	19	16	21	17	21	17
Georgia	21	....	21	....	22	....	22	....	22	....

COKE OVENS IN THE UNITED STATES.

The number of beehive ovens[1] in the United States has been decreasing for years, irrespective of the fluctuations in the production of coke. By-product ovens, on the contrary, have increased in number each year since 1894 and their building was considerably accelerated by the war demand for both coke and toluol, which began to be strongly felt in 1915. The greater advantages and economies of the newer process will continue to operate in the further decrease in beehive ovens, although a number of years must elapse before those ovens become entirely obsolete.

The history of the construction of beehive and by-product ovens in the United States is shown in figures 40 and 41 and by the tables on the following pages. The reports to the United States Geological Survey by the operators cover the number of ovens in existence and being built at the end of each year and the number abandoned during each year. Beehive ovens may be completely constructed during the 12-month period, or they may be abandoned, and the total shown for any year does not, therefore, necessarily represent the total of those in existence at the end of the previous year plus the number reported as under construction. Some beehive ovens in Kansas, Oklahoma, and Wisconsin have been idle for many years, but they are reported to the Geological Survey as idle, not as abandoned. In all probability, however, few of these ovens will ever be operated again.

The first by-product ovens were constructed in the United States in 1893, and since 1894 not a year has passed without additions to the number in operation. The number of ovens under construction and the total built at the end of each year are shown graphically in figure 40, and it is interesting to compare these curves with that in

[1] With beehive ovens are included the rectangular ovens and all modified types in which partial combustion of the coal takes place and no by-products are saved.

figure 39 showing the annual output from these ovens for the same period. A new record in the number of by-product ovens being built was established in 1916, and a still higher mark was reached in 1917. Prior to the war the greatest activity in construction was in the years 1901 and 1910. In 1900 there were 1,096 ovens being built,

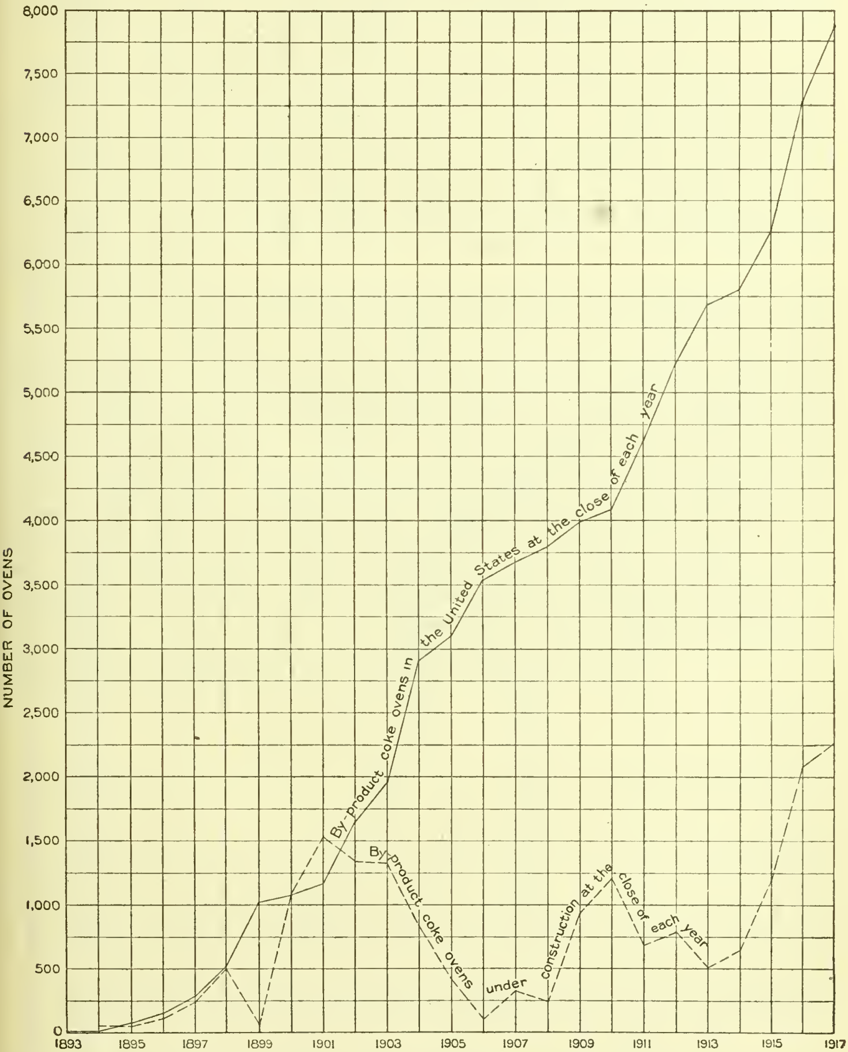


FIGURE 40.—By-product ovens completed and under construction in the United States at the end of each year, 1893–1917.

80 of which were completed in 1901. In 1901 there were 1,533 ovens, including 1,005 reported in 1900, under construction, 502 of which were put in operation in 1902. This activity was confined mainly to Alabama, Maryland, New York, and Pennsylvania, and most of the ovens built at this time were of the Otto-Hoffman or modified types. Between 1903 and 1909 there was a lull in the construction of by-

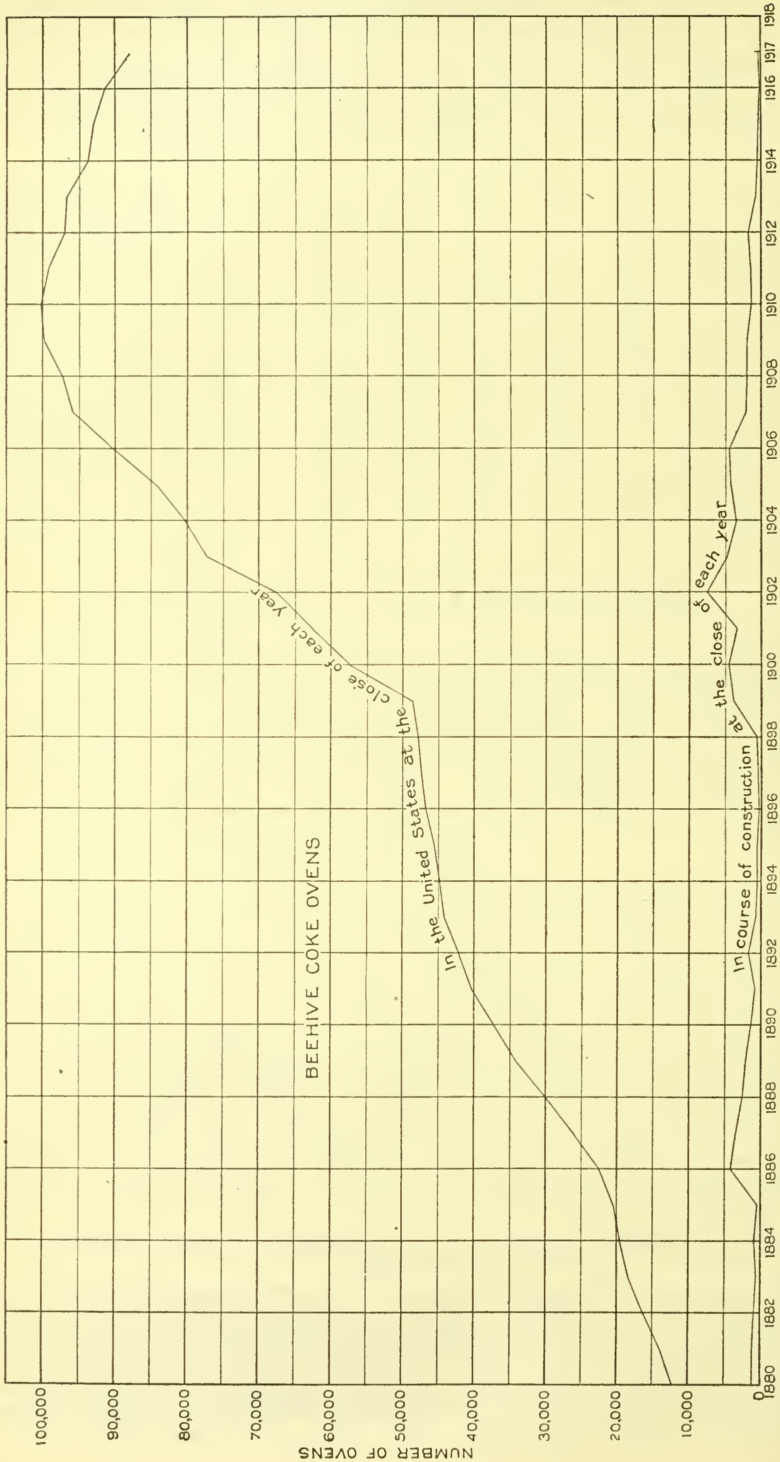


FIGURE 41.—Beehive ovens completed and under construction in the United States at the end of each year, 1880–1917.

product ovens. In 1909 large installations of Koppers ovens at Gary, Ind., and of Didier ovens at South Bethlehem, Pa., were begun, but as they were not completed in 1910 they are shown as under construction in the record for that year also. The number of by-product ovens in course of erection on December 31, 1917, was 2,260, compared with 2,084 under construction in 1916, and 1,191, building December 31, 1915. The number of completed ovens has increased at a rapid rate, the only period in which progress was slow having been in the years 1906 to 1910.

Figure 41 shows the number of completed beehive ovens at the end of each year for the period from 1880 to 1917. The number of beehive ovens under construction at the end of each year is also shown, but it is evident that this record is a very poor index of activity; for, as has been previously noted, beehive ovens are constructed in a comparatively short time (and abandoned with equal facility), and an annual statement of those in process of erection furnishes little real information.

From 1880 to 1893 steady progress was made in the erection of beehive ovens, compared with the period from 1894 to 1899 when there were but few additions. From 1900 to 1907, a period of great industrial expansion, particularly in the iron and steel business, the number of beehive ovens increased rapidly, and in 1910 the highest point in respect to number of beehive ovens was reached—the same year, it will be noted, that recorded a large number of by-product ovens under construction. Each succeeding year since 1910 has shown a decrease in beehive ovens, and in view of the present activity in the construction of by-product ovens, there is no reason to expect otherwise than that the trend will continue downward. Data are not available from which a curve could be constructed showing the number of beehive ovens active in contrast with the number in existence, but the appearance of such a curve may be inferred from the curve in figure 39 representing the output of beehive coke.

Coke ovens in the United States, 1915, 1916, and 1917.

1915.

State.	Active.		Idle.		Total.		Abandoned.		Under construction at end of year.	
	Beehive.	By-product.	Beehive.	By-product.	Beehive.	By-product.	Beehive.	By-product.	Beehive.	By-product.
Alabama	2,506	732	6,062	18	8,568	750				
Colorado	1,334		2,239		3,573					
Georgia	62		139		201					
Illinois		626				626				
Indiana		787		*a* 25		812				30
Kansas			2		2					
Kentucky	733	54	364		1,097	54				54
Maryland		120				120				
Massachusetts		400				400				
Michigan		205				205				20
Minnesota		120				120				24
Missouri		56				56				
Montana			112		112		239			
New Jersey		150				150				
New Mexico	600		430		1,030					
New York		555				555				100
Ohio	200	250	121	93	321	313				657
Oklahoma			50		50					
Pennsylvania	35,981	1,594	*b*17,128	150	53,112	1,744	189		540	212
Tennessee	805	12	1,497		2,302	12	1			
Utah	726				726					
Virginia	1,516		3,713		5,229		300		17	
Washington	249	5	82		331	5				
West Virginia	4,270	120	11,958		16,228	120	831			94
Wisconsin		196	228		228	196				
	48,985	5,982	44,125	286	93,110	6,268	1,563		557	1,191

1916.

State.	Active Beehive.	Active By-product.	Idle Beehive.	Idle By-product.	Total Beehive.	Total By-product.	Abandoned Beehive.	Abandoned By-product.	Under construction Beehive.	Under construction By-product.
Alabama	4,269	730	4,537	13	8,806	743	62	7		97
Colorado	2,089		1,484		3,573					120
Georgia	151		50		201					
Illinois		626				626				
Indiana		794		48		842				44
Kansas			2		2					
Kentucky	827	108	270		1,097	108				
Maryland		118		2		120				240
Massachusetts		400				400				
Michigan		226		3		229				40
Minnesota		146		9		155				65
Missouri		56				56				
Montana							251			
New Jersey		150				150				110
New Mexico	966		94		1,060				94	
New York		555				555				160
Ohio	197	512	124	404	321	916				472
Oklahoma			50		50					
Pennsylvania	44,711	1,854	7,705	102	52,416	1,956	847		10	700
Tennessee	1,121	11	1,107	1	2,228	12	75			
Utah	726				726					
Virginia	3,304		1,842		5,146		100			
Washington	262	5	69		331	5				
West Virginia	6,982	120	8,414	*a*94	15,396	214	930			
Wisconsin		196	228		228	196				36
	65,605	6,607	25,976	676	91,581	7,283	2,265	7	104	2,084

a New ovens, built but not yet in operation.
b Includes 34 new ovens, built but not yet in operation.

Coke ovens in the United States, 1915, 1916, and 1917—Continued.

1917.

State.	Active.		Idle.		Total.		Abandoned.		Under construction at end of year.	
	Beehive.	By-product.	Beehive.	By-product.	Beehive.	By-product.	Beehive.	By-product.	Beehive.	By-product.
Alabama	5,493	831	3,320	16	8,813	847	1			
Colorado	2,867		706		3,573					120
Georgia	151		50		201					
Illinois		619		7		626				
Indiana		861		25		886				260
Kansas			2		2					
Kentucky	801	108	296		1,097	108				
Maryland		120				120				240
Massachusetts		317		83		400				
Michigan		258		11		269				
Minnesota		152		3		155				65
Missouri		56				56				
New Jersey		260				260				55
New Mexico	1,134		70		1,204					
New York		615				615				
Ohio	198	1,009	134	99	332	1,108				760
Oklahoma			50		50					
Pennsylvania	44,534	1,629	5,415	327	49,949	1,956	3,430		3	700
Tennessee	1,266	12	962		2,228	12			100	24
Utah	726				726				93	
Virginia	3,029		1,950		4,979		191		100	
Washington	254	5	77		331	5			66	
West Virginia	8,234	214	6,080		14,314	214	1,199		20	
Wisconsin		232	228		228	232				36
	68,687	7,298	19,340	571	88,027	7,869	4,821		382	2,206

Beehive coke ovens at end of each year, 1913–1917.

State.	1913	1914	1915	1916	1917
Alabama	9,584	8,535	8,568	8,806	8,813
Colorado	3,588	3,573	3,573	3,573	3,573
Georgia	251	201	201	201	201
Kansas	2	2	2	2	2
Kentucky	995	1,097	1,097	1,097	1,097
Montana	351	351	112		
New Mexico	1,030	1,030	1,030	1,060	1,204
Ohio	322	321	321	321	332
Oklahoma	260	260	50	50	50
Pennsylvania	53,466	52,553	53,112	52,416	49,949
Tennessee	2,427	2,303	2,302	2,228	2,228
Utah	726	726	726	726	726
Virginia	5,695	5,435	5,229	5,146	4,979
Washington	331	331	331	331	331
West Virginia	17,706	17,000	16,228	15,396	14,314
Wisconsin	228	228	228	228	228
	93,962	93,946	93,110	91,581	88,027

By-product ovens in the United States at the end of the year in 1915, 1916, and 1917.

1915.

State.	Koppers.	United-Otto.[a]	Semet-Solvay.	Rothberg.	Didier.	Gas machinery.	Roberts flueless.	Klönne	Wilputte.	Total.
Alabama	450		300							750
Illinois	315		293						18	626
Indiana	646	100	41			3		22		812
Kentucky			54							54
Maryland	120									120
Massachusetts		400								400
Michigan		30	175							205
Minnesota	70	50								120
Missouri	56									56
New Jersey		150								150
New York		188	86	281						555
Ohio	143	100	100							343
Pennsylvania	304	903	360		150	27				1,744
Tennessee							12			12
Washington								5		5
West Virginia			120							120
Wisconsin		36	160							196
	2,104	1,957	1,689	281	150	30	12	27	18	6,268

[a] Includes the Otto-Hoffmann and Schniewind types.

1916.

State.	Koppers.	United-Otto.	Semet-Solvay.	Rothberg.	Didier.	Gas machinery.	Roberts flueless.	Klönne	Wilputte.	Total.
Alabama	443		300							743
Illinois	315		293						18	626
Indiana	646	100	41			33		22		842
Kentucky			108							108
Maryland	120									120
Massachusetts		400								400
Michigan		54	175							229
Minnesota	90	65								155
Missouri	56									56
New Jersey		150								150
New York		188	86	281						555
Ohio	692	100	100				24			916
Pennsylvania	516	903	360		150	27				1,956
Tennessee							12			12
Washington								5		5
West Virginia	94		120							214
Wisconsin		36	160							196
	2,972	1,996	1,743	281	150	60	36	27	18	7,283

1917.

State.	Koppers.	United-Otto.	Semet-Solvay.	Rothberg.	Didier.	Gas machinery.	Roberts flueless.	Klönne	Wilputte.	Total.
Alabama	487		300						60	847
Illinois	315		293						18	626
Indiana	690	100	41			33		22		886
Kentucky			108							108
Maryland	120									120
Massachusetts		400								400
Michigan		54	215							269
Minnesota	90	65								155
Missouri	56									56
New Jersey	110	150								260
New York		188	146	281						615
Ohio	776	100	208				24			1,108
Pennsylvania	636	903	240		150	27				1,956
Tennessee							12			12
Washington								5		5
West Virginia	94		120							214
Wisconsin		72	160							232
	3,374	2,032	1,831	281	150	60	36	27	78	7,869

By-product ovens at end of each year, 1913–1917.

State.	1913		1914		1915		1916		1917	
	Built.	Under construction.	Built.	Under construction.	Built.	Under construction.	Built.	Under construction.	Built.	Under construction.
Alabama	700	20	750		750		743	97	847	
Colorado								120		120
Illinois	568	58	586	40	626		626		626	
Indiana	749	41	789	33	812	30	842	44	886	260
Kentucky	54		54		54	54	108		108	
Maryland	[a] 0	120	120		120		120	240	120	240
Massachusetts	400		400		400		400		400	
Michigan	205		205		205	24	229	40	269	
Minnesota	50	90	140	90	120	20	155	65	155	65
Missouri		56		56	56		56		56	
New Jersey	150		150		150		150	110	260	55
New York	555		555	100	555	100	555	160	615	
Ohio	149	119	217	51	343	657	916	472	1,108	760
Pennsylvania	1,592		1,522	262	1,744	212	1,956	700	1,956	700
Tennessee				12	12		12		12	24
Washington			5		5		5		5	
West Virginia	120		120		120	94	214		214	
Wisconsin	196		196		196		196	36	232	36
	[a] 5,488	504	5,809	644	6,268	1,191	7,283	2,084	7,869	2,260

[a] At the close of 1913 the 200 ovens at Sparrows Point works of the Maryland Steel Co. that were operated during the year were being torn down to be replaced by 120 ovens of larger dimensions.

By-product ovens under construction in the United States at the end of 1916 and 1917.

1916.

State.	Koppers.	United-Otto.	Semet-Solvay.	Wilputte.	Total.
Alabama	37			60	97
Colorado	120				120
Indiana	44				44
Maryland	240				240
Michigan			40		40
Minnesota	65				65
New Jersey	110				110
New York		100	60		160
Ohio	472				472
Pennsylvania	700				700
Wisconsin		36			36
	1,788	136	100	60	2,084

1917.

State.	Koppers.	United-Otto.	Semet-Solvay.	Wilputte.	Total.
Colorado	120				120
Indiana	140		120		260
Maryland	240				240
Minnesota	65				65
New Jersey	55				55
Ohio	700		60		760
Pennsylvania	700				700
Tennessee			24		24
Wisconsin		36			36
	2,020	36	204		2,260

A list of by-product coke plants, with notes regarding types of ovens, dates of installation, and uses of by-products, is given in the following table. Similar data for ovens under construction at the end of 1917 are given in another table. Although used primarily as a source of coke for iron-furnace operations and for the most part built by the iron-producing interests, a number of these plants have been installed with the main purpose of producing domestic gas for municipalities.

By-product coke plants in the United States in 1917.

State.	Town.	Name of company owning plant.	Number of ovens	Type of oven.	Year put in blast.[a]	Uses of coke.	Uses of surplus gas.	Benzol recovery plant.	Remarks.
Alabama	Alabama City	Gulf States Steel Co.	37	Koppers	1917	Blast furnace	Industrial fuel	Yes	
	Ensley	Tennessee Coal, Iron & R. R. Co.	240	Semet-Solvay	1898–1902	do	Boiler fuel	Yes	
	Fairfield	do	280	Koppers	1912	do	Industrial fuel	Yes	
	Tuscaloosa	Central Iron & Coal Co.	60	Semet-Solvay	1906–1914	Furnace, foundry, and heating.	Boiler fuel	Yes	
	Woodward	Woodward Iron Co.	170	Koppers	1911–1914	Blast furnace	Industrial fuel	Yes	1917—Additional benzolrecovery plant operated by Thomas A. Edison.
	do	do	60	Wilputte	1917				
Illinois	Joliet	Coal Products Manufacturing Co.	18	do	1914	Furnace, foundry, and domestic.	Illuminating, domestic, and industrial fuel.	No	
	do	do	35	Koppers	1912				
	do	Illinois Steel Co.	280	do	1908–1909	Furnace	Industrial fuel	Yes	
	South Chicago	By-Products Coke Corporation.	280	Semet-Solvay	1905–1915	Furnace, foundry, and domestic.	Illumination and boiler fuel.	Yes	
	Waukegan	North Shore Gas Co.	13	do	1912	Domestic	Illumination and domestic fuel.	No	
Indiana	Gary	Illinois Steel Co.	560	Koppers	1911–1912	Blast furnace	Industrial fuel	Yes	Constructing 140 additional.
	Indiana Harbor	Inland Steel Co.	130	do	1913–1917	Furnace and domestic.	Boiler fuel	Yes	
	Indianapolis	Citizens Gas Co.	100	United-Otto	1909–1913	Furnace and foundry	Illumination, domestic, and industrial fuel.	Yes	Leased to Citizens Gas Co.
	do	Indianapolis Gas Co.	41	Semet-Solvay	1914				
	Linton	Linton Gas Co.	3	Gas machinery	1917	Domestic	do	No	Built 1915, but not operated until 1917.
	Muncie	Central Indiana Gas Co.	22	Klönne	1912	do	do		Built 1912, but not operated since 1913.
	Terre Haute	Indiana Coke & Gas Co.	30	Gas machinery	1916	Furnace, foundry, and domestic.	Illumination, domestic, and industrial fuel.	Yes	Gas sold to Citizens Gas & Fuel Co. and distributed by it.
Kentucky	Ashland	Kentucky Solvay Coke Co.	108	Semet-Solvay	1913–1916	do	Boiler fuel	Yes	
Maryland	Sparrows Point	Bethlehem Steel Co.	120	Koppers	1914	Blast furnace	Illumination and fuel.	Yes	Originally 200 United-Otto ovens; torn down 1913 and Koppers ovens substituted. Erecting 240 Koppers additional.
Massachusetts	Everett	New England Fuel & Transportation Co.	400	United-Otto	1899	Foundry and domestic.	Illumination	Yes	

Michigan	Detroit	Solvay Process Co.	215	Semet-Solvay	1901-1917	Furnace, foundry, and domestic.	Illumination and boiler fuel.	Yes	
	Wyandotte	Michigan Alkali Co.	54	Otto-Hoffmann	1902-1916	do	Domestic fuel	Yes	
Minnesota	Duluth	Minnesota Steel Co.	90	Koppers	1915-1916	Furnace and domestic.	Industrial fuel	No	
	West Duluth	Zenith Furnace Co.	65	United-Otto	1904-1916	Furnace, foundry, and domestic.	do	Yes	
Missouri	St. Louis	Laclede Gas Light Co.	56	Koppers	1915	do	Illumination, domestic, and industrial fuel.	Yes	
New Jersey	Camden	Camden Coke Co.	150	Otto-Hoffmann	1903-1906	Furnace and fuel	Illumination and fuel.	Yes	First to install enrichment by benzol transfer.
	Kearny	Seaboard By-Product Coke Co.	110	Koppers	1917	Furnace, foundry, and domestic.	Illumination, domestic, and industrial fuel.	Yes	Began Aug. 1, 1917. Constructing 55 Koppers additional.
New York	Buffalo	Wickwire Steel Co.	60	Semet-Solvay	1917	Blast furnace	Boiler fuel	Yes	Began May 7, 1917.
	Geneva	Empire Coke Co.	46	do	1904-1909	Foundry and domestic.	Gas-engine fuel	Yes	Operations reverted to owner Dec. 1, 1917.
	Lackawanna	Lackawanna Steel Co.	188	Otto-Hoffmann	1904	Furnace	Industrial fuel	Yes	
	do	do	281	Rothberg					
	Solvay	Solvay Process Co.	40	Semet-Solvay	1893-1903	Foundry and domestic.	Boiler fuel	Yes	First by-product plant in United States. Main purpose originally to obtain ammonia for alkali works.
Ohio	Canton	United Furnace Co.	47	Koppers	1916	Furnace and domestic.	Boiler fuel	Yes	Began Oct. 2, 1916.
	Cleveland	Cleveland Furnace Co.	100	Semet-Solvay	1910-1915	do	do	Yes	49 of these originally 80 Rothberg ovens.
	do	McKinney Steel Co.	204	Koppers	1916	Furnace	Domestic and industrial fuel.	Yes	Began Nov. 10, 1916. No benzol recovery until 1917.
	Dover	Dover By-Products Coke Co.	24	Roberts flueless	1916	do	Industrial fuel	Yes	Began Oct. 6, 1916.
	Hamilton	Hamilton-Otto Coke Co.	100	Otto-Hoffmann	1901-1909	do	Illumination, domestic and industrial fuel.	Yes	Gas purchased and distributed by Hamilton Utilities Co.
	Portsmouth	Portsmouth Solvay Coke Co.	108	Semet-Solvay	1917	Furnace and domestic.	Industrial fuel		Began Dec. 2, 1917.
	Toledo	Toledo Furnace Co.	94	Koppers	1916	Furnace, foundry, and domestic.	Illumination, domestic, and public utilities.	Yes	
	Youngstown	Brier Hill Steel Co.	84	do	1917	Furnace	Industrial fuel	Yes	Began April, 1917.
	do	Republic Iron & Steel Co.	143	do	1914-15	do	Steam and heating	Yes	
	do	Youngstown Sheet & Tube Co.	204	do	1916	do	Industrial fuel	Yes	Constructing 102 additional.

a The first and last years are given for those plants that have two or more installations.

By-product coke plants in the United States in 1917—Continued.

State.	Town.	Name of company owning plant.	Number of ovens.	Type of oven.	Year put in blast.	Uses of coke.	Uses of surplus gas.	Benzol recovery plant.	Remarks.
Pennsylvania	Chester	Philadelphia Suburban Gas & Electric Co.	40	Semet-Solvay	1904	Furnace and foundry.	Illumination, domestic, and industrial fuel.	Yes	Coke-oven gas mixed with water gas before being sold.
	Dunbar	American Manganese Manufacturing Co.	110	do	1896–1903	Furnace, foundry, and domestic.	Boiler fuel	Yes	
	Farrell	Carnegie Steel Co.	212	Otto-Hoffmann	1903	Furnace and domestic.	Industrial fuel	Yes	
	Glassport	Allegheny By-Product Coke Co.	120	do	1897	Furnace, foundry, and domestic.	Illumination and industrial fuel.	Yes	
	Johnstown	Cambria Steel Co.	92	Koppers	1915	Furnace	Fuel	Yes	Originally United-Otto ovens. 1917, additional benzol recovery plant operated by Thos. A. Edison.
	do	do	27	Gas machinery	1914				
	do	do	343	United-Otto	1895–1907				
	South Bethlehem	Bethlehem Steel Co.	150	Didier	1912–13	Furnace and foundry.	Fuel	Yes	Originally 300 ovens. 150 replaced by Koppers ovens.
	do	do	424	Koppers	1915–16				
	Lebanon	do	228	United-Otto	1903	Furnace	do	Yes	Taken over from Lackawana Iron & Steel Co., Feb. 1, 1917; Not operated since.
	do	do	90	Semet-Solvay	1904	do	do	Yes	
	Steelton	do	120	do	1907	do	Illumination and fuel.	Yes	Constructing 60 Koppers additional.
Tennessee	Altonpark	Chattanooga Coke & Gas Co.	12	Roberts flueless	1915	Furnace, foundry, and domestic.	Illumination	Yes	Constructing 24 Semet-Solvay ovens.
Washington	Seattle	Seattle Lighting Co.	5	Klönne	1914	do	Illumination, domestic and industrial fuel.	No	Gas mixed with other gases when sold; supplies Seattle and suburbs.
West Virginia	Benwood	National Tube Co.	120	Semet-Solvay	1898–1901	Furnace	Boiler fuel	Yes	
	Follansbee	La Belle Iron Works.	94	Koppers	1917	Blast furnace	Industrial fuel	Yes	Blown in March, 1917.
Wisconsin	Mayville	Northwestern Iron Co.	72	Otto-Hoffmann	1914–1917	Furnace and domestic.	Fuel	Yes	Constructing 36 additional ovens.
	Milwaukee	Milwaukee Coke & Gas Co.	160	Semet-Solvay	1904–1906	Furnace, foundry, and domestic.	Illumination	Yes	Gas sold to Milwaukee Gas Light Co.

By-product ovens under construction in the United States on January 1, 1917 and 1918.

1917.

State.	Town.	Name of company owning plant.	Number of ovens.	Type of oven.	Benzol-recovery plant.	Remarks.
Alabama	Alabama City	Gulf States Steel Co	37	Koppers	Yes	
	Woodward	Woodward Iron Co	60	Wilputte		Enlarging plant; 163 Koppers ovens already in operation.
Colorado	Minnequa	Colorado Fuel & Iron Co	120	Koppers	Yes	
Indiana	Indiana Harbor	Inland Steel Co	44	do	Yes	Enlarging plant; 86 Koppers ovens already in operation.
Maryland	Sparrows Point	Bethlehem Steel Co	240	do	Yes	Enlarging plant; 120 Koppers ovens already in operation.
Michigan	Detroit	Solvay Process Co	40	Semet-Solvay	Yes	Enlarging plant; 175 Semet-Solvay ovens already in operation.
Minnesota	St. Paul	Minnesota By-Product Coke Co	65	Koppers	Yes	
New Jersey	Kearney	Seaboard By-Product Coke Co	110	do	Yes	
New York	Lackawanna	Niagara Coke Corporation	100	Otto Regenerative	Yes	Began construction 1914. Project suspended.
	Harriet	Wickwire Steel Co	60	Semet-Solvay	Yes	
Ohio	Cleveland	American Steel & Wire Co	180	Koppers	Yes	
	Youngstown	Brier Hill Steel Co	84	do	Yes	
	Lorain	National Tube Co	208	do	Yes	
Pennsylvania	Clairton	Carnegie Steel Co	640	do	Yes	
	Steelton	Bethlehem Steel Co	60	do	Yes	Enlarging plant; 120 Semet-Solvay ovens already in operation.
Wisconsin	Mayville	Northwestern Iron Co	36	United-Otto	Yes	Doubling capacity of plant.

1918.

State.	Town.	Name of company owning plant.	Number of ovens.	Type of oven.	Benzol-recovery plant.	Remarks.
Colorado	Minnequa	Colorado Fuel & Iron Co	120	Koppers	Yes	
Indiana	Gary	Illinois Steel Co	140	do	Yes	Enlarging plant; 560 already in operation.
	Indiana Harbor	By-Products Coke Corporation	120	Semet-Solvay		
Maryland	Sparrows Point	Bethlehem Steel Co	240	Koppers	Yes	Enlarging plant; 120 already in operation.
Minnesota	St. Paul	Minnesota By-Product Coke Co	65	do	Yes	
New Jersey	Kearney	Seaboard By-Product Coke Co	55	do	Yes	Enlarging plant; 110 already in operation.
Ohio	Cleveland	American Steel & Wire Co	180	do	Yes	
	Youngstown	Carnegie Steel Co	210	do	Yes	Construction since suspended.
	Lorain	National Tube Co	208	do	Yes	
	Ironton	Ironton Solvay Coke Co	60	Semet-Solvay	Yes	
	Youngstown	Youngstown Sheet & Tube Co	102	Koppers	Yes	Enlarging plant; 204 already in operation.
Pennsylvania	Steelton	Bethlehem Steel Co	60	do	Yes	Enlarging plant; 120 Semet-Solvay already in operation.
	Clairton	Carnegie Steel Co	640	do	Yes	
Tennessee	Altonpark	Chattanooga Coke & Gas Co. (Inc.)	24	Semet Solvay	Yes	Enlarging plant; 12 Roberts flueless already in operation.
Wisconsin	Mayville	Northwestern Iron Co	36	United-Otto	Yes	Enlarging plant; 72 already in operation.

The great majority of by-product coke plants are roughly divisible into three main classes—those which produce fuel for blast furnaces or foundries; those which operate as producers of artificial gas for municipal use and sell much or all of their coke for domestic use; and a miscellaneous group of plants of which a few are operated primarily as a source of ammonia. The following tables show for each of these classes the number of available ovens and the number of active ovens, by months, as reported by the operators. It should be understood, however, that there is not the direct relation between the percentage of ovens active and the percentage of productive capacity realized implied by this tabulation.

By-product coke ovens available and active, by classes of producers, 1917.

Month.	Furnace coke.			Gas and domestic coke.			Miscellaneous.		
	Total ovens available.	Ovens active.	Percentage active.	Total ovens available.	Ovens active.	Percentage active.	Total ovens available.	Ovens active.	Percentage active.
January	5,603	4,866	86.8	1,131	1,112	98.3	549	545	99.3
February	5,603	4,949	88.3	1,131	1,100	97.3	549	546	99.5
March	5,697	4,985	87.5	1,131	1,095	96.8	549	540	99.2
April	5,821	5,149	88.5	1,131	1,107	97.9	549	537	97.8
May	5,891	5,225	88.7	1,131	1,110	98.1	549	534	97.3
June	5,891	5,238	88.9	1,131	1,110	97.3	549	534	97.3
July	5,891	5,238	88.9	1,131	1,106	97.8	549	534	97.3
August	5,891	5,232	88.8	1,131	1,101	97.3	681	666	97.8
September	5,891	5,197	88.2	1,131	1,108	98.0	729	710	97.4
October	5,891	5,131	87.1	1,131	1,095	96.8	729	714	97.9
November	5,948	5,163	86.8	1,131	1,093	96.6	729	688	94.4
December	5,948	5,159	86.7	1,131	1,090	96.4	729	698	95.7

VALUE OF COKE PRODUCED.

A considerable proportion of the coke produced in the United States is made in ovens or retorts operated by large corporations that not only mine the coal and make the coke but also operate blast furnaces and steel mills which consume the entire product of the ovens. Under such conditions the fixing of a value upon the coke and upon the coal consumed in its making is purely arbitrary. By some corporations the coke is charged to the furnace department at cost; by others a percentage of profit is added or the reported value is based on what the coke would cost if purchased. As the beehive ovens are replaced by the retorts the proportion of the coke upon which the arbitrary values are fixed will increase, because most of the retort ovens are constructed by or for furnace operators and the product of these ovens does not go to the general markets. It must not be considered, therefore, that the values as stated in this report represent the actual selling value of all the coke, but they are sufficiently exact for statistical comparison. As explained in previous reports, the higher value of retort coke is due not to the superior quality of that product but to the fact that the retort ovens are installed at or near the centers of consumption, where markets for the gas and other by-products as well as for the coke are available, but at considerable distances from the coal mines. Hence the expenses of transportation are borne by the coal and are added to the value of the coal as charged into the ovens, and an equivalent value is necessarily added to the coke. The beehive and similar types of ovens are, on the other hand, in the immediate vicinity of the mines, and the expenses of transportation are borne by the coke; the beehive coke thus costs the ultimate consumer as much as the apparently higher-valued retort coke.

The average value per ton for by-product coke in 1916 was $3.95, compared with $3.45 in 1915; for beehive coke it was $2.69, as against $2.07 in 1915. In 1917, owing to the demand for iron and steel products, prices of coke increased very greatly, reaching maximum quotations for spot coke of $16 a ton for furnace coke and $14[1] a ton for coke of foundry grade, prior to the interruption of the law of supply and demand by the fixing of maximum prices by the President on September 24, 1917. The original price of $6 a net ton of coke set by the President was modified by the Fuel Administrator, who, on November 10, set a maximum price of $6 a ton for furnace coke, $7 a ton for foundry coke, and $7.30 a ton for crushed coke. Additional orders issued immediately thereafter granted higher prices to certain high-cost plants and established a scale for interpreting the Connellsville base price for remote by-product plants, notably the plant at Everett, Mass.

In the following tables the average values of beehive and by-product coke for the years 1908 to 1917 are not the averages of the prices themselves, but are obtained by dividing the total value of the coke produced in each State and in the United States by the total quantity. The figures therefore represent closely the average prices obtained by the producers. As has already been explained, the values of the product reported to the Survey do not always represent actual cash or its equivalent received by the producers, as some of the largest operations are carried on in connection with blast furnaces or other manufacturing enterprises, and the placing of a value upon their coke by such producers is arbitrary. As the same methods of valuation at any one point are employed each year, however, they would not affect materially the changes due to market conditions, and the statement of value per ton may be accepted as indicating closely the relations of supply and demand.

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[1] See report on prices of coal and coke, Mineral Resources for 1918.

Value, at the ovens, of the coke made in the United States, 1913–1917.

State.	1913	1914	1915	1916	1917	Increase or decrease in 1917.			
						Quantity.	Percentage.		
							Total.	Beehive.	By-product.
Alabama	$9,627,170	$8,408,443	$8,545,555	$15,019,139	$28,394,272	+13,375,133	+ 88.8	+108.3	+ 76.9
Colorado	2,815,134	2,203,031	2,242,453	3,736,467	5,479,734	+ 1,743,267	+ 46.7	+ 46.7	
Georgia	186,304	100,529	81,170	232,630	322,175	+ 89,545	+ 38.5	+ 38.5	
Illinois	8,593,581	5,858,700	7,016,635	10,619,066	14,455,539	+ 3,836,473	+ 36.1		+ 36.1
Indiana	13,182,136	9,055,937	11,604,588	16,096,479	21,831,302	+ 5,734,823	+ 35.6		+ 35.6
Kentucky	753,897	971,060	1,129,769	2,225,186	4,119,263	+ 1,894,077	+ 85.1	+ 92.4	+ 79.9
Maryland	(a)	299,739	762,664	1,387,009	3,925,418	+ 2,538,409	+183.0		+ 183.0
Massachusetts	(a)	(a)	(a)	(a)	(a)	(a)	+ 77.9		+ 77.9
Michigan	(a)	(a)	(a)	(a)	(a)	(a)	+ 77.2		+ 77.2
Minnesota	(a)	(a)	475,952	1,968,675	3,468,355	+ 1,499,680	+ 76.2		+ 76.2
Missouri			(a)	(a)	(a)	(a)	+ 63.9		+ 63.9
New Jersey	695,041	(a)	(a)	(a)	(a)	(a)	+312.8		+ 312.8
New Mexico	1,548,536	1,228,045	1,265,268	1,718,976	2,805,277	+ 1,086,301	+ 63.2	+ 63.2	
New York	3,301,400	1,726,133	2,459,463	3,033,276	6,889,424	+ 3,856,148	+127.1		+ 127.1
Ohio	1,231,554	1,678,686	2,136,933	6,894,619	23,473,764	+16,579,145	+240.5	+176.1	+ 244.5
Pennsylvania	67,929,864	42,447,886	52,667,018	84,710,305	135,698,040	+50,987,735	+ 60.2	+ 57.8	+ 72.1
Tennessee	925,430	642,573	674,014	1,062,065	2,031,272	+ 969,207	+100.0	+102.4	+ 27.1
Utah	(a)	(a)	(a)	(b)	(b)	(b)	(b)	(b)	
Virginia	2,840,275	1,582,419	1,242,938	3,024,913	5,785,934	+ 2,761,021	+ 91.3	+ 91.3	
Washington	432,770	472,531	700,832	c2,432,615	c2,798,932	+ c366,317	+c15.1	+c13.8	+ 34.3
West Virginia	5,504,416	2,847,284	2,760,805	6,567,505	16,715,083	+10,147,578	+154.5	+145.4	+ 233.8
Wisconsin	(a)	(a)	(a)	(a)	(a)	(a)	+ 98.5		+ 98.8
Combined States	9,354,765	8,811,221	9,737,811	10,112,272	20,049,233	+ 9,936,961			
	128,922,273	88,334,217	105,503,868	170,841,197	298,243,017	+127,401,820	+ 74.6	+ 67.2	+ 83.5

a Included in "Combined States." b Included with Washington. c Includes Utah.

Average value per net ton, at the ovens, of the coke made in the United States, 1913–1917.

State.	1913	1914	1915	1916	1917
Alabama	$2.90	$2.73	$2.78	$3.49	$5.80
Colorado	3.20	3.30	3.34	3.55	4.93
Georgia	4.35	4.10	4.05	4.94	8.14
Illinois	4.62	4.11	4.16	4.58	6.31
Indiana	4.83	3.98	4.19	4.61	6.17
Kentucky	2.38	2.19	2.15	2.77	4.77
Maryland	(a)	(a)	2.43	2.83	7.57
Minnesota	(a)	(a)	3.72	4.56	7.07
New Jersey	2.72	2.67	(a)	(a)	(a)
New Mexico	3.31	3.39	3.25	3.42	4.86
New York	4.35	3.77	3.72	3.91	6.94
Ohio	3.50	3.21	3.12	3.82	6.35
Pennsylvania	2.36	2.10	2.06	2.71	4.86
Tennessee	2.50	2.43	2.62	2.78	4.94
Virginia	2.18	2.02	1.97	2.43	4.44
Washington	5.68	5.56	5.13	5.27	7.38
West Virginia	2.23	1.99	1.98	2.61	4.99
Other States	3.99	3.79	3.75	4.05	6.43
Average	2.78	2.56	2.54	3.13	5.36

a Included with other States having less than 3 producers.

Average values of beehive and by-product coke, 1908–1917, per net ton.

Year.	Beehive.	By-product.	Mean average.	Year.	Beehive.	By-product.	Mean average.
1908	$2.20	$3.44	$2.40	1913	$2.39	$3.82	$2.78
1909	2.10	3.27	2.29	1914	2.15	3.39	2.56
1910	2.17	3.47	2.39	1915	2.07	3.45	2.54
1911	2.05	3.48	2.37	1916	2.69	3.95	3.13
1912	2.10	3.84	2.54	1917	4.81	6.18	5.36

PRICES IN THE CONNELLSVILLE REGION.

The most active coke market in the United States is the Connellsville district of Pennsylvania, and as the prices for the coke from that district govern largely those in other places, the following table is given showing Connellsville prices, by months, during the years 1915, 1916, and 1917. These prices are the quotations for Connellsville coke at the ovens given in the current issues of the Iron Age. The spot prices are those quoted for immediate delivery and the contract prices, as the term implies, are those established to cover the requirements of the buyer for a period, usually for six months. The relation of supply to demand governs to a large extent, of course, the range of prices for both spot and contract coke. When demand is strong and a shortage of supplies is felt, as in the early months of 1913, the prices for spot coke were above contract prices. Normally the greater part of the coke of this region changes hands on the contract basis.

In 1916 prices per ton for both furnace and foundry coke were more than three times the top quotations for 1915 and were more than twice the previous maximum of 1913. This upward swing of prices continued in 1917, spot furnace coke reaching a maximum quotation of $16 in July and spot foundry coke a maximum quotation of $14 in March and again in July and August. On September 22 a presidential order was issued, effective September 24, establishing $6 a net ton as a maximum price for both grades of coke, and a subsequent order of the Fuel Administrator, effective November 10, 1917, set maximum prices of $6 a net ton f. o. b. for furnace coke and $7 a ton for foundry coke.

The Connellsville Courier is authority for the statement that prices realized from sales of spot coke in August, 1917, averaged for the region $13.42 a ton for furnace coke and $14.25 for foundry coke—a record for the region; and, according to the reports received by the Geological Survey, the average prices realized for the Connellsville and lower Connellsville districts were, respectively, $3.95 and $4.85 a ton in 1917, compared with $2.42 and $2.60 a ton in 1916, increases of 63 and 87 per cent.

Prices of Connellsville furnace and foundry coke per net ton at the ovens, 1915, 1916, and 1917.

Furnace.

Month.	1915		1916		1917	
	Spot.	Contract.	Spot.	Contract.	Spot.	Contract.
January	$1.50-$1.60	$1.65-$1.75	$2.75-$3.50	$2.50-$2.75	$8.50-$9.50	$6.00-$7.00
February	1.50- 1.60	1.65- 1.75	2.75- 4.00	2.50- 4.00	8.00-11.50	6.00- 7.00
March	1.50- 1.60	1.65- 1.75	3.25- 3.75	2.75- 3.00	8.00-12.00	....
April	1.50- 1.60	1.65- 1.75	2.00- 3.00	2.40- 3.00	7.00- 8.50	8.00
May	1.50- 1.60	1.65- 1.75	2.00- 3.00	2.50- 3.50	7.00- 9.00	8.00
June	1.50- 1.60	1.65- 1.75	2.30- 2.60	2.35- 2.75	10.00-13.00	9.00- 9.50
July	1.55- 1.75	1.70- 1.85	2.50- 2.75	2.35- 2.65	11.00-16.00	....
August	1.50- 1.60	1.75- 1.85	2.50- 3.00	2.35- 2.60	10.00-15.00	....
September	1.50- 1.75	1.75- 1.85	2.85- 3.10	2.50- 3.00	6.00-13.50	6.00- 9.00
October	1.75- 2.60	2.25- 2.40	3.25- 7.50	3.00- 4.00	6.00	6.00
November	2.10- 2.50	2.25- 2.50	6.50- 8.00	3.75- 4.00	6.00	6.00
December	2.10- 3.50	2.40- 2.50	7.00-10.00	4.00- 5.00	6.00	6.00

Foundry.

Month.	1915 Spot.	1915 Contract.	1916 Spot.	1916 Contract.	1917 Spot.	1917 Contract.
January	$2.00	$2.15-$2.25	$3.50-$3.75	$3.25-$3.50	$10.00	$7.00-$8.00
February	2.00	2.15- 2.50	3.50- 3.75	3.25- 3.50	$10.00-12.00	7.00- 9.00
March	2.00	2.15- 2.50	3.75- 4.00	3.50- 3.75	10.00-14.00	7.00- 8.00
April	$2.00- 2.25	2.15- 2.30	3.00- 4.00	3.25- 3.75	8.50-10.00	9.00
May	1.90- 2.25	2.15- 2.50	2.75- 3.25	3.25- 3.50	8.50-10.00	8.50- 9.50
June	1.90- 2.25	2.15- 2.50	2.75- 3.25	3.25- 3.50	10.50-13.00	10.00-11.00
July	2.00- 2.25	2.25- 2.50	2.75- 3.25	3.00- 3.50	13.00-14.00	10.00
August	2.00- 2.25	2.25- 2.50	3.00- 3.50	3.25- 3.75	11.50-14.00	12.50
September	2.00- 2.25	2.25- 2.50	3.25- 3.50	3.50- 3.75	6.00	6.00
October	2.15- 2.75	2.40- 2.75	3.25- 6.00	3.75- 4.50	6.00	6.00
November	2.75- 3.00	2.60- 3.25	6.00- 8.00	4.00- 6.00	6.00	6.00
December	2.75- 3.50	3.00- 3.25	7.50-10.00	5.00- 7.00	7.00	7.00

COAL USED IN THE MANUFACTURE OF COKE.

GENERAL STATISTICS.

The quantity of coal consumed in making coke reported in this chapter each year is at considerable variance with the quantity reported as made into coke in the chapter on the production of coal. The reason for this discrepancy is that in the chapter on coal the figures for the quantity made into coke take into account only that coal which is coked at the mines. The coal shipped to ovens at a distance, which includes nearly all the coal charged into by-product ovens reported by the coke manufacturers, is included by the coal operators in their shipments and not in the quantity made into coke.

The total quantity of coal made into coke in 1916 was 81,609,460 net tons, and in 1917 it amounted to 83,752,371 tons, whereas coal-mine operators reported 52,709,900 net tons made into coke at the mines in 1916, compared with 50,215,107 tons in 1917. Of these totals 31,505,759 net tons of coal was charged into by-product ovens in 1917, compared with 26,524,502 tons in 1916, and 19,554,382 tons in 1915.

Coal used in the manufacture of coke in the United States in 1915, 1916, and 1917.

1915.

State.	Coal used (net tons).	Total value of coal.	Value of coal per ton.	Quantity of coal per ton of coke (net tons).	Value of coal to a ton of coke.
Alabama	4,695,938	$6,955,215	$1.48	1.529	$2.263
Colorado	1,026,019	1,850,551	1.80	1.678	3.020
Georgia	35,377	64,869	1.83	1.765	3.230
Illinois	2,335,933	6,697,209	2.87	1.385	3.975
Indiana	3,685,774	10,830,362	2.94	1.332	3.916
Kentucky	799,847	1,000,721	1.25	1.520	1.900
Maryland	470,326	1,185,926	2.52	1.501	3.783
Massachusetts	666,930	(a)	(a)	1.322	(a)
Minnesota	180,767	490,864	2.72	1.414	3.846
New Mexico	732,830	804,550	1.10	1.882	2.070
New York	975,656	2,435,257	2.50	1.071	2.678
Ohio	985,471	1,853,574	1.88	1.439	2.705
Pennsylvania	38,273,744	43,779,862	1.14	1.494	1.703
Tennessee	465,865	498,256	1.07	1.813	1.940
Virginia	995,396	762,233	.77	1.580	1.217
Washington	204,879	604,867	2.95	1.500	4.425
West Virginia	2,273,763	1,864,315	.82	1.633	1.339
Other States [b]	3,028,383	[b] 8,355,493	[c] 2.26	1.445	[c] 3,211
	61,832,898	90,034,124	1.46	1.487	2.171

[a] Included in other States.
[b] Includes Michigan, Missouri, New Jersey, Utah, and Wisconsin.
[c] Includes also Massachusetts.

1916.

State.	Coal used (net tons).	Total value of coal.	Value of coal per ton.	Quantity of coal per ton of coke (net tons).	Value of coal to a ton of coke.
Alabama	6,794,100	$11,000,238	$1.62	1.581	$2.561
Colorado	1,674,096	2,920,511	1.74	1.589	2.765
Georgia	87,178	157,840	1.81	1.850	3.349
Illinois	3,182,650	9,319,729	2.93	1.372	4.020
Indiana	4,626,204	14,086,992	3.05	1.326	4.044
Kentucky	1,205,109	1,536,175	1.27	1.502	1.908
Maryland	749,936	2,287,724	3.05	1.531	4.670
Minnesota	573,371	1,686,454	2.94	1.329	3.907
New Mexico	843,814	918,699	1.09	1.678	1.829
New York	1,098,249	3,002,135	2.73	1.417	3.868
Ohio	2,604,772	6,629,956	2.55	1.444	3.682
Pennsylvania	46,950,086	66,799,644	1.42	1.501	2.131
Tennessee	673,869	770,392	1.14	1.763	2.010
Utah and Washington	941,360	1,689,805	1.80	1.761	3.170
Virginia	1,977,616	1,718,394	.87	1.592	1.385
West Virginia	4,072,415	3,891,961	.96	1.615	1.550
Other States [a]	3,554,635	9,651,045	2.72	1.389	3.778
	81,609,460	138,067,694	1.69	1.496	2.528

[a] Includes Massachusetts, Michigan, Missouri, New Jersey, and Wisconsin.

Coal used in the manufacture of coke in the United States in 1915, 1916, and 1917—Contd.

1917.

State.	Coal used (net tons).	Total value of coal.	Value of coal per ton.	Quantity of coal per ton of coke (net tons).	Value of coal to a ton of coke.
Alabama	7,638,841	$18,776,218	$2.46	1.561	$3.840
Colorado	1,784,631	4,232,780	2.37	1.604	3,801
Georgia	72,689	180,358	2.48	1.836	4.553
Illinois	3,233,669	12,310,776	3.81	1.412	5.380
Indiana	4,817,942	18,626,179	3.87	1.361	5.267
Kentucky	1,341,788	3,005,665	2.24	1.555	3.483
Maryland	733,184	3,707,132	5.06	1.413	7.150
Minnesota	676,881	2,710,955	4.01	1.381	5.538
New Mexico	936,411	1,373,262	1.47	1.621	2.383
New York	1,401,458	6,061,526	4.33	1.411	6.110
Ohio	5,365,998	23,457,589	4.37	1.453	6.350
Pennsylvania	42,310,784	93,275,893	2.20	1.516	3.335
Tennessee	759,634	1,286,095	1.69	1.847	3.121
Utah and Washington	876,067	1,941,199	2.22	1.761	3.909
Virginia	2,093,943	3,484,193	1.66	1.606	2.666
West Virginia	5,482,094	9,785,358	1.78	1.687	3.003
Other States [a]	4,226,357	17,093,680	4.04	1.355	5.474
	83,752,371	221,308,858	2.64	1.509	3.984

[a] Includes Massachusetts, Michigan, Missouri, New Jersey, and Wisconsin.

Approximately 83,750,000 net tons of coal was used in the manufacture of coke in 1917, compared with 81,600,000 tons in 1916 and 61,800,000 tons in 1915. About one-fifth of the coal is washed before being charged into the coke ovens, and the refuse from the washeries is excluded from these statistics. The total value of the coal charged in 1917 was $221,308,858, compared with $138,067,694 in 1916 and $90,034,124 in 1915, with corresponding average values per ton of $2.64 in 1917, $1.69 in 1916, and $1.46 in 1915. There was a slight decrease in the yield of coke from coal, an average of 1.509 tons of coal being required per ton of coke in 1917, compared with 1.496 tons in 1916 and 1.487 tons in 1915. The difference between the total value (equivalent to cost) of the coal used and the coke produced in 1915 was $15,470,000, compared with $32,780,000 in 1916 and $76,900,000 in 1917, with average differences per ton of coke of 37 cents in 1915, 60 cents in 1916, and $1.38 in 1917.

Practically all the coal charged into beehive ovens comes from mines immediately adjacent to the ovens or at no great distance, and the coal used in the manufacture of beehive coke may be considered to have its source in the same State as the beehive coke. Most of the by-product plants are in the iron-producing centers and are at a considerable distance from the coal fields; in fact, by-product coke was made in 5 States in 1917 in which there are no coal deposits and in 5 others in which no high-grade coking coal is found. It is the usual practice to use a mixture of coals in by-product ovens, and a favorite combination seems to be high-volatile or "gas" coal from eastern Kentucky, the Kanawha or Fairmont district of West Virginia, or southwestern Pennsylvania, with low-volatile or "smokeless" coal from the Pocahontas and New River fields of West Virginia or from central Pennsylvania. It thus happens that a large part of the coal used comes from the mines in West Virginia (in 1916 nearly 30 per cent was from that State), and in 1917 West Virginia coal was used at places as far distant as Illinois, Indiana, Wisconsin, and Minnesota.

QUANTITY AND SOURCE OF COAL USED IN THE MANUFACTURE OF BY-PRODUCT COKE.

Coal used in the manufacture of by-product coke in the United States, 1907–1917, in net tons.

State.	1907	1908	1909	1910	1911	1912
Alabama	671,334	685,354	770,319	769,212	928,255	1,873,581
Illinois	506,388	500,400	1,681,493	1,971,386	2,087,870	2,317,307
Indiana	...	...	...	107,402	1,137,257	3,198,874
Kentucky	...	...	...	...	...	...
Maryland	456,208	375,515	464,788	511,622	518,738	462,998
Massachusetts	624,816	594,095	572,142	581,955	616,614	677,793
Michigan	(a)	(a)	(a)	(a)	(a)	(a)
Minnesota	(a)	(a)	(a)	(a)	(a)	(a)
Missouri	...	...	...	...	...	...
New Jersey	(a)	(a)	(a)	(a)	(a)	(a)
New York	819,423	664,121	727,569	910,293	955,067	1,095,198
Ohio	195,877	102,832	123,471	227,327	285,836	337,987
Pennsylvania	2,681,179	1,483,762	2,422,239	2,696,645	1,969,950	2,676,751
Tennessee	...	...	...	...	...	...
Washington	...	...	...	...	...	...
West Virginia	205,371	...	125,656	114,779	221,609	252,849
Wisconsin	509,042	519,617	593,931	672,707	770,839	831,984
Combined States	836,536	773,362	908,521	965,714	954,549	1,042,221
	7,506,174	5,699,058	8,390,129	9,529,042	10,446,584	14,767,543

State.	1913	1914	1915	1916	1917
Alabama	2,832,282	2,909,348	2,987,710	3,635,683	3,980,243
Illinois	2,481,198	1,932,132	2,335,933	3,182,650	3,233,669
Indiana	3,535,136	3,125,207	3,685,774	4,626,204	4,817,942
Kentucky	98,846	280,456	337,679	614,922	742,162
Maryland	372,005	129,891	470,326	749,936	733,184
Massachusetts	696,679	707,718	666,930	728,256	738,873
Michigan	(a)	(a)	(a)	(a)	(a)
Minnesota	(a)	(a)	180,767	573,371	676,881
Missouri	...	...	(a)	(a)	(a)
New Jersey	(a)	(a)	(a)	(a)	621,699
New York	1,067,207	659,418	975,656	1,098,249	1,401,458
Ohio	327,694	643,169	956,656	2,447,812	5,141,046
Pennsylvania	3,492,227	2,964,559	4,301,726	5,650,352	5,716,221
Tennessee	...	...	32,084	68,451	63,793
Washington	...	(a)	(a)	45,756	45,025
West Virginia	192,270	64,314	202,762	276,481	727,778
Wisconsin	847,469	(a)	(a)	(a)	(a)
Combined States	1,152,356	2,083,809	2,420,379	2,826,379	2,865,785
	17,095,369	15,500,021	19,554,382	26,524,502	31,505,759

a Included in "Combined States."

Source of coal used in the manufacture of by-product coke in 1915.

State in which coke was made.	Coal used (net tons).	States from which coal was obtained.
Alabama	2,987,710	Alabama.
Illinois	2,335,933	West Virginia mainly; remainder from Illinois, Kentucky, and Pennsylvania.
Indiana	3,685,774	Do.
Kentucky	337,679	West Virginia and Kentucky.
Maryland	470,326	West Virginia, Pennsylvania, and Maryland.
Massachusetts	666,930	Canada, Virginia, and West Virginia.
Michigan	(a)	West Virginia, Pennsylvania, and Kentucky.
Minnesota	180,767	Pennsylvania mainly; remainder from West Virginia.
Missouri	(a)	Kentucky and West Virginia.
New Jersey	(a)	West Virginia.
New York	975,656	Pennsylvania mainly; remainder from West Virginia.
Ohio	956,656	West Virginia, Pennsylvania, and Kentucky.
Pennsylvania	4,301,726	Nearly all from Pennsylvania; small part from West Virginia.
Tennessee	32,084	Tennessee.
Washington	(a)	Washington.
West Virginia	202,762	Pennsylvania, 90 per cent; West Virginia, 10 per cent.
Wisconsin	(a)	West Virginia.
Other States	2,420,379	
	19,554,382	

a Included in "Other States."

Source of coal used in the manufacture of by-product coke in 1916.

State in which coke was made.	Alabama.	Illinois.	Indiana.	Kentucky.	Ohio.	Pennsylvania.	Tennessee.	Washington.	West Virginia.	Foreign.	Total.
Alabama	3,635,683										3,635,683
Illinois		9,304		638,133		42,000			2,493,213		3,182,650
Indiana			36,000	1,318,103		300,918			2,971,183		4,626,204
Kentucky									614,922		614,922
Maryland						187,484			562,452		749,936
Massachusetts									488,256	240,000	728,256
Minnesota						271,744			301,627		573,371
New York						1,000,065			98,184		1,098,249
Ohio				448,972	22,147	1,283,013			693,680		2,447,812
Pennsylvania						5,286,484			363,868		5,650,352
Tennessee							68,451				68,451
Washington								45,756			45,756
West Virginia									276,481		276,481
Michigan, Missouri, New Jersey, Wisconsin				336,087		93,502			2,396,790		2,826,379
	3,635,683	9,304	36,000	2,741,295	22,147	8,465,210	68,451	45,756	11,260,656	240,000	26,524,502

Source of coal used in the manufacture of by-product coke in 1917.

State in which coke was made.	Alabama.	Illinois.	Indiana.	Kentucky.	Ohio.	Pennsylvania.	Tennessee.	Virginia.	Washington.	West Virginia.	Foreign.	Total.
Alabama	3,980,243											3,980,243
Illinois		330,604		634,096		34,579		8,171		2,226,219		3,233,669
Indiana		104,559	448,631	1,131,277		397,229		83,328		2,652,918		4,817,942
Kentucky				284,990						457,172		742,162
Maryland						183,296				549,888		733,184
Massachusetts				13,148				116,322		454,793	154,610	738,873
Minnesota						232,711				444,170		676,881
New Jersey						278,585				343,114		621,699
New York						1,283,264				118,194		1,401,458
Ohio				1,700,372	61,136	2,106,629				1,272,909		5,141,046
Pennsylvania						5,563,609				152,612		5,716,221
Tennessee							63,793					63,793
Washington									45,025			45,025
West Virginia						552,695				175,083		727,778
Michigan												
Missouri		10,351		482,371		386,556	16,960			1,969,547		2,865,785
Wisconsin												
	3,980,243	445,514	448,631	4,246,254	61,136	11,019,153	80,753	207,821	45,025	10,816,619	154,610	31,505,759

CHARACTER OF COAL USED IN THE MANUFACTURE OF COKE.

Of the coal used in the manufacture of coke in 1917, 18.5 per cent was washed, compared with 19.5 per cent in 1916 and 21.4 per cent in 1915. Coke for iron furnaces must be as free from ash and sulphur as possible. Dirty coals are therefore cleaned by washing before being charged into coke ovens, and in 1917 coal so treated amounted to more than 15,500,000 tons, compared with about 16,000,000 tons in 1916 and 13,000,000 tons in 1915. Of the quantities washed run-of-mine formed about 55 per cent in 1917, 42 per cent in 1916, and 47 per cent in 1915, slack coal making up the remainder. All the coal used for making coke in Georgia, New Mexico, Washington and more than 85 per cent of that in Alabama, Colorado, and Tennessee was washed. In some of the coal fields the slack is screened out and used in making beehive coke and the lump coal is shipped to market. The by-product ovens generally use run-of-mine coal of the best quality, and practically all the coal made into coke in ovens of that type, outside of Alabama, was unwashed coal of that character.

Coal used in the manufacture of coke in 1915, 1916, and 1917, by kinds, in net tons.

1915.

State.	Run of mine.		Slack.		Total.			
	Unwashed.	Washed.	Unwashed.	Washed.	Unwashed.	Percentage.	Washed.	Percentage.
Alabama	158,480	1,522,149	47,061	2,968,248	205,541	4.4	4,490,397	95.6
Colorado	11,519	978,913	3,330	32,257	14,849	1.4	1,011,170	98.6
Georgia				35,377			35,377	100.0
Illinois	2,295,933	40,000			2,295,933	98.3	40,000	1.7
Indiana	3,335,843		349,931		3,685,774	100.0		
Kentucky	738,963		10,871	50,013	749.834	93.7	50,013	6.3
Maryland	470,326				470,326	100.0		
Massachusetts	666,930				666,930	100.0		
Minnesota	45,767		135,000		180,767	100.0		
New Mexico				732,830			732,830	100.0
New York	750,628		2,340	222,688	752,968	77.2	222,688	22.8
Ohio	984,028		1,443		985,471	100.0		
Pennsylvania	32,219,894	3,337,005	442,791	2,274,054	32,662,685	85.3	5,611,059	14.7
Tennessee		156,738		309,127			465,865	100.0
Virginia	198,290		698,998	98,108	897,288	90.1	98,108	9.9
Washington		158,496		46,383			204,879	100.0
West Virginia	478,048	65,120	1,500,389	230,206	1,978,437	87.0	295,326	13.0
Other States[a]	2,279,806		748,577		3,028,383	100.0		
	44,634,455	6,258,421	3,940,731	6,999,291	48,575,186	78.6	13,257,712	21.4

[a] Includes Michigan, Missouri, New Jersey, Utah, and Wisconsin.

Coal used in the manufacture of coke in 1915, 1916, and 1917, by kinds, in net tons—Contd.

1916.

State.	Run of mine.		Slack.		Total.			
	Unwashed.	Washed.	Unwashed.	Washed.	Unwashed.	Percentage.	Washed.	Percentage.
Alabama	238,849	2,352,907		4,202,344	238,849	3.5	6,555,251	96.5
Colorado	44,658	1,532,284		97,154	44,658	2.7	1,629,438	97.3
Georgia				87,178			87,178	100.0
Illinois	3,043,105	42,000	97,545		3,140,650	98.7	42,000	1.3
Indiana	4,463,332		162,872		4,626,204	100.0		
Kentucky	848,017		300,814	56,278	1,148,831	95.3	56,278	4.7
Maryland	749,936				749,936	100.0		
Massachusetts	728,256				728,256	100.0		
Minnesota	431,371		142,000		573,371	100.0		
New Mexico				843,814			843,814	100.0
New York	891,413		1,160	205,676	892,573	81.3	205,676	18.7
Ohio	2,441,699		163,073		2,604,772	100.0		
Pennsylvania	40,678,354	3,192,620	1,135,735	1,943,377	41,814,089	89.1	5,135,997	10.9
Tennessee	76,044	158,859		438,966	76,044	11.3	597,825	88.7
Virginia	629,082		1,142,284	206,250	1,771,366	89.6	206,250	10.4
Washington and Utah		158,751	736,853	45,756	736,853	78.3	204,507	21.7
West Virginia	1,519,551	93,019	2,213,808	246,037	3,733,359	91.7	339,056	8.3
Other States[a]	2,684,212		142,167		2,826,379	100.0		
	59,467,879	7,530,440	6,238,311	8,372,830	65,706,190	80.5	15,903,270	19.5

[a] Includes Michigan, Missouri, New Jersey, and Wisconsin.

1917.

State.	Run of mine: Unwashed.	Run of mine: Washed.	Slack: Unwashed.	Slack: Washed.	Total: Unwashed.	Percentage.	Total: Washed.	Percentage.
Alabama	445,695	4,228,357		2,964,789	445,695	5.8	7,193,146	94.2
Colorado	52,880	1,368,152		363,599	52,880	3.0	1,731,751	97.0
Georgia				72,689			72,689	100.0
Illinois	3,133,977	34,579	65,113		3,199,090	98.9	34,579	1.1
Indiana	4,817,942				4,817,942	100.0		
Kentucky	941,106		400,682		1,341,788	100.0		
Maryland	733,184				733,184	100.0		
Massachusetts	738,873				738,873	100.0		
Minnesota	495,508		181,373		676,881	100.0		
New Jersey	621,699				621,699	100.0		
New Mexico				936,411			936,411	100.0
New York	1,164,813		4,769	231,876	1,169,582	83.5	231,876	16.5
Ohio	4,984,931		381,067		5,365,998	100.0		
Pennsylvania	36,530,676	2,728,553	1,962,302	1,089,253	38,492,978	91.0	3,817,806	9.0
Tennessee	95,873	161,072	262	502,427	96,135	12.7	663,499	87.3
Virginia	1,003,138		797,044	293,761	1,800,182	86.0	293,761	14.0
Washington and Utah		160,550	670,492	45,025	670,492	76.5	205,575	23.5
West Virginia	3,022,995	70,094	2,121,057	267,948	5,144,052	93.8	338,042	6.2
Other States[a]	2,761,229		104,556		2,865,785	100.0		
	61,544,519	8,751,357	6,688,717	6,767,778	68,233,236	81.5	15,519,135	18.5

[a] Includes Michigan, Missouri, and Wisconsin.

DISTRIBUTION.

SHIPMENTS OF CONNELLSVILLE COKE.

The following table compiled by the Courier, of Connellsville, Pa., shows the shipments of coke, by months, from the Connellsville and Lower Connellsville districts. This authority reports shipments of 17,884,357 net tons in 1917, compared with 21,654,502 net tons in 1916, whereas the combined production of the Connellsville and Lower Connellsville districts, as reported to the Geological Survey, amounted to 18,579,636 tons in 1917.

It will be noted (fig. 42) that March, 1916, set a new record of the movement of coke from these two districts. The movement gradually declined from the high level prevailing from January to August, 1916, until a minimum was reached in February, 1917. Shipments of coke for the several months of 1917 were uniformally smaller than for the corresponding months of 1916, and the effects of bad weather, car shortage, and scarcity of labor are clearly visible in the production curve of figure 42.

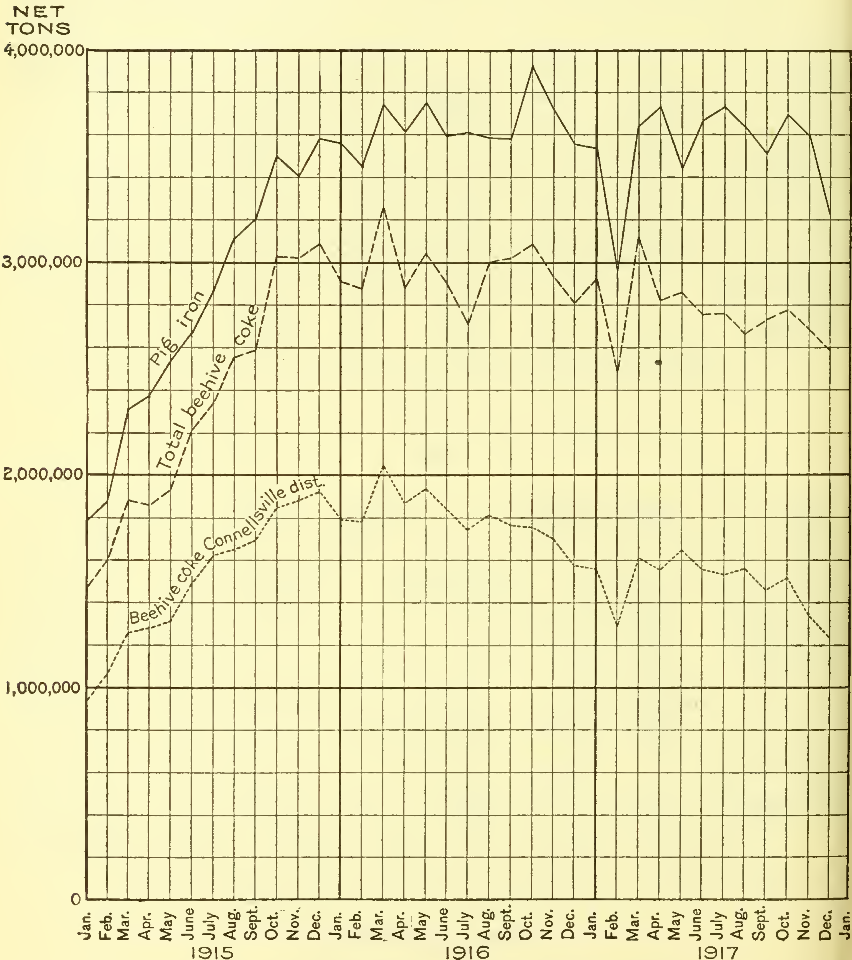

FIGURE 42.—Production of pig iron and beehive coke in the United States by months, in 1915, 1916, and 1917.

Railroad embargoes and car shortage were potent factors in limiting the output of coke during the later part of 1916 and the early part of 1917, and scarcity of labor reduced possible output during the spring and summer. It is estimated by the Connellsville Courier that car shortage was responsible for the loss of 1,200,000 net tons of beehive coke from the Connellsville district in the first quarter of 1917, and of almost an equal quantity in the second quarter, and during October, November, and December the car supply was also far short of the productive capacity of the ovens.

Coke shipped from the Connellsville and Lower Connellsville districts, 1913–1917, in net tons.

Month.	1913	1914	1915	1916	1917
January	1,868,149	1,222,282	940,781	1,793,951	1,564,173
February	1,715,917	1,270,107	1,045,739	1,781,068	1,288,763
March	1,728,709	1,594,267	1,258,559	2,038,812	1,618,969
April	1,730,183	1,423,048	1,268,292	1,861,290	1,558,247
May	1,817,805	1,198,651	1,310,639	1,937,404	1,649,989
June	1,685,635	1,129,821	1,486,845	1,842,521	1,563,616
July	1,710,435	1,189,834	1,618,199	1,748,365	1,539,931
August	1,696,368	1,157,942	1,657,203	1,806,422	1,554,935
September	1,649,368	1,112,653	1,683,414	1,771,405	1,464,200
October	1,719,045	1,028,764	1,851,938	1,768,800	1,509,903
November	1,496,000	823,595	1,873,405	1,719,715	1,350,374
December	1,280,287	924,674	1,926,202	1,584,749	1,221,257
	20,097,901	14,075,638	17,921,216	21,654,502	17,884,357

The total shipments in cars for the last 30 years, the total number of cars shipped in 1915, 1916, and 1917, and the daily car average, as reported by the Courier, are shown in the following tables:

Coke shipped from the Connellsville and Lower Connellsville districts, 1888–1917, in carloads.

Year.	Daily average.	Total.	Year.	Daily average.	Total.	Year.	Daily average.	Total.
1888	905	282,441	1898	1,415	441,249	1908	1,173	368,222
1889	1,046	326,220	1899	1,676	523,203	1909	1,920	600,979
1890	1,147	355,070	1900	1,619	504,410	1910	1,923	598,706
1891	884	274,000	1901	1,857	581,051	1911	1,570	448,672
1892	1,106	347,012	1902	1,986	624,198	1912	1,911	595,336
1893	874	270,930	1903	1,782	558,738	1913	1,872	582,071
1894	900	281,677	1904	1,623	510,759	1914	1,235	383,961
1895	1,410	441,243	1905	1,886	688,328	1915	1,557	483,958
1896	920	289,137	1906	2,385	745,274	1916	1,948	605,878
1897	1,181	367,383	1907	2,210	691,757	1917	1,629	504,481

Coke shipped from the Connellsville and Lower Connellsville districts, 1915, 1916, and 1917, by months, in carloads.

Month.	1915		1916		1917	
	Total.	Daily average.	Total.	Daily average.	Total.	Daily average.
January	25,511	981	49,564	1,907	44,033	1,519
February	28,463	1,186	49,550	1,942	35,117	1,463
March	33,934	1,257	56,614	2,097	45,846	1,698
April	34,288	1,315	51,341	2,053	45,195	1,883
May	35,078	1,349	53,787	1,992	45,331	1,679
June	40,097	1,542	51,676	1,987	44,117	1,696
July	43,448	1,671	48,733	1,949	44,316	1,772
August	44,574	1,714	50,558	1,940	42,897	1,588
September	45,479	1,749	49,665	1,911	41,612	1,664
October	50,167	1,929	50,554	1,944	42,118	1,559
November	51,244	1,971	48,730	1,874	39,701	1,527
December	51,675	1,987	45,106	1,804	34,198	1,367
	483,958	1,557	605,878	1,948	504,481	1,629

The collection of statistics covering the shipment of beehive coke by originating railroads and waterways was begun in 1917. Approximately 2,750,000 tons of beehive coke was consumed at points of origin during the year, and consequently shipment totals were proportionately below those of production, save for West Virginia, which showed small shipments from stock.

BEEHIVE COKE SHIPPED BY ORIGINATING RAILROADS AND WATERWAYS.

Beehive coke shipped by originating railroads and waterways in the United States in 1917, by States.

State.	Railroad.	Shipments (net tons).	Production (net tons).	Percentage of production shipped.
Alabama	Louisville & Nashville	615,906		
	Southern	496,026		
	Birmingham Southern, Alabama Great Southern, and St. Louis-San Francisco.	291,233		
		1,403,165	2,151,828	65.2
Colorado	Colorado & Southern	378,829		
	Denver & Rio Grande	135,281		
	Colorado & Southeastern, Colorado & Wyoming, and Atchison, Topeka & Santa Fe.	586,762		
		1,100,872	1,112,449	99.0
Georgia	Central of Georgia	39,589	39,589	100.0
Kentucky	Chesapeake & Ohio and Louisville & Nashville.	331,532	331,532	100.0
New Mexico	Atchison, Topeka & Santa Fe and El Paso & Southwestern.	577,679	577,679	100.0
Ohio			147,826	0.0
Pennsylvania	Baltimore & Ohio	2,774,681		
	Buffalo, Rochester & Pittsburgh	219,797		
	Ligonier Valley	268,742		
	Monongahela	5,620,456		
	Pennsylvania	11,026,867		
	Pittsburgh & Lake Erie	1,364,384		
	Buffalo & Susquehanna and Reynoldsville & Falls Creek.	493,099		
	Washington Run and Huntingdon & Broad Top Mountain.	242,008		
		22,010,034	23,816,420	92.4
Tennessee	Nashville, Chattanooga & St. Louis	85,372		
	Southern	89,413		
		174,785	376,080	46.5
Utah and Washington	Denver & Rio Grande and Northern Pacific.	471,187	471,187	100.0
Virginia	Norfolk & Western	383,843		
	Interstate	678,303		
	Southern and Louisville & Nashville	192,026		
		1,254,172	1,304,230	96.2
West Virginia	Baltimore & Ohio	284,410		
	Chesapeake & Ohio	232,476		
	Coal & Coke	108,237		
	Kanawha & Michigan	204,083		
	Morgantown & Kingwood	246,153		
	Norfolk & Western	1,684,580		
	Western Maryland	91,160		
		[a] 2,851,099	2,838,728	100.4
Total railroad shipments		30,214,114		
Total waterways shipments (Monongahela River, Pennsylvania).		169,176		
Grand total		30,383,290	33,167,548	91.6

[a] 12,371 tons shipped from stock.

Beehive coke shipped by originating railroads and waterways in the United States in 1917, by routes.

Route.	State.	Quantity (net tons).	Total (net tons).	Percentage of total.
Railroads:				
Alabama Great Southern, Birmingham Southern, and St. Louis-San Francisco.	Alabama	291,233	291,233	1.0
Atchison, Topeka & Santa Fe and El Paso & Southwestern.	Colorado and New Mexico.	655,692	655,692	2.2
Baltimore & Ohio	Pennsylvania	2,774,681	3,059,091	10.1
	West Virginia	284,410		
Buffalo & Susquehanna, Huntingdon & Broad Top Mountain, and Washington Run.	Pennsylvania	646,391	646,391	2.1
Buffalo, Rochester & Pittsburgh	Pennsylvania	219,797	219,797	.7
Central of Georgia	Georgia	39,589	39,589	.1
Chesapeake & Ohio	Kentucky	131,224	363,700	1.2
	West Virginia	232,476		
Coal & Coke	West Virginia	108,237	108,237	.4
Colorado & Southeastern and Colorado & Wyoming.	Colorado	508,749	508,749	1.7
Colorado & Southern	Colorado	378,829	378,829	1.2
Denver & Rio Grande and Northern Pacific.	Colorado, Utah and Washington.	606,468	606,468	2.0
Interstate	Virginia	678,303	678,303	2.2
Kanawha & Michigan	West Virginia	204,083	204,083	.7
Ligonier Valley	Pennsylvania	268,742	268,742	.9
Louisville & Nashville	Alabama	615,906	924,743	3.0
	Kentucky	200,308		
	Virginia	108,529		
Monongahela	Pennsylvania	5,620,456	5,620,456	18.5
Morgantown & Kingwood	West Virginia	246,153	246,153	.8
Nashville, Chattanooga & St. Louis	Tennessee	85,372	85,372	.3
Norfolk & Western	Virginia	383,843	2,068,423	6.8
	West Virginia	1,684,580		
Pennsylvania	Pennsylvania	11,026,867	11,026,867	36.2
Pittsburgh & Lake Erie	do	1,364,384	1,364,384	4.5
Reynoldsville & Falls Creek	do	88,716	88,716	.3
Southern	Alabama	496,026	668,936	2.2
	Tennessee and Virginia	172,910		
Western Maryland	West Virginia	91,160	91,160	.3
Total railroad shipments		30,214,114	30,214,114	99.4
Waterways:				
Monongahela River	Pennsylvania	169,176	169,176	.6
Grand total		30,383,290	30,383,290	100.0

DESTINATION OF COKE PRODUCED IN 1916.

The following tables show distribution for consumption from the coke-producing States during 1916, so far as it is possible to publish such data without the disclosure of individual operations. The quantity exported from each State is also given. As explained on page 1189, the figures for exports of coke compiled from the reports of the operators do not fully agree with the official figures obtained by the Bureau of Foreign and Domestic Commerce, but the difference, in view of the methods of compilation, is negligible.

Coke produced in individual States in 1916, in net tons.

Alabama.

Destination.	Furnace.	Foundry.	Domestic fuel, and other kinds.	Export.
Alabama	4,048,471	157,323	393	
Arizona and Colorado		184	4,204	
Arkansas, Kansas, and Oklahoma		762	200	
California		3,479		
Florida	155	1,274	72	
Georgia		13,411	581	
Illinois, Indiana, and Virginia		236	121	
Kentucky		50		
Louisiana	231	41,173	586	
Mississippi		1,763	662	
Missouri		5,021	96	
North and South Carolina		175		
Oregon		126		
Tennessee		24,609	671	
Texas	1,444	16,256	3,827	
	4,050,301	265,842	11,413	14,984

Colorado.

Destination.	Furnace.	Foundry.	Domestic fuel, and other kinds.	Export.
Arizona	121,727			
California	15,988	4,927	1,051	
Colorado	789,582	17,611	1,982	
Idaho and Nevada	1,831	687		
Kansas and Oklahoma	1,892	1,145		
Montana	34,598	1,286		
Nebraska and South Dakota	25	667		
New Mexico	697	359		
Texas	20,790	2,135		
Utah	29,512	1,011		
Washington and Wyoming	183	676		
	1,016,825	30,504	3,033	3,851

Illinois.

Destination.	Furnace.	Foundry.	Domestic fuel, and other kinds.	Export.
California, Oklahoma, and Texas		78	109	
Illinois	1,663,731	170,678	317,830	
Indiana, Kansas, Louisiana, and Ohio	787	4,308	1,594	
Iowa		2,109	10,799	
Michigan		2,024	5,015	
Minnesota		9,014	11,560	
Missouri		1,522	31	
Nebraska		212	1,668	
South Dakota			2,272	
Wisconsin	115,685	3,251	12,830	
	1,780,203	193,196	363,708	

Indiana.

Destination.	Furnace.	Foundry.	Domestic fuel, and other kinds.	Export.
California, Colorado, Montana, and Utah	1,706	5,606		
New England and Kansas		2,648		
Illinois	1,301,922	51,818	65,372	
Indiana	1,712,590	94,542	75,429	
Iowa	392	3,158	12,662	
Kentucky			268	
Michigan	737	2,398	31,811	
Minnesota, Missouri, Nebraska, and Oklahoma	563	23,762	5,598	
Ohio		3,796	1,544	
Wisconsin	1,963	3,922	1,382	
	3,019,873	191,650	194,066	

Coke produced in individual States in 1916, in net tons—Continued.

Kentucky.

Destination.	Furnace.	Foundry.	Domestic fuel, and other kinds.	Export.
Illinois and Indiana	72	63	15,447	
Kentucky	391,327	22,369	5,154	
Louisiana, Michigan, Missouri, and Oklahoma	1,042	8,684	21,428	
Ohio	256,710	41,138	36,943	
Tennessee, Virginia, and West Virginia		21	1,997	
	649,151	72,275	80,969	

New Mexico.

Destination.	Furnace.	Foundry.	Domestic fuel, and other kinds.	Export.
Arizona	261,160			
California, Colorado, and Montana	30,971			
Kansas and Oklahoma	6,525			
New Mexico	10,871			
Texas	43,521			
	353,048			154,054

New York.

Destination.	Furnace.	Foundry.	Domestic fuel, and other kinds.	Export.
New England and New York	621,268	23,123	129,639	
	621,268	23,123	129,639	1,405

Ohio.

Destination.	Furnace.	Foundry.	Domestic fuel, and other kinds.	Export.
Indiana and New York	65	926		
Michigan	6,622	30,190	7,536	
Ohio	1,722,458	2,897	13,973	
Pennsylvania	2,732			
	1,731,877	34,013	21,509	5,471

Pennsylvania.

Destination.	Furnace.	Foundry.	Domestic fuel, and other kinds.	Export.
Arizona and Oklahoma		250		
California		2,577		
Delaware	1,900	8,352	800	
District of Columbia	599	273		
Illinois	554,909	19,229	3,428	
Indiana	202,611	4,870	3,324	
Iowa		440	21	
Maryland	72,113	11,169	2,156	
Michigan	216,160	31,457	58,297	
Minnesota and Missouri	48	8,064	719	
Montana and South Dakota		22	24	
New England	6,994	86,749	1,685	
New Jersey	63,443	57,988	15,280	
New York	2,202,851	180,615	29,480	
Ohio	7,056,150	144,065	45,447	
Oregon, Utah, and Washington		1,250		
Pennsylvania	18,469,708	367,539	177,822	
Virginia		96	1,000	
West Virginia	198,041	3,471	3,700	
Wisconsin	25,087	2,165	3,116	
	29,070,614	930,641	346,299	777,672

Coke produced in individual States in 1916, in net tons—Continued.

Tennessee.

Destination.	Furnace.	Foundry.	Domestic fuel, and other kinds.	Export.
Alabama, Florida, and Kentucky	35	200	532	
Arizona, California, and Utah	100	594	1,655	
Georgia	452	628	2,918	
Illinois			4,163	
Indiana and Michigan	73		112	
Missouri		11,988	716	
North and South Carolina	26		866	
Kansas and Ohio	398	115	6,779	
Tennessee	303,168	13,552	40,840	
	304,252	27,077	58,581	

Utah and Washington.

Destination.	Furnace.	Foundry.	Domestic fuel, and other kinds.	Export.
California	17,810			
Idaho, Montana, Nevada, and Utah	385,248	49	6,000	
Oregon	399	1,095		
Washington	62,476	8,149	3,933	
	465,933	9,293	9,933	45,884

Virginia and West Virginia.

Destination.	Furnace.	Foundry.	Domestic fuel, and other kinds.	Export.
Alabama		443		
Arkansas	169	466		
California		820		
Colorado, Nebraska, and Texas	150	3,292	1,299	
Delaware and District of Columbia	1,126			
Florida	3,842	113		
Georgia	6,699	2,562	1,397	
Illinois	768,327	27,528	4,539	
Indiana	6,834	17,028	1,276	
Iowa	469	584		
Kansas	292	3,672		
Kentucky	5,534	20,868		
Louisiana		6,750		
Maryland	36,207	15,007		
Michigan	33,009	33,121	470	
Minnesota		4,338		
Missouri	5,457	9,221		
New England	175	2,556		
New Jersey	36,397	4,292		
New York	83,186	74,588		
North and South Carolina	6,878	10,752	1,667	
Ohio	731,579	74,996	3,642	
Oklahoma		110		
Oregon		208		
Pennsylvania	167,803	24,666		
South Dakota		26		
Tennessee	295,230	19,258	279	
Utah and Washington	564	98		
Virginia	763,023	29,361	174	
West Virginia	255,767	28,808	3,927	
Wisconsin	29,067	6,728	339	
	3,237,784	422,260	19,009	54,748

EXPORTS OF COKE.

1916.—Coke exported in 1916 set new records, both in quantity and in value. The exports were 1,174,645 net tons, compared with 895,509 tons in 1915 and 1,023,727 tons, the previous record, in 1911. Of the total exports Canada received 772,523 tons in 1916, Mexico 205,383 tons, South America 124,280 tons, and European countries 57,261 tons.

1917.—In 1917 exports of coke again broke all records, exceeding the exports in 1916 by 20 per cent in quantity and 103 per cent in value. Exports in 1917 amounted to 1,409,320 net tons, a gain of 234,675 tons compared with 1916. Eastern Canada receives more than half of the coke exported by the United States, and the continued growth of this trade is largely responsible for the increases in total exports. Coke shipped to Canada amounted to 981,671 tons in 1917, Mexico received 255,982 tons, South America 130,445 tons, and European countries 28,088 tons. Coke imported from the United States by Chile, Peru, and Mexico was used principally for smelting copper.

The statistics of exports are presented in the following tables. It will be noted that the total reported by the Bureau of Foreign and Domestic Commerce does not agree with the total shown by the reports from operators in the table on page 1193. The difference may be ascribed to two factors: Some gas-house may have been exported, and it is quite probable that the declared weight was only approximate.

Coke exported from the United States, 1909–1917.

Year.	Quantity (net tons).	Value.	Year.	Quantity (net tons).	Value.
1909	1,002,916	$3,232,673	1914	663,585	$2,233,686
1910	984,618	3,053,293	1915	895,509	3,092,498
1911	1,023,727	3,215,990	1916	1,174,645	4,202,236
1912	912,576	3,002,742	1917	1,409,320	8,543,746
1913	987,395	3,309,930			

Coke exported from the United States in 1915, 1916, and 1917, by customs districts.

District.	1915		1916		1917	
	Quantity (net tons).	Value.	Quantity (net tons).	Value.	Quantity (net tons).	Value.
Alaska					3	$60
Arizona	38,409	$111,907	166,886	$584,886	148,041	704,714
Buffalo	469,187	1,466,872	502,862	1,273,137	417,807	2,094,284
Dakota	6,022	19,333	7,711	30,137	6,446	49,295
Duluth-Superior	1,211	3,182	1,654	6,528	1,446	12,919
Eagle Pass	482	3,232	4,247	14,845	3,693	15,096
El Paso	101,983	366,063	6,199	38,292	4,362	23,530
Florida			99	438	105	1,291
Laredo	2,137	7,813	17,484	60,490	85,781	622,243
Maine and New Hampshire			15	73	1,027	10,512
Maryland	39,526	137,596	105,811	557,743	125,225	1,317,819
Michigan	89,986	323,857	124,348	522,962	233,465	1,629,990
Montana and Idaho	1	11				
New Orleans	196	740	1,378	8,637	1,403	22,570
New York	8,073	55,535	21,137	147,011	24,518	282,305
Ohio	7,335	21,302	49,232	110,727	223,266	763,996
Philadelphia	16,612	64,168	20,293	104,236	5,000	56,985
Porto Rico	2	45			6	152
Rochester	5,219	18,867	8,296	23,814	11,245	42,427
Sabine	6	52	11	114	28	382
St. Lawrence	20,370	93,575	24,810	104,531	44,634	313,311
San Francisco	176	2,914	7,679	96,759	10,307	123,296
South Carolina			5,426	26,183		
Southern California	1	19	609	2,575	249	5,613
Vermont	1,047	3,368	411	1,431	9,785	64,369
Virginia	36,851	144,033	44,657	222,808	18,915	197,682
Washington	50,677	248,014	53,390	263,879	32,563	188,905
	895,509	3,092,498	1,174,645	4,202,236	1,409,320	8,543,746

Coke exported from the United States in 1915, 1916, and 1917, by countries.

Country.	1915		1916		1917	
	Quantity (net tons).	Value.	Quantity (net tons).	Value.	Quantity (net tons).	Value.
Argentina	3,911	$15,713	7,230	$41,619	2,690	$39,701
Australia	13	94				
Azores and Madeira Islands					280	6,194
Barbados			353	1,966		
Bermuda			1	10	7	49
Bolivia	9	50			827	5,899
Brazil	544	2,479	2,398	22,312	1,393	23,429
British Guiana					11	282
British Honduras	16	53	31	123	6	126
British South Africa					2	44
Canada	651,139	2,198,727	772,523	2,336,182	981,671	5,170,002
Chile	30,548	108,186	85,445	413,370	91,274	853,837
Colombia	109	748	82	645	64	1,638
Costa Rica	85	803	93	831	1,158	4,131
Cuba	12,578	51,107	12,450	57,198	8,761	85,106
Danish West Indies	1	10	3	37	7	165
Dominican Republic	22	200	57	603	38	725
Dutch East Indies	130	580	908	6,472	263	5,859
Dutch West Indies	16	111	3	28		
Ecuador	28	227	58	547	87	1,264
England	728	4,057	8,695	50,258	3,395	29,888
France	454	3,040	8,242	47,021	10,403	80,028
French Oceania	2,630	8,218				
French West Indies	36	254	56	431	215	3,701
Greece	1,849	7,228	2,752	16,498	373	4,995
Guatemala	66	264	186	1,070	78	1,161
Haiti	2	17				
Honduras	24	111	14	90	25	280
Italy	23,092	99,172	27,748	132,585	5,796	68,215
Jamaica			85	631	1	30
Japan	13	74				
Mexico	151,661	521,880	205,383	808,772	255,982	1,541,753
Nicaragua	6	21	11	119	6	135
Norway	2,522	17,800	1,515	12,184	2,336	20,755
Panama	263	2,020	711	4,911	2,000	33,317
Peru	12,092	44,570	25,049	179,711	33,854	501,483
Philippine Islands					163	6,522
Portugal			1	6	1	27
Russia in Asia			67	494		
Russia in Europe			22	160		
Salvador	103	1,020	151	1,537	71	869
Spain	92	326	7,158	35,826	5,784	48,393
Switzerland			1,128	6,548		
Trinidad and Tobago	15	100	18	128	53	985
Uruguay	649	2,757	499	2,809	25	520
Venezuela	63	481	3,519	18,504	220	2,238
	895,509	3,092,498	1,174,645	4,202,236	1,409,320	8,543,746

CONSUMPTION.

GENERAL STATEMENT.[1]

Coke of domestic origin consumed in the United States in 1916 amounted to 53,171,577 net tons, of which 47,875,153 tons, or 90 per cent, was furnace coke; 2,680,104 tons, or 5 per cent, was foundry coke; and 2,616,320 tons, or 5 per cent, was used for other purposes, mainly domestic, although some was used by railroads as locomotive fuel and a small quantity was consumed by chemical works. The destination of 187,892 tons was not specified, but the coke may be considered as consumed in this country. Imports of coke (p. 1197) amounted to 54,955 net tons, used chiefly in the Western and Northwestern States. The total consumption of coke in the United States (exclusive of gas-house coke, which is not considered in this report)

[1] It has not been found practicable to collect the data for the consumption of coke in the year 1917, hence the following discussion is confined to the year 1916.

was 53,226,532 net tons. Exports amounted to 1,174,645 tons, or 2 per cent, of the total output, and 187,363 tons was on hand and had not been shipped by the operators at the end of the year.

FURNACE COKE.

Coke is used most largely, of course, in the manufacture of iron, and the States leading in the production of pig iron show a correspondingly large consumption of blast-furnace fuel. Pennsylvania manufactures a large surplus of furnace coke, but the adjacent States (Ohio and New York), though producing large quantities, import coke, mainly from Pennsylvania. Illinois likewise finds it necessary to draw upon other States for its supply of furnace fuel. The production in Indiana is slightly above domestic requirements. In Alabama production and consumption of furnace coke are about equal. New York has no coal deposits, and the coal in Ohio is not used to any extent for making coke. New York and Ohio have in the past depended largely upon Connellsville coke from Pennsylvania. They are, therefore, the States in which production of by-product coke will greatly increase in the future; in fact, Ohio has already shown a marked development in the construction of by-product plants, with 1,108 by-product ovens in operation in 1917 and 760 in course of erection, compared with 343 in operation in 1915 and 657 under construction.

Coke designated by the producers as furnace coke was reported as shipped to several States in which there are no iron or smelting furnaces. The aggregate of these shipments is small, however, and is considered to represent coke of furnace grade for consumption in the manufacturing industries.

FOUNDRY COKE.

Foundry coke, or coke for foundry purposes, was consumed in every State except Wyoming. It is used principally in the cupola for melting pig iron and scrap for castings, although it is also used to a small extent for melting the nonferrous metals. A general idea of the extent of the working of iron in the different States is afforded by these statistics, as the quantity of iron melted is proportionate to the coke used. Pennsylvania continued to be the largest consumer of foundry coke in 1916, with Illinois, New York, Ohio, and Michigan following in the order named.

DOMESTIC COKE.

More than 2,500,000 tons of coke from beehive and by-product ovens was used in 1916 for heating, mainly domestic. For household use coke possesses many advantages, and it is said to be rapidly coming into favor. In a general way it has the composition and heating value of anthracite, and it has the advantage of not clinkering and of igniting more easily. It is a much cleaner fuel than raw bituminous coal, and its use is much less wasteful in that the ammonia, tar, and benzol recovered in the by-product ovens are lost when bituminous coal is burned in ordinary heating apparatus, without a corresponding return in heating value.

Coke consumed in the United States in 1915, exclusive of imports, in net tons.

State.	Furnace.	Foundry.	Domestic fuel and other kinds.	State.	Furnace.	Foundry.	Domestic fuel and other kinds.
Alabama	2,870,378	110,901	....	Montana	210,448	448	....
Arizona	274,965	30	....	Nebraska [b]	....	1,710	....
Arkansas	....	88	....	New England states	397	79,209	489,000
California	14,679	27,569	....	New Jersey	79,527	64,365	....
Colorado	550,004	21,266	....	New Mexico	6,754	328	....
Delaware	335	6,941	....	New York	2,442,423	203,197	131,662
Florida	....	1,007	....	North Carolina and South Carolina	1,452	2,906	....
Georgia	3,729	17,599	....	Ohio	7,886,415	156,475	17,081
Idaho	106	44	....	Oklahoma	....	275	....
Illinois	2,933,487	151,572	172,098	Pennsylvania	15,036,595	308,941	364,009
Indiana	1,781,278	18,265	146,851	Tennessee	222,202	39,546	....
Iowa	....	12,516	....	Texas	42,886	16,798	....
Kansas	4,456	18,164	5,000	Utah and Oregon	183,002	3,002	....
Kentucky	120,300	15,076	5,245	Virginia	384,436	41,392	....
Louisiana	....	31,237	....	Washington	49,411	8,124	21,185
Maryland [a]	336,127	8,773	....	West Virginia	294,926	24,339	41
Michigan	549,888	103,266	303,052	Wisconsin	293,540	76,365	298,878
Minnesota	128,197	18,117	....				
Mississippi and Nevada	230	2,741	....				
Missouri	....	71,956	20,000		36,702,573	1,664,548	1,974,102

[a] Includes District of Columbia. [b] Includes North Dakota and South Dakota.

Coke consumed in the United States in 1916, exclusive of imports, in net tons.

State.	Furnace.	Foundry.	Domestic fuel and other kinds.	State.	Furnace.	Foundry.	Domestic fuel and other kinds.
Alabama	4,048,471	158,339	747	New England	7,169	142,949	508,285
Arizona	382,887	50	4,401	New Jersey	100,240	62,280	58,079
Arkansas	169	892	200	New Mexico	11,568	359	....
California	47,995	28,633	2,711	New York	2,912,370	276,041	160,319
Colorado	797,628	19,218	2,243	North Carolina and South Carolina	6,904	10,927	2,533
Delaware	2,950	8,352	800	North Dakota and South Dakota	....	167	7,804
District of Columbia	675	273	....	Ohio	9,766,983	270,231	118,707
Florida	4,032	1,916	101	Oklahoma	1,856	1,596	165
Georgia	7,151	24,422	4,896	Oregon and Wyoming	451	2,582	....
Idaho and Nevada	3,298	736	....	Pennsylvania	18,678,838	392,205	306,220
Illinois	4,303,889	287,626	430,887	Tennessee	598,398	78,713	43,693
Indiana	1,922,894	126,820	82,532	Texas	65,755	23,075	5,039
Iowa	861	17,735	72,346	Utah	236,902	5,123	6,000
Kansas	7,165	11,975	162	Virginia	763,023	29,663	1,202
Kentucky	396,861	43,287	5,571	Washington	67,607	8,538	3,933
Louisiana	451	50,067	2,130	West Virginia	453,808	32,300	7,693
Maryland	598,302	26,176	2,156	Wisconsin	440,088	120,928	277,275
Michigan	526,745	262,479	333,931				
Minnesota	418,664	29,717	37,339				
Missouri	62,043	118,250	91,095				
Montana	222,087	2,839	....				
Nebraska	7,975	2,625	35,125		47,875,153	2,680,104	2,616,320

Coke produced in the United States in 1916, by uses, in net tons.

State.	Used or sold for— Furnace.	Foundry.	Domestic fuel and other uses.	Exports.	Unspecified.	In (+) or out (−) of stock piles.	Total production.
Alabama	4,050,301	265,842	11,413	14,984	....	−44,123	4,298,417
Colorado	1,016,825	30,504	3,033	3,851	....	− 660	1,053,553
Gleorgia	....	45,543	....	1,534	....	+ 50	47,127
Ilinois	1,780,203	193,196	363,708	....	....	−16,707	2,320,400
Indiana	3,019,873	191,650	194,066	....	96,215	−12,144	3,489,660
Kentucky	649,151	72,275	80,969	....	....	+ 131	802,526
Maryland	489,982	....	....	....	....	....	489,982
Massachusetts	5,400	49,500	507,800	300	....	+ 48	563,048
Minnesota	418,639	400	9,825	....	....	+ 2,455	431,319
New Mexico	353,048	....	....	154,054	....	− 4,290	502,812
New York	621,268	23,123	129,639	1,405	....	− 421	775,014
Ohio	1,731,877	34,013	21,509	5,471	....	+10,398	1,803,268
Pennsylvania	29,070,614	930,641	346,299	777,672	55,827	+98,642	31,279,695
Tennessee	304,252	27,077	58,581	....	....	− 7,735	382,175
Utah and Washington	465,933	9,293	9,933	45,884	....	+ 3,610	534,653
Virginia and West Virginia	3,237,784	422,260	19,009	54,748	35,850	− 6,010	3,763,641
Michigan, Missouri, New Jersey, Wisconsin	660,003	384,787	860,536	113,382	....	−22,413	1,996,295
	47,875,153	2,680,104	2,616,320	1,173,285	187,892	+ 831	54,533,585

Coke consumed in individual States in 1916, in net tons.

Source.	Furnace.	Foundry.	Domestic fuel and other kinds.
Alabama.			
Alabama	4,048,471	157,323	393
Georgia, Tennessee, Virginia, and West Virginia	....	1,016	354
	4,048,471	158,339	747
Arizona.			
Colorado	121,727	....	....
New Mexico	261,160	....	....
Alabama, Pennsylvania, and Tennessee	....	50	4,401
	382,887	50	4,401
Arkansas.			
Alabama and Georgia	....	426	200
Virginia and West Virginia	169	466	....
	169	892	200
California.			
Alabama	....	3,479	....
Colorado and New Mexico	30,185	4,927	1,051
Pennsylvania	....	2,577	....
Georgia and Missouri	....	14,731	....
Utah, Washington, and Wisconsin	17,810	402	202
Indiana and Illinois	....	1,103	....
Tennessee and Virginia	....	992	1,458
West Virginia	....	422	....
	47,995	28,633	2,711
Colorado.			
Alabama and West Virginia	....	237	261
Indiana, New Mexico, and Wisconsin	8,046	1,370	....
Colorado	789,582	17,611	1,982
	797,628	19,218	2,243

Coke consumed in individual States in 1916, in net tons—Continued.

Source.	Furnace.	Foundry.	Domestic fuel and other kinds.
Delaware.			
Pennsylvania	1,900	8,352	800
West Virginia	1,050	....	....
	2,950	8,352	800
Florida.			
Alabama	155	1,274	72
Georgia and Tennessee	35	529	29
Virginia and West Virginia	3,842	113	....
	4,032	1,916	101
Georgia.			
Alabama	....	13,411	581
Georgia and Tennessee	452	8,449	2,918
Virginia	6,374	2,303	....
West Virginia	325	259	1,397
	7,151	24,422	4,896
Idaho.			
Colorado and Washington	53	537	....
	53	537	....
Illinois.			
Alabama and Kentucky	....	39	14,687
Illinois	1,663,731	170,678	317,830
Indiana	1,301,922	51,818	65,372
Missouri, Tennessee, and Wisconsin	15,000	18,334	25,031
Pennsylvania	554,909	19,229	3,428
Virginia	202,174	14,723	....
West Virginia	566,153	12,805	4,539
	4,303,889	287,626	430,887
Indiana.			
Alabama, Tennessee, and Kentucky	72	54	961
Illinois, Michigan, and Ohio	787	10,326	1,542
Indiana	1,712,590	94,542	75,429
Pennsylvania	202,611	4,870	3,324
Virginia	5,515	7,841	....
West Virginia	1,319	9,187	1,276
	1,922,894	126,820	82,532
Iowa.			
Illinois	....	2,109	10,799
Indiana	392	3,158	12,662
Missouri, Pennsylvania, and Wisconsin	....	11,884	48,885
Virginia and West Virginia	469	584	....
	861	17,735	72,346
Kansas.			
Alabama, Georgia, and Tennessee	312	266	138
Colorado, New Mexico, and Wisconsin	6,561	5,664	....
Illinois and Indiana	....	2,373	24
Virginia	292	3,672	....
	7,165	11,975	162
Kentucky.			
Alabama, Indiana, and Tennessee	....	50	417
Kentucky	391,327	22,369	5,154
Virginia	1,534	14,697	....
West Virginia	4,000	6,171	....
	396,861	43,287	5,571
Louisiana.			
Alabama	231	41,173	586
Illinois and Kentucky	220	....	882
Virginia and West Virginia	....	6,750	....
	451	47,923	1,468
Maryland and District of Columbia.			
Maryland	489,982	....	....
Pennsylvania	72,712	11,442	2,156
West Virginia	36,283	15,007	....
	598,977	26,449	2,156
Michigan.			
Illinois and Indiana	737	4,422	36,826
Michigan, Ohio, and Wisconsin	275,944	193,427	227,085
Pennsylvania	216,160	31,457	58,297
Virginia	146	14,698	....
West Virginia	32,863	18,423	470
Kentucky and Tennessee	895	52	11,253
	526,745	262,479	333,931

Coke consumed in individual States in 1916, in net tons—Continued.

Source.	Furnace.	Foundry.	Domestic fuel and other kinds.
Minnesota.			
Illinois and Indiana	....	9,014	11,871
Minnesota and Wisconsin	418,639	15,925	25,122
Pennsylvania	25	440	346
Virginia and West Virginia	....	4,338	....
	418,664	29,717	37,339
Missouri.			
Alabama and Georgia	....	5,288	96
Illinois and Indiana	563	25,072	5,318
Kentucky and Tennessee	....	20,620	9,960
Missouri and Wisconsin	56,000	50,425	75,348
Pennsylvania	23	7,624	373
Virginia and West Virginia	5,457	9,221	....
	62,043	118,250	91,095
Montana.			
Colorado	4,598	1,286	....
Indiana and Pennsylvania	31,666	1,130	....
New Mexico, Utah, and Wisconsin	185,823	423	....
	222,087	2,839	....
Nebraska.			
Colorado, Missouri, and Wisconsin	7,825	2,259	33,457
Illinois and Indiana	....	262	1,668
Virginia and West Virginia	150	104	....
	7,975	2,625	35,125
New England.			
Indiana and West Virginia	175	3,682	....
Massachusetts and New York	....	52,518	506,600
Pennsylvania	6,994	86,749	1,685
	7,169	142,949	508,285
New Jersey.			
Massachusetts and New Jersey	400	....	42,799
Pennsylvania	63,443	57,988	15,280
West Virginia	36,397	4,292	....
	100,240	62,280	58,079

Source.	Furnace.	Foundry.	Domestic fuel and other kinds.
New Mexico.			
Colorado and New Mexico	11,568	359	....
New York.			
Massachusetts and New York	626,268	20,105	130,839
Ohio and Michigan	65	733	....
Pennsylvania	2,202,851	180,615	29,480
West Virginia	83,186	74,588	....
	2,912,370	276,041	160,319
North Carolina and South Carolina.			
Alabama and Tennessee	26	175	866
Virginia	5,946	6,017	88
West Virginia	932	4,735	1,579
	6,904	10,927	2,533
North Dakota and South Dakota.			
Colorado, Missouri, and Wisconsin	....	141	5,508
Illinois, Pennsylvania, and West Virginia	....	26	2,296
	....	167	7,804
Ohio.			
Illinois and Indiana	....	3,799	1,544
Michigan and Tennessee	86	3,336	17,158
Kentucky	256,710	41,138	36,943
Ohio	1,722,458	2,897	13,973
Pennsylvania	7,056,150	144,065	45,447
Virginia	4,445	38,342	....
West Virginia	727,134	36,654	3,642
	9,766,983	270,231	118,707
Oklahoma.			
Alabama, Georgia, Kentucky	....	1,099	109
Colorado and New Mexico	1,856	25	....
Illinois and Indiana	....	162	56
Pennsylvania and West Virginia	....	310	....
	1,856	1,596	165

Coke consumed in individual States in 1916, in net tons—Continued.

Source.	Furnace.	Foundry.	Domestic fuel and other kinds.
Oregon.			
Alabama, Pennsylvania, and West Virginia	....	834	....
Washington	399	1,095	....
	399	1,929	....
Pennsylvania.			
New Jersey and Ohio	41,327	....	128,398
Pennsylvania	18,469,708	367,539	177,822
West Virginia	167,803	24,666	....
	18,678,838	392,205	306,220
Tennessee.			
Alabama	....	24,609	671
Georgia and Kentucky	....	21,294	1,903
Tennessee	303,168	13,552	40,840
Virginia	295,200	18,142	....
West Virginia	30	1,116	279
	598,398	78,713	43,693
Texas.			
Alabama and Georgia	1,444	16,989	3,827
Colorado and New Mexico	64,311	2,135	....
Illinois and Wisconsin	....	816	174
Virginia and West Virginia	....	3,135	1,038
	65,755	23,075	5,039
Utah.			
Colorado and Utah	236,238	1,011	6,000
Indiana and Pennsylvania	....	4,034	....
Tennessee, Virginia, and West Virginia	664	78	....
	236,902	5,123	6,000
Virginia.			
Alabama, Kentucky, and Pennsylvania	....	302	1,028
Virginia	440,795	3,348	....
West Virginia	322,228	26,013	174
	763,023	29,663	1,202
Washington.			
Colorado, Missouri, Pennsylvania, Utah, West Virginia, and Wisconsin	5,456	389	....
Washington	62,151	8,149	3,933
	67,607	8,538	3,933
West Virginia.			
Kentucky	....	21	66
Pennsylvania	198,041	3,471	3,700
West Virginia	255,767	28,808	3,927
	453,808	32,300	7,693
Wisconsin.			
Illinois, Indiana, and Wisconsin	385,934	112,035	273,820
Pennsylvania	25,087	2,165	3,116
Virginia and West Virginia	29,067	6,728	339
	440,088	120,928	277,275

RAILROAD CONSUMPTION OF COKE.

The following table shows the quantity of coke consumed during 1916 by the railroads of the United States, divided according to the districts established by the Interstate Commerce Commission:

Coke consumed by railroads in the United States in 1916, in net tons.

State in which coke was produced.	Eastern district.	Southern district.	Western district.	Total.
Illinois	104		2,684	2,788
Indiana	731			731
Michigan	1,073			1,073
Ohio	585			585
West Virginia		11,797	603	12,400
Iowa			136	136
Colorado			1,388	1,388
Minnesota			519	519
Missouri			59	59
Pennsylvania			1,721	1,721
Utah			552	552
Washington			292	292
Wisconsin			257	257
Shipped via Lakes[a]			450	450
	2,493	11,797	8,661	22,951

[a] Source not known.

IMPORTS OF COKE.

Coke imported into the United States amounted to 24,872 net tons in 1917, compared with 54,955 tons in 1916 and 53,222 tons in 1915. The greater part of the coke of foreign origin consumed in the United States came from British Columbia and was used in the copper and lead smelters of the Northwest.

Coke imported into the United States, by customs districts, in 1915, 1916, and 1917.[a]

District.	1915		1916		1917	
	Quantity (net tons).	Value.	Quantity (net tons).	Value.	Quantity (net tons).	Value.
Arizona					65	$309
Buffalo	7,414	$34,279	7,739	$34,478	6,720	41,065
Eagle Pass			1,053	2,855		
Hawaii	170	796				
Maine and New Hampshire			215	853	394	2,352
Michigan	941	3,107	45	114	3,483	15,575
Montana and Idaho	27,815	125,219	38,471	176,276	[b]14,117	[b]86,788
New York					6	99
Oregon			28	100		
St. Lawrence					3	39
San Francisco	15,849	53,389	7,317	34,591		
Vermont			87	247	84	224
Washington	1,033	5,592				
	53,222	222,382	54,955	249,514	24,872	146,451

[a] In the reports of the Bureau of Foreign and Domestic Commerce, Department of Commerce, from whose records these figures are compiled, the quantities are expressed in gross tons of 2,240 pounds. These have been reduced to net (short) tons in order to make them conform to the standard unit of measurement of this report.

[b] Montana only.

Coke imported into the United States in 1917, by countries.

Country.	1917	
	Quantity (net tons).	Value.
Canada	24,801	$146,043
Mexico	65	309
England	6	99
	24,872	146,451

Coke imported and entered for consumption in the United States, 1908–1917.

Year.	Quantity (net tons).	Value.	Year.	Quantity (net tons).	Value.
1908	147,427	$606,294	1913	101,212	$435,157
1909	191,253	736,120	1914	133,226	551,104
1910	172,716	625,130	1915	53,222	222,382
1911	77,923	254,455	1916	54,955	249,514
1912	123,614	488,398	1917	24,872	146,451

BY-PRODUCTS OBTAINED IN THE MANUFACTURE OF COKE.

1916.—The recovery of the valuable by-products obtainable from American coke ovens continued to make important gains in 1916. The quantities of by-products obtained increased approximately in ratio with the increase in the output of by-product coke, with the exception of the benzol products, which showed gains ranging in round figures from 400 to 1,800 per cent. The value of these benzol products amounted to $30,000,000 in 1916, compared with $7,340,000 in 1915 and less than $1,000,000 in 1914, whereas the total value of all by-products obtained rose from $30,000,000 in 1915 to $62,000,000 in 1916.

Under the stimulus of war prices the number of plants equipped for benzol recovery increased from 30 in 1915 to 39 at the end of 1916. The benzol products obtained in 1916 amounted to 43,709,779 gallons. More than 16,500,000 gallons of the output was reported as crude light oil, with an average value of 30 cents a gallon. An increasingly large number of by-product plants operated their own refineries, and the output of pure benzol reported in 1916 from these sources increased nearly 750 per cent over the figures for 1915 and amounted to 21,079,500 gallons, with an average value of more than 62 cents a gallon. Similarly the reported production of toluol gained more than 500 per cent and amounted to 3,939,636 gallons in 1916, with an average value of slightly more than $2.85 a gallon.

Approximately 185,500,000 gallons of tar was obtained from by-product coke ovens in 1916, the value of which was $4,865,921.

The output in 1916 of ammonia, of which about 135,000 tons was reported as sulphate, 3,224,718 gallons as liquor, and 47,739,602 pounds as anhydrous ammonia, was equivalent to a total of 470,530,547 pounds of ammonium sulphate and had a value of $14,152,243. Surplus gas, amounting to 110,062,000,000 cubic feet and valued at $10,779,208 was sold or used, of which 20,552,000,000 feet was used as illuminating gas, 6,558,000,000 feet as domestic fuel, and 82,951,000,000 feet as fuel for raising steam for open-hearth furnaces in gas engines and for other industrial purposes. These by-products, which had a total value of $61,931,595, were obtained by the carbonization of 26,524,502 net tons of coal, from which was also obtained 19,069,361 tons of coke, valued at $75,373,070. The total value of the output of coke and by-products in 1916 was more than $137,300,000, compared with $78,300,000 in 1915.

1917.—Increased quantities of by-products were recovered from coke plants in 1917, the gain paralleling the continued expansion of the whole by-product coke industry. Benzol products remained the feature of greatest interest, and the number of plants equipped for their recovery rose from 39 in 1916 to 47 in 1917. Late in 1917 all toluol was commandeered by the War Department, and prices were set at a figure much below the prevailing market rates by a voluntary agreement between the Government and the toluol producers. In consequence, the aggregate value of these products declined from $30,000,000 in 1916 to $28,500,000 in 1917, although production increased nearly 25 per cent, the total volume of benzol products amounting to 54,387,266 gallons in 1917.

Additional plants were equipped for refining their light oil fractions, with the result that the quantity of crude light oil reported for 1917 was only about 7,500,000 gallons, compared with 16,500,000 gallons in 1916, while pure benzol reported from these sources increased from 21,000,000 gallons in 1916 to nearly 37,000,000 gallons in 1917, with an average value per gallon for the latter year of 45 cents. Nearly twice as much toluol (7,395,174 gallons) was produced at by-product plants in 1917 as in 1916. Because of the price agreement with the Government, the average value per gallon of toluol was $1.37 in 1917, compared with $2.85 in 1916.

Tar obtained from by-product ovens amounted to 221,999,264 gallons in 1917, valued at $5,566,302.

The output of ammonia in 1917, equivalent to 560,792,322 pounds of ammonium sulphate, had a value of $17,903,864.

Surplus gas, amounting to 131,027,000,000 cubic feet, and valued at $11,360,335, was sold or used in 1917, of which 21,289,000,000 feet was used for illuminating purposes, 7,271,000,000 feet was reported as domestic fuel, and 102,466,000,000 feet served as industrial fuel for open-hearth furnaces, in gas engines, and for other purposes.

By-products obtained in 1917 had a total value of $67,670,679 and their production required the carbonization of 31,505,759 net tons of coal, from which was also obtained 22,439,280 net tons of coke valued at $138,643,153. The total value of the output of all by-product ovens in 1917 was more than $206,300,000, compared with $137,300,000 in 1916 and $78,300,000 in 1915.

By-products obtained from coke-oven operations in 1915, 1916, and 1917.

1915.

Product.	Quantity.	Value.	Average value.
Tar obtained and sold....gallons..	138,414,601	$3,568,384	$0.026
Ammonia obtained and sold:			
Sulphate....pounds..	199,900,487	5,648,958	.028
Liquor....gallons..	10,626,612	1,240,473	.117
Anhydrous or free ammonia [a]....pounds..	30,002,196	2,978,044	.099
Gas produced....M cubic feet..	213,667,614	....	....
Surplus gas sold or used:			
Illuminating....do....	17,196,426	3,083,311	.179
Domestic fuel....do....	27,590,624	3,158,129	.114
Industrial fuel....do....	39,568,864	2,383,459	.060
Benzol products:			
Crude light oils....gallons..	13,082,678	4,304,281	.33
Secondary light oils....do....	182,039	28,731	.16
Benzol....do....	2,516,483	1,428,323	.568
Toluol....do....	623,506	1,529,803	2.45
Solvent naphtha....do....	196,151	46,233	.24
Naphthalene....pounds..	465,865	46,959	.10
Other products [b]....	....	379,491	....
	....	29,824,579	....
Coke....net tons..	14,072,895	48,558,325	3.45
	....	78,382,904	....

1916.

Product.	Quantity.	Value.	Average value.
Tar obtained and sold....gallons..	185,506,024	$4,865,921	$0.026
Ammonia obtained and sold:			
Sulphate....pounds..	271,832,816	8,496,278	.031
Liquor....gallons..	3,224,718	602,241	.318
Anhydrous or free ammonia [a]....pounds..	47,739,602	5,053,724	.106
Gas produced....M cubic feet..	291,991,844	....	....
Surplus gas sold or used:			
Illuminating....do....	20,551,916	3,639,821	.177
Domestic fuel....do....	6,558,484	2,849,909	.435
Industrial fuel....do....	82,951,207	4,289,478	.052
	110,061,607	10,779,208	.098
Benzol products:			
Crude light oils....gallons..	16,572,544	4,962,055	.299
Secondary light oils....do....	767,373	257,800	.336
Benzol....do....	21,079,500	13,159,374	.624
Toluol....do....	3,939,636	11,238,268	2.853
Solvent naphtha....do....	1,350,726	383,584	.284
	43,709,779	30,001,081	.686
Naphthalene....pounds..	8,820,405	289,688	.033
Other products [c]....	....	143,398	....
Coke breeze....net tons..	1,030,830	1,700,056	1.65
	....	61,931,595	....
Coke....do....	19,069,361	75,373,070	3.95
	....	137,304,665	....

[a] Includes liquor and sulphate sold on pound basis of NH_3.
[b] Includes breeze, retort carbon, domestic coke and coke dust, and aniline oil.
[c] Includes drip oil, spent oxide, sodium ferrocyanide, domestic coke and coke dust, retort carbon, and xylol.

By-products obtained from coke-oven operations in 1915, 1916, and 1917—Continued.

1917.

Product.	Quantity.	Value.	Average value.
Tar obtained and sold........gallons..	221,999,264	$5,566,302	$0.025
Ammonia obtained and sold:			
Sulphate........pounds..	352,722,848	11,973,468	.034
Liquor........gallons..	7,055,039	1,106,950	.157
Anhydrous or free ammonia [a]........pounds..	47,784,345	4,823,446	.101
Gas produced........M cubic feet..	337,728,251	....	....
Surplus gas sold or used:			
Illuminating........do....	21,289,102	3,210,398	.155
Domestic fuel........do....	7,271,102	2,859,452	.410
Industrial fuel........do....	102,466,371	5,290,485	.052
	131,026,575	11,360,335	.087
Benzol products:			
Crude light oils........gallons..	7,516,695	1,490,733	.198
Secondary light oils........do....	326,540	30,538	.094
Benzol........do....	36,804,228	16,576,865	.450
Toluol........do....	7,395,174	10,140,013	1.371
Other refined oil........	229,113	65,925	.288
Solvent naphtha........gallons..	2,115,516	351,130	.166
	54,387,266	28,655,204	.527
Naphthalene........pounds..	17,276,044	569,449	.033
Other products [b]........	....	1,267,322	....
Coke breeze........net tons..	1,495,545	2,348,203	1.570
	....	67,670,679	....
Coke........do....	22,439,280	138,643,153	6.18
	....	206,313,832	....

[a] Includes liquor and sulphate sold on pound basis of NH_3.
[b] Sodium ferrocyanide, drip oil, spent oxide, retort carbon, residue.

Average yield of by-products per net ton of coal (2,000 pounds) from all operations in 1915 1916, and 1917.

	1915	1916	1917
Coke........pounds..	1,440	1,438	1,424
Tar........gallons..	7.1	7.0	7.0
Ammonium sulphate........pounds..	20.1	17.7	17.8
Light oil........gallons..	1.54	1.70	1.78
Gas:			
Total........cubic feet..	10,950	11,008	10,720
Surplus sold or used........do....	4,325	4,149	4,159
Burned in coking process........do....	6,270	6,423	5,986
Wasted........do....	355	436	575

The yield of coke per ton of coal in different plants ranged from 1,106 to 1,682 pounds Several operators reported the recovery of more than 10 gallons of tar from 2,000 pounds of coal; one reported 13.5 gallons and one as little as 4.8 gallons. Twenty-one operators reported their ammonia entirely in the form of sulphate, and the average recovery in these operations was 19.85 pounds of sulphate per ton of coal. Twenty-three operators reported their ammonia as pounds of NH_3, with an average of 4.96 pounds of NH_3 recovered from each 2,000 pounds of coal. The other operators reported their ammonia either wholly or in part as liquor or as sulphate and NH_3. Individual operations showed average recovery ranging from 3.2 to 6.2 pounds of NH_3 and from 12.1 to 26.3 pounds of ammonium sulphate per ton of coal.

Some plants are not equipped for fractionating the oils of the benzol group, but ship their crude products to refineries or chemical works for further treatment, and for that reason part of these products were reported and are shown here as crude and secondary oils.

COAL—PART B, DISTRIBUTION AND CONSUMPTION.

By C. E. Lesher.

INTRODUCTION.

OBJECT AND SCOPE OF THE REPORT.

The report of the Geological Survey on the distribution and consumption of coal in 1915,[1] the first attempt to present such detailed statistics, was so generally well received and appeared to fill such a timely need that it was hoped to continue the statistics for succeeding years. The work of supplying the demand for statistics of coal and coke that followed the entrance of the United States into the war, in April, 1917, was so heavy that it precluded any attempt to compile data on distribution and consumption for 1916. The advent of the United States Fuel Administration, late in 1917, with its demand for statistical information, presented a special need and afforded a means of comprehensive study of the statistics of distribution for 1917. The particular need for these data by the Fuel Administration was connected with the proposed allotment of bituminous coal from producing districts to consuming States, and the zone system of distribution. The work of compilation was undertaken by the writer in his capacity of geologist in charge of coal statistics for the Geological Survey and director of the bureau of statistics of the Fuel Administration. The data originally compiled in the early months of 1918 have all been rechecked and are presented as nearly as possible in the form of the report for 1915.

SOURCES OF INFORMATION.

The statistics of distribution in 1917 were compiled largely from data furnished by the railroads, supplemented by data from operators and their local statistical bureaus and, not like those for 1915, from reports from the companies that ship coal. The United States Railroad Administration cooperated with the Geological Survey and the Fuel Administration in the study that preceded the establishment of the zone system, and individual railroads generally furnished detailed data on the distribution of bituminous coal to an extent that under ordinary circumstances would hardly be war-

[1] See report on coal in 1915, Part B, distribution and consumption: U. S. Geol. Survey, Mineral Resources, 1915, pt. 2, pp. 433–513, 1917.

ranted. One of the most difficult problems in the past—the determination of the origin, quantity, and distribution of bituminous coal shipped to tidewater—was solved by the reorganization of the work of the Bureau of Tidewater Coal Statistics, a railroad organization, and of the work of the Federal fuel administrator for New England, Mr. J. J. Storrow. The extension in April, 1917, of the work of the Ohio Bureau of Coal Statistics, a railroad organization under Mr. H. V. Davis, to include in addition to coal originating in Ohio all westbound shipments of coal from the Appalachian region as far south as Tennessee, added materially to the available information.

The report for 1917 shows the distribution of coal from producing districts, information more significant than that in the report for 1915, which classified the sources only by States.

Complete and absolutely accurate reports of distribution are impossible to obtain and any attempt to compile such statistics as this report contains must include estimates, but it is believed that these data in all important respects are accurate and that some of the shortcomings of the statistics for 1915 have been overcome.

UNIT OF MEASUREMENT.

The net ton of 2,000 pounds has been used as the unit of measurement throughout this report.

ACKNOWLEDGMENTS.

The writer is indebted to many persons for assistance in the preparation of the statistics contained in this report, but most particularly to Mr. Wayne P. Ellis, of the Fuel Administration, whose broad knowledge of coal traffic, genius for detail, and untiring efforts have made this compilation possible under the trying conditions. Grateful acknowledgment for valuable assistance is made to the coal-traffic officials and auditors of railroads, to the local coal operators' associations, the Illinois-Indiana Coal Traffic Bureau, the Ohio Bureau of Coal Statistics, the Bureau of Tidewater Coal Statistics, and many others, individuals and associations.

DISTRIBUTION OF BITUMINOUS COAL AND LIGNITE.

GENERAL FEATURES.

The statistics collected from the operators of coal mines and published in Part A of this report show the quantities of bituminous coal and lignite (1) used at the mines for generating steam and heat, (2) sold locally or used by employees, (3) used at the mines for making coke (none of this coal is shipped), and (4) shipped to market, either by rail or by river. The destination and use of the coal embraced in the first three items are thus recorded, but a special investigation was necessary to determine the destination and use of the coal shipped, which forms 86 per cent of the quantity produced.

Coal reaches the market by three general methods of transportation—(1) all rail, with which in this report are included the shipments by rivers; (2) rail to tidewater, thence by vessel to foreign markets (exports) or by vessel to other points on the coasts of the

United States or its insular possessions (coastwise), or used at tidewater points for fuel on steamships (bunker); (3) rail to the Great Lakes, notably to lower Lake ports on Lake Erie, thence by boat to upper Lake ports on Lake Superior or Lake Michigan or to Canada, and from upper Lake ports again by rail to markets in the interior.

The statistics in this report show the coal consumed in each State for domestic and industrial purposes, by public utilities, both gas and electric, and by manufacturers of coke. Coal used by railroads is not shown by States but by classes of roads and by the three large recognized districts in the country.

The all-rail movement, which, as has been explained, includes shipments by rivers, is separated into (1) shipments to points within the State in which the coal was mined, with which, for convenience, are included quantities not shipped, used at the mines for steam and heat and used locally and by employees at the coal mines; (2) shipments to other States; (3) quantities used by railroads serving the coal fields or delivered by them to other railroads; and (4) exports to Canada and Mexico by rail. The details of the shipments to other States and of the tidewater and Lake movements are given in succeeding tables.

DISTRIBUTION BY ALL-RAIL ROUTES.

About 96 per cent of the bituminous coal produced in the United States is used in this country and more than 86 per cent of the total output reaches the consumers by all-rail delivery. The States in which the coal is mined are the largest consumers, 37 per cent of the total having been consumed in the States of origin in 1917. The railroads received by all-rail delivery 145,800,000 tons, or 26 per cent of the total, in addition to which the roads in New England and the roads in the Northwest received 10,340,000 tons by way of tidewater and Lake and from Canada. Shipments to tidewater represented 7 per cent of the total production and shipments to the Lakes were 5 per cent of the total.

The statistics of distribution of bituminous coal produced in the United States in 1915 and 1917 are given in the following tables. The total statistics for these two years are comparable except that those for 1917 are shown with the source divided according to producing districts rather than by States as in 1915. Several of the districts are in more than one State, and it is not possible to show for such districts the distribution of the coal originating in each State.

Distribution of bituminous coal produced in the United States, 1917, by routes and destination.

Source.		All-rail shipments.								Shipped to tidewater.[b]		Shipped to Great Lakes for cargo.[c]		Total quantity (net tons).
		Used within the State.		Shipped to other States.		Used by railroads.		Exported by rail.[a]						
Field.	State.	Quantity (net tons).	Percentage of production.	Quantity (net tons).	Percentage of production.	Quantity (net tons).	Percentage of production.	Quantity (net tons).	Percentage of production.	Quantity (net tons).	Percentage of production.	Quantity (net tons).	Percentage of production.	
Alabama	Alabama	11,222,916	56	2,622,000	13	5,641,254	28			581,904	3			20,068,074
Arkansas	Arkansas	671,468	31	735,000	34	737,111	35							2,143,579
California and Idaho	California and Idaho.	6,423	100											6,423
Colorado	Colorado	7,297,039	59	2,138,000	17	3,038,297	24	10,000	0					12,483,336
Georgia	Georgia	119,028	100											119,028
Illinois	Illinois	31,696,717	35	19,019,000	24	35,431,220	41	50,000		2,450	0			86,199,387
Indiana	Indiana	11,841,298	45	7,200,000	27	7,498,031	28							26,539,329
Iowa	Iowa	3,887,501	43	445,000	5	4,633,329	52							8,965,830
Kansas	Kansas	2,436,794	34	1,548,000	22	3,200,181	44							7,184,975
Hazard	Kentucky	153,751	8	1,276,000	70	254,836	14	3,000				147,766	8	1,835,353
Northeastern Kentucky	do	815,401	13	4,230,000	65	514,675	8	37,000	1			856,603	13	6,453,679
Southeastern Kentucky	do	1,467,282	23	3,585,000	56	1,103,865	17	4,000		36,600	1	184,397	3	6,381,144
Western Kentucky	do	2,986,500	29	4,294,000	42	2,966,930	29			2,050	0			10,249,480
Kanawha and Kenova-Thacker	do	703,519	2	(d)		(d)		(d)		(d)		(d)		703,519
Cumberland-Piedmont and Somerset.	Maryland	1,955,901	14	(e)		(e)		(e)		(e)		(e)		1,955,901
Michigan	Michigan	1,013,958	74			360,847	26							1,374,805
Missouri	Missouri	3,114,593	55	462,000	8	2,093,956	37							5,670,549
Montana and northern Wyoming.	Montana	1,573,770	22	(f)		(f)		(f)		(f)		(f)		1,573,770
New Mexico	New Mexico	1,271,997	32	534,000	13	1,991,066	50	60,464	1	143,000	4			4,000,527
North Dakota	North Dakota	752,193	95	12,000	2	26,355	3							790,548
Southern Ohio	Ohio	4,307,338	30	2,221,000	16	4,485,028	32	106,000	1			2,907,625	20	14,026,991
Northern Ohio	do	11,314,047	44	1,576,000	6	7,088,626	26	1,921,000	6	36,059		4,913,771	18	26,849,503
Oklahoma	Oklahoma	1,479,013	34	580,000	13	2,327,831	53							4,386,844
Oregon	Oregon	26,226	93			2,101	7							28,327
Central Pennsylvania	Pennsylvania	12,905,235	22	14,424,364	24	18,023,766	31	3,070,000	5	9,550,146	16	1,070,581	2	59,044,092
Northern Pennsylvania	do	2,445,772	33	2,561,000	35	1,627,090	22	578,000	8	25,000	0	144,466	2	7,381,328
Greensburg-Westmoreland-Latrobe-Ligonier.	do	7,825,741	46	2,251,000	13	4,835,493	29	350,000	2	1,616,985	10			16,879,219
Connellsville	do	29,355,674	85	3,379,000	10	1,246,737	3	161,000	1	454,492	1			34,596,903

Cumberland-Piedmont and Somerset.	.....do	2,771,166	20	2,170,000	16	1,562,890	11	7,000	1	5,127,529	37	51,210	....	11,689,795
Pittsburgh and Panhandle.....	.....do	20,868,664	42	13,054,000	26	5,045,018	10	2,289,000	4	379,438	1	7,359,447	14	48,995,567
South Dakota................	South Dakota...	8,042	100	....	....	....	....	....	....	....	....	....	....	8,042
Tennessee	Tennessee	2,208,018	36	1,514,145	24	2,457,870	40	....	....	14,188	....	....	....	6,194,221
Texas	Texas...........	1,236,033	53	7,000	....	952,051	40	93,331	4	67,400	3	....	....	2,355,815
Utah and southern Wyoming..	Utah	2,210,472	23	(g)	....	(g)	....	(g)	....	(g)	....	(g)	....	2,210,472
Southwestern Virginia.........	Virginia	3,005,229	35	2,353,000	27	2,657,491	31	....	....	582,781	7	5,817	....	8,604,318
Pocahontas and Tug River.....	.....do	2,057,607	8	(h)	....	(h)	....	(h)	....	(h)	....	(h)	....	2,057,607
Washington	Washington	1,238,700	31	440,000	11	2,002,615	50	15,000	....	313,587	8	....	....	4,009,902
Fairmont........................	West Virginia...	2,600,926	15	5,246,000	30	5,862,206	33	130,000	1	2,699,242	15	1,029,201	6	17,567,575
New River	.....do	1,144,646	7	3,272,000	22	897,178	6	2,000	....	9,201,898	61	578,314	4	15,096,036
Pocahontas and Tug River....	.....do	3,662,623	15	8,938,000	36	1,250,967	5	168,000	1	6,294,209	25	2,575,956	10	22,889,755
Kanawha and Kenova-Thacker.	.....do	1,283,318	5	12,628,000	45	5,601,077	20	185,000	1	1,389,026	5	6,074,183	22	27,160,604
Cumberland-Piedmont and Somerset.	.....do	197,542	1	(i)	....	(i)	....	(i)	....	(i)	....	(i)	....	197,542
Pittsburgh and Panhandle.....	.....do	1,592,202	3	(j)	....	(j)	....	(j)	....	(j)	....	(j)	....	1,592,202
Southern Ohio..................	.....do	71,416	1	(k)	....	(k)	....	(k)	....	(k)	....	(k)	....	71,416
Montana and northern Wyoming.	Wyoming.......	285,198	4	1,461,000	21	3,707,562	53	1,000	....	....	....	....	....	5,454,760
Utah and southern Wyoming..	.....do	393,697	4	2,596,000	26	4,675,978	47	....	....	22,861	0	....	....	7,688,536
Alaska...........................	Alaska..........	53,955	100	....	....	....	....	....	....	....	....	....	....	53,955
		[l]201,536,549	37	128,771,509	23	[m]145,801,528	26	9,240,795	2	38,540,845	7	27,899,337	5	[n]551,790,563

a Includes 163,795 tons to Mexico; 9,077,000 tons to Canada.
b Includes 3,320,912 tons railroad fuel for United States; 19,286,713 tons commercial coal for United States; 5,603,782 tons export cargo; 10,329,438 tons bunker.
c Includes 4,567,107 tons railroad fuel coal for United States, 195,581 tons via Lake Ontario; 8,076,196 tons exports to Canada, 875,000 tons via Lake Ontario; 14,656,034 tons commercial coal for United States; 60,000 tons increase in stocks on upper Lake docks.
d Combined with "Kanawha and Kenova-Thacker," W. Va.
e Combined with "Cumberland-Piedmont, Somerset, and Meyerdale," Pa.
f Combined with Montana and northern Wyoming, Wyo.
g Combined with Utah and southern Wyoming, Wyo.
h Combined with "Pocahontas and Tug River," W. Va.
i Combined with "Cumberland-Piedmont, Somerset, and Meyersdale," Pa.
j Combined with "Pittsburgh and Panhandle," Pa.
k Combined with southern Ohio, Ohio.
l Includes coal used at mines for steam and heat, that sold to local trade and used by employees, and that made into coke at the mines, none of which is shipped.
m Does not include tons of railroad fuel shipped via the Lakes or by tidewater.
n Imports of coal for domestic consumption and coal consumed from storage are not included in this tabulation.

DISTRIBUTION OF TIDEWATER SHIPMENTS.

The quantity of bituminous coal shipped to tidewater and dumped over piers into boats either as bunker coal or as cargo in 1917 was 39,095,527 net tons. Of this total more than 95 per cent was handled at four northern Atlantic ports—Hampton Roads, Baltimore, Philadelphia, and New York. Except as to the total and certain of the items, the figures given below are not comparable with those published for 1915.[1] A more recent study of the statistics published for 1915 indicates that a considerable quantity was shown as destined for New England, whereas it was used in or about New York Harbor.

Foreign exports by ocean vessels (offshore) from both Atlantic and Pacific ports represented 5,600,000 net tons, or 14 per cent of the total tidewater dumping. Coastwise shipments, mainly to New England, amounted to 13,552,000 net tons, or about 35 per cent of the total; bunker coal for vessels engaged in both foreign and domestic trade amounted to nearly 10,884,000 tons, or about 28 per cent of the total; and the remainder, including that used in and about New York Harbor and inside Delaware and Chesapeake Bays and that taken by the Navy and by the Army transport service, was 23 per cent of the total.

Distribution of tidewater shipments of bituminous coal, 1917.

	Net tons.
Foreign export	[2] 5,604,281
Coastwise shipments:	
For New England	12,268,480
For other parts of the United States	1,283,469
Total coastwise shipments	13,551,949
Local at New York and inside the Capes	[3] 9,055,676
Bunker coal, foreign and domestic	[4] 10,883,621
Total tidewater shipments	39,095,527

The coal fields in central Pennsylvania were, in 1917, the largest shippers of bituminous coal to tidewater, mainly to New York Harbor, for use in and about New York City and for bunker coal. The New River field was the second largest shipper of coal to tidewater, reaching Hampton Roads with coal for New England and for foreign cargo and for bunker fuel. The Pocahontas and Tug River fields followed in importance, and only three other fields, Fairmont, W. Va., Greensburg-Westmoreland, Pa., and the Kanawha and Kenova-Thacker districts of southern West Virginia, in order of importance, recorded more than a million tons to tidewater in the year.

More than one-fourth of the total bituminous coal dumped at tidewater is used for steamship bunker fuel—about one-third of which is used by vessels in coastwise trade and two-thirds by vessels engaged in foreign trade. Exports to foreign countries represented 14 per cent of the total. Shipments by vessel to New England were nearly one-third of the total tidewater business, and local use in and about New York Harbor, at Philadelphia and Wilmington, and in Chesapeake Bay accounted for more than 10,000,000 tons, or 26 per cent of the total.

[1] U. S. Geol. Survey Mineral Resources, 1915, pt. 2, p. 441, 1917.
[2] Includes 272 tons exported from New England and 227 tons imports reexported.
[3] Excludes 569,363 tons estimated inside Capes bunker.
[4] Includes 276,854 tons bunkered from New England, other than import coal, and 277,329 tons bunkered from import coal.

Origin and distribution by use and destination of bituminous coal shipped to tidewater in 1917.

[Quantities in net tons.]

Producing district.	Foreign trade.[a]		Domestic trade.											
				Coastwise cargo.										Total.
								New England.						
	Cargo.	Bunker.	Coastwise bunker.[a]	California.	Delaware.	Florida.	Maryland.	Commercial.	Railway fuel.	New Jersey.	New York.	Pennsylvania.	Unspecified.	
Central Pennsylvania	235,215	2,401,675	900,000		60,000		132,972	631,175	262,658	594,237	3,591,756	739,237	1,221	9,550,146
Northern Pennsylvania												25,000		25,000
Pittsburgh and Panhandle of West Virginia	17,389	36,049	60,187				14,729	14,652			144,960	91,472		379,438
Greensburg-Westmoreland-Latrobe-Ligonier	313,370	59,319	109,139		20,000		100,118	399,712	414,927		137,402	62,998		1,616,985
Connellsville								50,000	254,492		150,000			454,492
Cumberland-Piedmont-Somerset	136,096	1,173,574	926,405		44,168		631,648	890,515	145,397	115,707	764,383	299,636		5,127,529
Fairmont	154,555	65,673	279,438		40,000		31,884	331,235	915,567	71,205	551,070	258,615		2,699,242
Kanawha and Kenova-Thacker	437,275	46,000	36,137				121,522	15,292	732,800					1,389,026
Pocahontas and Tug River	2,053,449	959,980	405,900			30,000	258,210	2,142,675	83,383	150,000	210,612			6,294,209
New River	2,142,949	1,161,723	559,207			35,000	364,690	4,474,883	88,446	150,000	225,000			9,201,898
Southeastern Kentucky	8,500	25,500	2,600											36,600
Tennessee	1,200	11,488	1,500											14,188
Southwestern Virginia	42,675	102,022	17,413						420,671					582,781
Alabama	49,896	378,101	153,907											581,904
Northern Ohio		2,015	1,045				112			13,359	19,528			36,059
Western Kentucky	2,050													2,050
Illinois	2,450													2,450
Texas	43	58,545	8,812											67,400
Utah and southern Wyoming	193	17,645	5,023											22,861
New Mexico		120,000	23,000											143,000
Washington	6,477	112,230	108,186	85,344									1,350	313,587
Total	[b] 5,603,782	[c] 6,731,539	[d] 3,597,899	85,344	164,168	65,000	1,655,885	8,950,139	3,318,341	1,094,508	5,794,711	1,476,958	2,571	38,540,845

[a] Does not include coal for export or bunker coal from New England ports or import coal.
[b] Does not include 272 tons exported from New England or 227 tons import coal exported.
[c] Does not include 126,854 tons bunkered from New England other than import coal or 265,375 tons bunkered from import coal.
[d] Does not include 150,000 tons bunkered from New England other than import coal or 11,954 tons bunkered from import coal.

Of the 13,669,000 net tons of bituminous coal dumped over the piers in New York Harbor in 1917, 8,171,000 tons, or 60 per cent, came from the central Pennsylvania fields, and the greater part of the remainder from the Somerset, Pa., and Cumberland-Piedmont, Md.-W. Va., fields. A substantial quantity of coal from the Fairmont district reaches New York Harbor over the Reading Railroad and smaller quantities from the districts in western Pennsylvania reach tide at New York over the Pennsylvania Railroad. Nearly half of the bituminous coal dumped at New York is used locally, and about half the remainder is taken for fuel by vessels engaged in foreign trade. About 2,600,000 tons, or 20 per cent of the total, is transshipped, mainly in barges, to New England points on Long Island Sound. Little or no export coal originates at the port of New York.

The piers in Delaware River handled 3,186,000 net tons of bituminous coal in 1917, of which about 1,173,000 tons, or 37 per cent, was used locally, and about 900,000 tons, or 30 per cent, was shipped in coastwise trade to New England.

Baltimore ranks fourth in the United States as a coal-handling port. The quantity dumped there in 1917 amounted to about 3,000,000 net tons, of which 1,111,000 tons was destined for New England and 976,000 tons was used in Chesapeake Bay.

Hampton Roads is the chief coal-handling port of the United States. More than 17,300,000 net tons of bituminous coal was dumped in 1917 over the piers of the three railroads (Chesapeake & Ohio, Norfolk & Western, and Virginian), reaching this terminal, of which one-half was shipped to New England and about one-quarter to foreign countries. Compared with 3,000,000 tons taken in 1917 at New York Harbor for bunkering vessels engaged in foreign trade, 2,203,000 tons was so consigned at Hampton Roads.

The South Atlantic and Gulf ports, south of Hampton Roads, are of relatively small but increasing importance in the coal trade. The total quantity of coal handled at all these ports in 1917 was less than a million tons (935,431 net tons), mainly for steamship bunkers and largely from the Alabama coal fields.

Because of the domination of fuel oil on the Pacific coast the tidewater coal trade has not in recent years assumed an important part. Only a little more than half a million tons of coal was shipped to tide at all Pacific coast ports in 1917, including 252,000 tons of imports at American ports reshipped for steamship bunkers.

Bituminous coal received in New England is in small part taken for bunkers by ships trading at the various ports. The business in 1917 amounted to 300,000 tons divided about equally between bunkers for vessels in foreign and in domestic trade.

Source and distribution of bituminous coal dumped at different ports, 1917.

New York Harbor.

[Quantities in net tons.]

Originating field.	Cargo.			Bunker.		Total.
	Foreign.	Coastwise.	Local.	Foreign	Coastwise.	
Central Pennsylvania [a]	2,708	785,611	4,922,508	1,988,250	472,200	8,171,277
Greensburg		358,960	34,549	11,200	22,400	427,109
Westmoreland [b]		408,800	102,853	22,400	39,200	573,253
Pittsburgh [c]		52,800	294,960	28,000	56,000	431,760
Somerset	7,165	300,835	421,924	504,000	240,000	1,473,924
Cumberland-Piedmont	4,777	286,423	342,459	476,000	382,400	1,492,059
Fairmont	1,420	458,399	477,734	11,760	129,480	1,078,793
Ohio No. 8			19,528	807	347	20,682
	16,070	2,651,828	6.616,515	3,042,417	1,342,027	13,668,857

Philadelphia and Wilmington.

Originating field.	Cargo: Foreign.	Cargo: Coastwise.	Cargo: Local.	Bunker: Foreign	Bunker: Coastwise.	Total.
Central Pennsylvania [c]	213,635	107,960	338,306	211,471	111,119	982,491
Greensburg	15,144	69,035	50,886	2,632	5,263	142,960
Westmoreland [b]	239,003	232,336	47,112	2,369	4,740	525,560
Pittsburgh [a]	9,284	11,745	91,472	5,541	3,909	121,951
Somerset-Meyersdale	20,823	122,775	188,672	59,818	31,285	423,373
Cumberland-Piedmont	16,658	110,459	220,839	6,008	5,665	359,629
Fairmont	45,811	289,106	221,993	33,738	25,099	615,747
Ohio No. 8			13,359	632	698	14,689
	560,358	943,416	1,172,639	322,209	187,778	3,186,400

Baltimore.

Originating field.	Cargo: Foreign.	Cargo: Coastwise.	Cargo: Local.	Bunker: Foreign	Bunker: Coastwise.	Total.
Central Pennsylvania	18,872	262	132,972	201,954	67,318	421,378
Greensburg			78,385	10,597	4,163	93,145
Westmoreland [b]	59,223		36,733	10,121	3,373	109,450
Pittsburgh [d]	8,105	107	14,729	2,508	278	25,727
Cumberland-Piedmont Somerset-Meyersdale	86,673	315,420	681,648	127,748	167,055	1,378,544
Fairmont	107,324	795,460	31,884	20,175	49,859	1,004,702
Ohio No. 8			112	576		688
	280,197	1,111,249	976,463	373,679	292,046	3,033,634

Hampton Roads.

Originating field.	Cargo: Foreign.	Cargo: Coastwise.	Cargo: Local.	Bunker: Foreign	Bunker: Coastwise.	Total.
Pocahontas	1,950,808	2,215,289	274,695	814,212	301,158	5,556,162
Tug River	97,554	401,381	33,515	145,768	53,913	732,131
Clinch Valley	25,336	420,671		35,722	13,213	494,942
Thacker	41,377	96,409	79,628	12,684	6,490	236,588
Kenova	163	697			368	1,228
Radford	5,087				829	5,916
New River	2,142,949	4,973,329	414,690	1,161,723	509,207	9,201,898
Kanawha	395,735	650,986	56,894	33,316	14,279	1,151,210
	4,659,009	8,758,762	859,422	2,203,425	899,457	17,380,075

[a] Includes a small quantity of coal originating on the Pennsylvania Railroad and connecting lines in northwestern Pennsylvania.
[b] Includes coal originating on the Pennsylvania Railroad in the Connellsville district.
[c] Includes coal originating on the Baltimore & Ohio and Pittsburgh & Lake Erie railroads in the Connellsville district.
[d] Includes coal originating on the Baltimore & Ohio Railroad in the Connellsville district.

Source and distribution of bituminous coal dumped at different ports, 1917—Cont.

South Atlantic and Gulf ports.

Originating field.[a]	Cargo, foreign.	Bunker.		Total.
		Foreign.	Coastwise.	
Southwestern Virginia	17,339	66,300	4,200	87,839
Southeastern Kentucky	8,500	25,500	2,600	36,600
Tennessee	1,200	11,488	1,500	14,188
Alabama	49,896	378,101	153,907	581,904
Western Kentucky	2,050			2,050
Illinois	2,450			2,450
Texas	43	58,545	8,812	67,400
New Mexico		120,000	23,000	143,000
	81,478	659,934	194,019	935,431

Pacific coast ports.

Originating field.[a]	Cargo.		Bunker.		Total.
	Foreign.	Coastwise.	Foreign.	Coastwise.	
Washington	6,477	86,694	112,230	108,186	313,587
Utah and southern Wyoming	193		17,645	5,023	22,861
Imports	227		240,103	11,954	252,284
	6,897	86,694	369,978	125,163	588,732

New England ports.

Originating field.[b]	Cargo, foreign.	Bunker.		Total.
		Foreign.	Coastwise.	
Pocahontas	272	102,524	120,000	222,796
Cental Pennsylvania		19,204	30,000	49,204
Fairmont		5,126		5,126
Imports		25,272		25,272
	272	152,126	150,000	302,398

[a] Estimated by fields.
[b] Estimated by source. Figures in this table are not included in the distribution by producing districts as bunker and cargo coal, but are included under shipments to New England.

DISTRIBUTION OF LAKE CARGO SHIPMENTS.[1]

A portion of Canada and a section of the United States in the region of the head of the Great Lakes depend largely for bituminous coal on the supplies taken up each summer from eastern coal fields by vessels from lower Lake ports. More than 26,000,000 net tons of bituminous coal was shipped up the Lakes in the season of 1917 from producing districts in Pennsylvania, Ohio, Kentucky, West Virginia, and Tennessee.

[1] The statistics of Lake cargo shipments presented here are those compiled by the Ohio Bureau of Coal Statistics.

Bituminous coal shipped to lower Lake ports in 1917, by districts, in net tons.

Producing district.	Toledo.	Sandusky.	Huron.	Lorain.	Cleveland.	Fairport.	Ashtabula.	Conneaut.	Erie.	Total.
Pittsburgh		16,634	473,806	37,806	727,202	255,078	3,077,243	1,631,940	439,738	6,659,447
Pennsylvania (outside Pittsburgh district)		47					17,563	844,329	27,430	889,369
Northern Ohio [a]	1,342	41,459	1,348,623	1,803,198	1,211,212		252,386		255,551	4,913,771
Southern Ohio	2,897,788	2,111		7,726						2,907,625
Fairmont	5,780			1,004,710			18,711			1,029,201
Kanawha (Chesapeake & Ohio Ry.)	3,674,768									3,674,768
Kanawha (Kanawha & Michigan Ry.) [b]	1,421,561									1,421,561
Thacker-Kenova	15,897	961,957								977,854
Cumberland-Piedmont				6,307						6,307
New River	578,314									578,314
Pocahontas	104,312	2,471,614								2,575,956
Northeastern Kentucky [c]	651,397									651,397
Southeastern Kentucky [d]	537,369									537,369
Virginia and Tennessee	5,817									5,817
	9,894,345	3,493,852	1,822,429	2,859,747	1,938,414	255,078	3,365,903	2,476,269	722,719	26,828,756

[a] Includes northern Ohio, Ohio No. 8, and Cambridge districts, as shown by Ohio Bureau of Coal Statistics.
[b] Includes Kanawha & Michigan and Coal & Coke railways in the Kanawha district, and Kanawha & West Virginia Railroad and short-line connections.
[c] Includes Chesapeake & Ohio Railway and Sandy Valley & Elkhorn railroads and short-line connections.
[d] Includes Louisville & Nashville Railroad and Cincinnati, New Orleans & Texas Pacific Railway and short-line connections.

Bituminous coal shipped to lower Lake ports in 1917, by months, in net tons.

Producing district.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Pittsburgh	182,894	764,793	825,962	903,763	1,189,796	1,118,162	1,000,149	568,525	105,403	6,659,447
Pennsylvania (outside Pittsburgh district)	50,947	104,302	71,602	119,570	123,607	109,977	142,204	152,067	15,093	889,369
Northern Ohio [a]	143,178	434,611	708,649	602,194	747,174	775,190	761,356	651,735	89,684	4,913,771
Southern Ohio	28,616	165,528	312,316	466,141	525,974	531,840	433,213	359,552	84,445	2,907,625
Fairmont	1,933	52,917	77,694	123,386	192,012	257,158	175,068	138,762	10,271	1,029,201
Kanawha (Chesapeake & Ohio Ry.)	75,634	289,810	454,766	478,149	507,113	663,075	573,808	487,734	144,679	3,674,768
Kanawha (Kanawha & Michigan Ry.) [b]	39,317	135,982	201,318	200,950	261,867	232,019	188,418	130,643	31,047	1,421,561
Thacker-Kenova	29,173	116,179	98,315	145,984	169,549	182,456	109,235	89,341	37,622	977,854
Cumberland-Piedmont		3,524	323	1,673	318	469				6,307
New River		47,326	58,471	67,264	65,122	109,858	103,947	100,627	25,699	578,314
Pocahontas	82,288	249,464	301,198	374,655	335,580	478,995	362,518	305,559	85,699	2,575,956
Northeastern Kentucky [c]	7,650	26,587	101,051	78,556	90,893	149,100	92,629	87,719	17,212	651,397
Southeastern Kentucky [d]	9,849	37,095	37,494	117,226	102,996	90,938	71,304	57,683	12,784	537,369
Virginia			990							990
Tennessee					4,726	101				4,827
	651,479	2,428,118	3,250,149	3,679,511	4,316,727	4,699,338	4,013,849	3,129,947	659,638	26,828,756

[a] Includes northern Ohio, Ohio No. 8, and Cambridge districts, as shown by Ohio Bureau of Coal Statistics.
[b] Includes Kanawha & Michigan and Coal & Coke railways in the Kanawha district, and Kanawha & West Virginia Railroad and short-line connections.
[c] Includes Chesapeake & Ohio Railway and Sandy Valley & Elkhorn railroads and short-line connections.
[d] Includes Louisville & Nashville Railroad and Cincinnati, New Orleans & Texas Pacific Railway and short-line connections.

Shipments of Lake coal by originating districts from 1909 to 1917 are given in the following table. The quantity shipped in 1917 almost equaled the previous high record of 1913 and exceeded the movement in 1916 by more than 2,000,000 tons, or 9 per cent.

Bituminous coal shipped to lower Lake ports, 1909–1917, in net tons.

Producing district.	1909	1910	1911	1912	1913	1914	1915	1916	1917
Pittsburgh	7,842,971	10,197,127	10,071,930	9,893,870	12,261,334	10,216,126	9,350,166	8,672,829	6,659,447
Pennsylvania (outside Pittsburgh district)	212,518	245,116	155,877	158,719	301,179	423,609	269,535	91,709	889,369
Northern Ohio [a]	1,718,801	2,303,278	2,739,069	3,094,388	4,248,309	512,123	2,168,481	4,474,067	4,913,771
Southern Ohio	1,199,670	1,464,684	1,370,925	1,223,249	1,397,718	734,456	315,846	827,906	2,907,625
Fairmont	1,277,011	1,611,005	1,784,279	1,686,729	2,161,523	2,214,672	2,030,408	1,617,945	1,029,201
Kanawha (Chesapeake & Ohio Ry.)	910,290	1,343,148	1,799,956	1,160,736	1,570,477	2,202,076	2,181,668	2,930,765	3,674,768
Kanawha (Kanawha & Michigan Ry.) [b]	866,696	1,272,169	1,307,576	1,053,320	1,385,844	1,263,866	1,321,172	1,272,618	1,429,561
Kenova-Thacker	240,781	320,317	380,619	366,140	587,648	627,167	628,348	884,871	977,854
Cumberland-Piedmont	39,428	102,219	43,545	34,750	32,741	35,961	26,229	11,250	6,307
New River	235,726	410,031	639,217	988,985	488,338	414,474	338,671	505,396	578,314
Pocahontas	798,818	987,124	1,324,192	1,622,467	1,998,116	1,880,260	2,175,676	2,480,822	2,575,956
Northeastern Kentucky [c]	7,849	....	6,075	20,487	386,396	842,466	633,566	745,137	651,397
Southeastern Kentucky [d]	....	11,031	3,743	6,164	10,724	16,361	67,608	174,621	537,369
Virginia	....	....	....	....	....	....	....	....	990
Tennessee	....	....	....	....	....	....	....	....	4,827
	15,350,559	20,267,249	21,627,003	21,310,004	26,830,347	21,383,617	21,507,374	24,692,936	26,828,756

[a] Includes Northern Ohio, Ohio No. 8, and Cambridge districts, as shown by Ohio Bureau of Coal Statistics.
[b] Includes Kanawha & Michigan and Coal & Coke railways in the Kanawha district and Kanawha & West Virginia Railroad and short-line connections.
[c] Includes Chesapeake & Ohio Railway and Sandy Valley and Elkhorn railroads and short-line connections.
[d] Includes Louisville & Nashville Railroad and Cincinnati, New Orleans & Texas Pacific Railway and short-line connections.

The Lake coal is received at the upper Lake ports, both Canadian and American, on Lake Superior and at American docks on Lake Michigan as well as to a less extent at points on Lake Huron and at Canadian ports on Lake Erie. Coal loaded at Lake Erie ports is also transported down the Lakes to points on Lake Ontario. Coal loaded in vessels at Lake Erie ports reaches Canada by delivery direct to Canadian Lake ports or by subsequent rail delivery from American docks at upper Lake ports. The receipts of bituminous coal in Canada by way of the Lakes in 1917 was 7,201,000 net tons, or 27 per cent of the total movement. Coal for use of the railroads in the Northwest is a large item in the Lake trade, and 4,371,500 tons were taken from the receipts in 1917 for this purpose. Wisconsin and Minnesota likewise each received more than 4,000,000 tons of Lake coal in 1917, and Michigan, mainly the Upper Peninsula, received more than 2,700,000 tons. For the use mainly of the by-product coke ovens in the Chicago district more than 1,600,000 tons of Lake coal were received in Illinois and Indiana in 1917.

The statistics in the following table showing the distribution of Lake coal in 1917 were obtained largely from the reports of the Northwest Coal Dock Operators Association, through the courtesy of W. H. Groverman, secretary.

Distribution of Lake cargo bituminous coal, 1917.

	Net tons.
United States:	
Commercial coal:	
Illinois	1,050,221
Indiana	562,850
Iowa	271,560
Michigan	2,726,931
Minnesota	4,151,132
Nebraska	54,842
North Dakota	618,131
South Dakota	477,961
Montana	29,289
Oregon	16,925
Wisconsin	4,484,768
New York	155,145
Ohio	56,171
Washington	35
Idaho	43
Kansas	30
	14,656,034
Railroad fuel	4,371,526
Exported to Canada, Lake and rail[1]	7,201,196
Increase in stocks on hand at upper Lake docks in United States	600,000
Total Lake cargo shipments	26,828,756

BITUMINOUS COAL AND LIGNITE SHIPPED BY RAILROADS AND RIVERS.

According to the reports furnished to the Geological Survey by the coal operators, bituminous coal and lignite shipped by railroads in 1917 amounted to 469,850,975 net tons, compared with 423,666,685 tons in 1916. The shipments, which are summarized by railroads in

[1] By water from lower Lake ports and by rail from upper Lake ports.

the accompanying table, include all coal loaded on cars at the mines. A small part of the coal shipped is carried only a short distance, perhaps only switched from the tipple to coke ovens or to some adjacent industrial plant, but the greater part is moved a considerable distance from the mines. As these statistics include fuel coal taken by railroads that serve the coal mines, not all the shipments furnished revenue to the railroads, coal for "company use" being nonrevenue freight. The statistics of coal traffic published by a railroad company usually show only revenue freight and include coal received from connecting lines as well as that originating at mines on the line. For that reason the figures given in the following table will be at variance with those that may be compiled by the railroads.

The table of railroad shipments in this report is arranged in a form different from that of the tables in previous reports of the series. The quantities of bituminous coal and lignite shipped on each road are given in so far as they can be published without disclosing the output of individual mines, rather than combined, as in previous reports, according to the railroad system to which the roads belong, and the names of the roads are arranged in alphabetical order rather than in the order of the importance of the roads as coal carriers. The name of every railroad on which coal was reported to have originated is given, and for most of the roads the quantity from each States. Roads on which the mines are operated by less than three companies are grouped in such a manner as to avoid disclosing the operations of mines or companies.

Shipments originating on rivers are given at the end of the table.

Bituminous coal shipped in the United States in 1917, by originating railroads and waterways, in net tons.

Route.	State.	Quantity.	Total.
Railroad.			
Alabama Central	Alabama	74,464	74,464
Altoona Northern	Pennsylvania	81,460	81,460
Arkansas Central	Arkansas	21,618	21,618
Ashland Coal & Iron	Kentucky	138,589	138,589
Atchison, Topeka & Santa Fe	Colorado	741,289	5,448,880
	Illinois	362,118	
	Kansas	1,783,174	
	Missouri	595,243	
	New Mexico	1,824,928	
	Oklahoma	142,128	
Atlanta, Birmingham & Atlantic	Alabama	185,297	185,297
Baltimore & Ohio	Illinois	2,101,209	34,093,939
	Indiana	278,529	
	Maryland	85,826	
	Ohio	9,418,515	
	Pennsylvania	9,015,913	
	West Virginia	13,193,947	
Beaver Valley T action	Pennsylvania	8,098	8,098
Bessemer & Lake Erie	do	3,631,939	3,631,939
Bevier & Southern	Missouri	612,719	612,719
Big Sandy & Cumberland	Kentucky	6,000	6,000
Birmingham Southern	Alabama	3,144,419	3,144,419
Book Cliff	Colorado	3,261	3,261
Buffalo Creek & Gauley	West Virginia	349,141	349,141
Buffalo, Rochester & Pittsburgh	Pennsylvania	10,728,252	10,728,252
Buffalo & Susquehanna	do	1,791,002	1,791,002
Cambria & Indiana	do	1,286,191	1,286,191
Campbell's Creek	West Virginia	352,040	352,040
Carolina, Clinchfield & Ohio	Kentucky	7,559	1,880,890
	Virginia	1,873,331	
Caseyville	Illinois	7,909	7,909
Central of Georgia	Alabama	767,618	805,473
	Georgia	37,855	
Central Indiana	Indiana	111,425	111,425

Bituminous coal shipped in the United States in 1917, etc.—Continued.

Route.	State.	Quantity.	Total.
Railroad—Continued.			
Chesapeake & Ohio	Kentucky	2,395,544	25,647,120
	West Virginia	23,251,576	
Chicago & Alton	Illinois	3,387,662	3,694,813
	Missouri	307,151	
Chicago, Burlington & Quincy	Colorado	480,535	17,571,303
	Illinois	13,077,728	
	Iowa	965,105	
	Missouri	612,462	
	Wyoming	2,435,473	
Chicago & Eastern Illinois	Illinois	7,165,312	14,386,738
	Indiana	7,221,426	
Chicago Great Western	Iowa	272,642	272,642
Chicago & Illinois Midland	Illinois	1,727,500	1,727,500
Chicago, Indianapolis & Louisville	Indiana	1,481,483	1,481,483
Chicago, Milwaukee & St. Paul	Illinois	1,373,123	4,100,648
	Iowa	1,660,216	
	Montana	987,665	
	North Dakota	16,065	
	South Dakota	647	
	Washington	62,932	
Chicago & Northwestern	Illinois	5,009,971	7,344,772
	Iowa	2,130,398	
	Wyoming	204,403	
Chicago, Peoria & St. Louis	Illinois	859,485	859,485
Chicago, Rock Island & Pacific	Arkansas	155,846	4,045,162
	Colorado	83,805	
	Illinois	273,935	
	Iowa	2,238,496	
	Missouri	95,860	
	Oklahoma	1,163,518	
	Texas	33,702	
Chicago, Terre Haute & Southeastern	Indiana	5,479,632	5,479,632
Cincinnati, Indianapolis & Western	Illinois	256,314	256,314
Cleveland, Chicago, Cincinnati & St. Louis	....do	7,527,822	8,789,599
	Indiana	1,261,777	
Coal and Coke	West Virginia	1,091,088	1,091,088
Cobbs Creek	....do	7,916	7,916
Colorado Midland	Colorado	260,530	260,530
Colorado & Southern	....do	3,333,289	3,333,289
Colorado, Wyoming & Eastern	....do	202,541	202,541
Cumberland	Kentucky	185,601	185,601
Cumberland & Manchester	....do	286	286
Cumberland & Pennsylvania	Maryland	2,767,034	2,798,374
	Ohio	580	
	Pennsylvania	30,760	
Dayton Coal Manufacturing & Railway Co.	Tennessee	7,800	7,800
Denver & Intermountain	Colorado	117,805	117,805
Denver & Rio Grande	....do	2,890,982	6,058,813
	New Mexico	8,400	
	Utah	3,159,431	
Denver & Salt Lake	Colorado	1,033,015	1,033,015
Detroit, Toledo & Ironton	Ohio	408,403	408,403
East Broad Top	Pennsylvania	111,391	111,391
East Liverpool Traction & Light	....do	39,560	39,560
East St. Louis & Suburban	Illinois	860,624	860,624
Eastern Kentucky	Kentucky	18,231	18,231
Eastern Railway & Lumber Co	Washington	1,751	1,751
Elgin, Joliet & Eastern	Illinois	446,329	446,329
El Paso & Southwestern	New Mexico	873,370	873,370
Erie	Ohio	110,767	1,610,665
	Pennsylvania	1,499,898	
Evansville & Indianapolis	Indiana	535,991	535,991
Evansville, Suburban & Newburgh	....do	237,317	237,317
Fort Dodge, Des Moines & Southern	Iowa	111,718	111,718
Fort Smith & Western	Oklahoma	189,826	189,826
Great Northern	Montana	1,252,683	1,368,351
	North Dakota	111,877	
	Washington	3,791	
Hocking Valley	Ohio	5,506,085	5,506,085
Huntington & Broad Top Mountain	Pennsylvania	1,669,291	1,669,291
Illinois Central	Alabama	116,864	19,089,650
	Illinois	14,289,585	
	Indiana	554,251	
	Kentucky	4,128,950	
Illinois Southern	Illinois	394,857	394,857
Illinois Traction	....do	649,251	649,251
Indian Creek Valley	Pennsylvania	97,810	97,810
Indiana County Street Railway	....do	9,430	9,430
International & Great Northern	Texas	351,918	351,918

Bituminous coal shipped in the United States in 1917, etc.—Continued.

Route.	State.	Quantity.	Total.
Railroad—Continued.			
Interstate	Virginia	1,515,087	1,515,087
Interurban	Iowa	79,026	79,026
Iowa State Utilities	do	25,138	25,138
Johnstown & Stony Creek	Pennsylvania	164,425	164,425
Joplin & Pittsburgh	Kansas	28,928	28,928
Juniata & Southern	Pennsylvania	3,194	3,194
Kanawha, Glen Jean & Eastern	West Virginia	671,725	671,725
Kanawha & Michigan	Ohio	2,080,038	4,849,394
	West Virginia	2,769,356	
Kansas City, Clinton & Springfield	Missouri	13,066	13,066
Kansas City Northwestern	Kansas	2,524	2,524
Kansas City Southern	Arkansas	14,684	1,144,244
	Kansas	761,395	
	Missouri	249,917	
	Oklahoma	127,248	
Kentucky Midland	Kentucky	109,139	109,139
Kentucky & Tennessee	do	557,856	557,856
Lake Erie, Franklin & Clarion	Pennsylvania	384,442	384,442
Lake Erie & Western	Illinois	3,145	3,145
Ligonier Valley	Pennsylvania	926,047	926,047
Litchfield & Madison	Illinois	1,365,902	1,365,902
Louisville, Henderson & St. Louis	Kentucky	84,317	84,317
Louisville & Nashville	Alabama	3,555,390	18,549,484
	Illinois	1,180,466	
	Kentucky	12,749,684	
	Tennessee	918,957	
	Virginia	144,987	
Marietta, Columbus & Cleveland	Ohio	25,300	25,300
Marion & Eastern	Illinois	79,526	79,526
Mary Lee	Alabama	21,190	21,190
Michigan Central	Michigan	661,904	661,904
Midland Valley	Arkansas	310,515	379,424
	Oklahoma	68,909	
Minneapolis, St. Paul & Sault Ste. Marie	Montana	5,368	258,253
	North Dakota	252,885	
Minneapolis & St. Louis	Illinois	968,115	1,386,796
	Iowa	418,681	
Missouri, Kansas & Texas	Kansas	434,574	2,477,701
	Missouri	103,542	
	Oklahoma	1,396,844	
	Texas	542,741	
Missouri, Oklahoma & Gulf	Oklahoma	573,684	573,684
Missouri Pacific	Arkansas	877,230	7,303,392
	Illinois	3,676,046	
	Kansas	1,520,140	
	Missouri	1,229,976	
Mobile & Ohio	Alabama	326,382	1,657,501
	Illinois	1,331,119	
Monongahela	Pennsylvania	1,500,868	2,174,283
	West Virginia	673,415	
Montana, Wyoming & Southern	Montana	647,085	647,085
Montour	Pennsylvania	3,701,476	3,701,476
Morehead & North Fork	Kentucky	10,138	10,138
Morgan & Fentress	Tennessee	56,145	56,145
Morgantown & Kingwood	West Virginia	454,147	454,147
Nashville, Chattanooga & St. Louis	Alabama	18,037	1,182,950
	Tennessee	1,164,913	
New Mexico Central	New Mexico	600	600
New Mexico Midland	do	72,069	72,069
New York Central	Michigan	9,333	11,256,628
	Ohio	2,365,834	
	Pennsylvania	8,881,461	
Norfolk & Western	Kentucky	2,767,581	28,788,052
	Ohio	32,774	
	Virginia	2,693,647	
	West Virginia	23,294,050	
Northern Pacific	Montana	990,118	3,714,541
	North Dakota	178,744	
	Washington	2,545,679	
Norton & Northern	Virginia	73,149	73,149
Ohio & Kentucky	Kentucky	60,323	60,323
Ohio River Electric	Ohio	50,000	50,000
Oneida & Western	Tennessee	3,069	3,069
Oregon Short Line	Wyoming	1,548,930	1,548,930
Oregon-Washington Railroad and Navigation	Washington	207,886	496,523
	Wyoming	288,637	
Owensboro	Kentucky	9,692	9,692
Pacific Coast	Washington	722,507	722,507

Bituminous coal shipped in the United States in 1917, etc.—Continued.

Route.	State.	Quantity.	Total.
Railroad—Continued.			
Pennsylvania East	Pennsylvania	44,642,508	44,642,508
Pennsylvania West	Illinois	1,237,883	31,546,969
	Indiana	6,293,941	
	Ohio	9,900,542	
	Pennsylvania	13,187,102	
	West Virginia	927,501	
Peoria & Pekin Union	Illinois	542,720	542,720
Peoria Railway Terminal	do	222,294	222,294
Pere Marquette	Michigan	573,558	573,558
Pittsburgh, Chartiers & Youghiogheny	Pennsylvania	893,879	893,879
Pittsburgh & Lake Erie	do	7,367,333	7,367,333
Pittsburgh, Lisbon & Western	Ohio	41,592	87,681
	Pennsylvania	46,089	
Pittsburgh & Shawmut	do	2,505,102	2,505,102
Pittsburg, Shawmut & Northern	do	402,556	402,556
Pittsburgh & Susquehanna	do	303,315	303,315
Pittsburgh & West Virginia	Ohio	627,289	4,657,316
	Pennsylvania	3,915,672	
	West Virginia	114,355	
Puget Sound Electric	Washington	69,783	69,783
Quincy, Omaha & Kansas City	Missouri	216,358	216,358
Rio Grande & Eagle Pass	Texas	100,505	100,505
Rock Island & Southern	Illinois	128,371	128,371
St. Louis & Belleville & Electric	do	506,230	506,230
St. Louis & Hannibal	Missouri	11,968	11,968
St. Louis & O'Fallon	Illinois	1,052,925	1,052,925
St. Louis-San Francisco	Alabama	2,293,246	6,087,133
	Arkansas	629,515	
	Kansas	2,282,371	
	Missouri	391,996	
	Oklahoma	490,005	
St. Louis-Southwestern of Texas	Texas	73,266	73,266
St. Louis, Troy & Eastern	Illinois	1,590,065	1,590,065
Sandy Valley & Elkhorn	Kentucky	1,517,675	1,517,675
Santa Fe, Raton & Eastern	New Mexico	148,587	148,587
Seaboard Air Line	Alabama	45,452	45,452
Sewell Valley	West Virginia	20,070	20,070
Southern	Alabama	4,017,868	11,361,731
	Illinois	1,530,542	
	Indiana	1,487,247	
	Kentucky	490,282	
	Tennessee	2,402,509	
	Virginia	1,433,283	
Southern Pacific	California	2,800	141,998
	Oregon	13,502	
	Texas	125,696	
Susquehanna & New York	Pennsylvania	23,557	23,557
Tennessee	Tennessee	59,870	59,870
Tennessee Central	do	557,323	557,323
Texas & Pacific	Texas	952,742	952,742
Texas Short Line	do	76,643	76,643
Thomas & Sayreton	Alabama	476,467	476,467
Toledo & Ohio Central	Ohio	2,914,484	2,914,484
Toledo, Peoria & Western	Illinois	374,864	374,864
Toledo, St. Louis & Western	Illinois	813,246	828,756
	Indiana	15,510	
Trinity & Brazos Valley	Texas	35,145	35,145
Uintah	Colorado	10,996	12,496
	Utah	1,500	
Union	Pennsylvania	61,718	61,718
Union Pacific	Colorado	612,411	4,416,403
	Kansas	25,401	
	Missouri	50,591	
	Utah	25,749	
	Wyoming	3,702,251	
Utah	Utah	106,078	106,078
Virginian	Virginia	142	6,206,050
	West Virginia	6,205,908	
Wabash	Illinois	3,789,226	4,298,969
	Iowa	53,046	
	Missouri	456,697	
Wabash, Chester & Western	Illinois	94,119	94,119
Washington Run Railway	Pennsylvania	151,933	151,933
Western Allegheny	do	369,008	369,008
Western Maryland	Maryland	1,729,576	5,653,244
	Pennsylvania	545,537	
	West Virginia	3,378,131	
West Virginia Northern	do	232,048	232,048
Wheeling & Lake Erie	Ohio	3,647,864	3,647,864
Woodstock & Blockton	Alabama	101,730	101,730

Bituminous coal shipped in the United States in 1917, etc.—Continued.

Route.	State.	Quantity.	Total.
Railroad—Continued.			
Woodward Iron Co. Railroad	Alabama	60,347	60,347
Youngstown & Ohio River	Ohio	209,685	209,685
Youngstown & Southern Electric	do	3,600	3,600
Railroad total			459,165,646
Water.			
Coquille River	Oregon	234	234
Green River	Kentucky	37,900	37,900
Illinois River	Illinois	25,807	25,807
Kanawha River	West Virginia	988,551	988,551
Kentucky River	Kentucky	3,100	3,100
Missouri River	Missouri	4,143	4,143
Monongahela River	Pennsylvania	8,987,720	8,987,720
Ohio River	Indiana	32,648	568,376
	Ohio	117,644	
	Kentucky	396,351	
	West Virginia	21,733	
Warrior River	Alabama	67,945	67,945
Water total			10,683,776
Recapitulation.			
Railroad total			459,165,646
Water total			10,683,776
Miscellaneous			1,553
Grand total			469,850,975

DISTRIBUTION OF COAL, BY PRODUCING DISTRICTS.

CENTRAL PENNSYLVANIA.[1]

The coal fields of central Pennsylvania are the principal source of supply of all-rail coal for the most important industrial section of the United States. Steam coal for New England and the north Atlantic seaboard and Canada, railroad fuel, and bunker coal at New York and Philadelphia represent the principal markets. Of the total production of this district in 1917 of 59,000,000 net tons, 12,905,000 tons, or about 22 per cent, was used within the State of Pennsylvania; 14,424,000 tons, or 24.4 per cent, was shipped as commercial coal to other States by rail; 18,000,000 tons, or 30.5 per cent, was taken by railroads; and 9,550,000 tons, or 16 per cent was shipped to tidewater.

The coal produced in central Pennsylvania ranges from high to low volatile and, although not generally of the superior quality of the coal from the Pittsburgh district, to the west, or of the southern West Virginia fields, it meets the exacting demands for bunker coal and to a certain extent for the manufacture of by-product coke. This district is the nearest to the large steam-coal market of the northeastern section of the United States, and thereby derives its chief advantage through freight rates lower than those from competing fields farther west and south.

[1] The districts are arranged in this report in the order adopted by the Fuel Administration, from east to west, in order to permit ready reference from this report to the reports of the Fuel Administration.

Distribution of coal mined in the central Pennsylvania district in 1917.[a]

	Quantity (net tons).	Percentage of total.
Used in Pennsylvania:		
Used at mines for steam and heat	1,160,397	
Sold to coal trade, not shipped	2,239,021	
Made into coke at the mines	2,923,034	
Shipped to Pennsylvania points	6,582,783	
	12,905,235	21.9
Shipped to other States:		
Delaware	190,000	
District of Columbia	30,000	
Illinois	52,000	
Indiana	25,000	
Maryland	104,000	
Michigan	25,000	
New England States	5,847,364	
New Jersey	1,951,000	
New York	5,950,000	
Ohio	175,000	
Miscellaneous	75,000	
	14,424,364	24.4
Used by railroads, all-rail [b]	18,023,766	30.5
Exported by rail	3,070,000	5.2
Shipped to tidewater	9,550,146	16.2
Shipped to Great Lakes for cargo (by Lake Ontario)	1,070,581	1.8
	59,044,092	100.0

[a] Includes Bedford, Blair, Cambria, Cameron, Center, Clinton, Elk, Huntingdon, Indiana (except northwest corner), Jefferson, and McKean counties.
[b] Does not include 459,460 tons of railroad fuel shipped to tidewater and by Lake Ontario.

NORTHERN PENNSYLVANIA.

The scattered mines in the northwestern part of Pennsylvania find their principal markets in northern and western Pennsylvania, western New York, and Canada, and with the railroads for fuel.

Distribution of coal mined in the northern Pennsylvania district in 1917.

	Quantity (net tons).	Percentage of total.
Used in northern Pennsylvania:		
Used at mines for steam and heat	200,551	
Sold to coal trade, not shipped	367,192	
Made into coke at the mines		
Shipped to Pennsylvania points	1,878,029	
	2,445,772	33.1
Shipped to other States:		
New England States	350,000	
New Jersey	283,000	
New York	1,647,000	
Ohio	281,000	
	2,561,000	34.7
Used by railroads, all-rail	1,627,090	22.1
Exported by rail	578,000	7.8
Shipped to tidewater	25,000	.3
Shipped to Great Lakes for cargo	144,466	2.0
	7,381,328	100.0

PITTSBURGH, PA., AND PANHANDLE OF WEST VIRGINIA.

Next to central Pennsylvania the Pittsburgh field is the largest producing district in the East. The largest market for coal from this field is in the district about Pittsburgh in western Pennsylvania and northeastern Ohio. This field ships very little coal to tidewater but furnishes a large share of the coal for the Northwest by way of the Lakes. Nearly 10 per cent of the output in 1917 was taken by the railroads.

Distribution of coal mined in the Pittsburgh districts, Pa., and the Panhandle of West Virginia [a] in 1917.

	Quantity (net tons).	Percentage of total.
Used in West Virginia:		
Used at mines for steam and heat	49,516	
Sold to local trade, not shipped	792,686	
Shipped to West Virginia points	750,000	
	1,592,202	3
Used in Pennsylvania:		
Used at mines for steam and heat	806,627	
Sold to local trade, not shipped	1,600,487	
Made into coke at mines	1,529,748	
Shipped to Pennsylvania points	16,931,802	
	20,868,664	42
Shipped to other States by rail:		
Delaware	10,000	
Illinois	55,000	
Indiana	112,000	
Michigan	290,000	
New England	450,000	
New Jersey	1,170,000	
New York	4,130,000	
Ohio	7,025,500	
Wisconsin	18,000	
	13,260,500	26
Used by railroads, all rail delivery [b]	5,045,018	10
Exported by rail	2,289,000	4
Shipped to tidewater	379,438	1
Shipped to Great Lakes for cargo	7,152,947	14
	50,587,769	100

[a] Includes Pittsburgh district of Pennsylvania and Brooke, Hancock, Ohio, and Marshall counties, in West Virginia.
[b] Includes 126,626 tons originating on river, but not 1,848,296 tons shipped by Lake.

GREENSBURG-WESTMORELAND, LATROBE, AND LIGONIER DISTRICTS, PA.

The Greensburg-Westmoreland, Latrobe, and Ligonier districts constitute an important source of gas, by-product, and steam coal originating mainly on the Pennsylvania Railroad and its connections. Nearly half the output is either coked at the mines in beehive ovens or used by industries within the State, though from half to three-quarters of a million tons, representing in the aggregate 13 per cent of the output, were shipped to New England, New Jersey, and Ohio, with smaller quantities to New York, Delaware, and Maryland.

Distribution of coal mined in Greensburg-Westmoreland, Latrobe, and Ligonier districts,[a] Pa., in 1917.

	Quantity (net tons).	Percentage of total.
Used in Pennsylvania:		
Used at mines for steam and heat	323,844	....
Sold to local trade, not shipped	288,057	....
Made into coke at the mines	3,742,461	....
Shipped to Pennsylvania points	3,471,379	....
	7,825,741	46.4
Shipped to other States by rail:		
Delaware	75,000	....
Maryland	25,000	....
New England	543,000	....
New Jersey	505,000	....
New York	353,000	....
Ohio	750,000	....
	2,251,000	13.3
Used by railroads, all-rail delivery [b]	4,835,493	28.6
Exported by rail	350,000	2.1
Shipped to tidewater	1,616,985	9.6
Shipped to Great Lakes for cargoes [c]	....	....
	16,879,219	100.0

[a] Include the districts named in the northern part of Westmoreland County, Pa.
[b] Does not include 414,927 tons shipped to tidewater.
[c] Included with output of Pittsburgh district.

CONNELLSVILLE.

The Connellsville field is the principal source of beehive coke in the United States, and 26,500,000 tons, or 77 per cent of output of coal from this district, was charged into beehive ovens at the mines in 1917. Less than 4 per cent of the output was taken as railroad fuel and only small quantities were shipped either to tidewater or to the Lakes. Shipments of 1,793,500 tons to Ohio, almost entirely for use in by-product coke ovens indicate the extent to which coal from this field is reaching new markets.

Distribution of coal mined in Connellsville district in 1917.

	Quantity (net tons).	Percentage of total.
Used in Pennsylvania:		
Used at mines for steam and heat	799,058	....
Sold to local trade, not shipped	534,362	....
Made into coke at the mines	26,511,494	....
Shipped to Pennsylvania points	1,510,760	....
	29,355,674	84.8
Shipped to other States by rail:		
Delaware	30,000	....
Maryland	149,000	....
New England	400,000	....
New Jersey	300,000	....
New York	350,000	....
Ohio	1,793,500	....
West Virginia	150,000	....
	3,172,500	9.2
Used by railroads, all-rail delivery [a]	1,246,737	3.6
Exported by rail	161,000	.5
Shipped to tidewater	454,492	1.3
Shipped to Great Lakes for cargo	206,500	.6
	34,596,903	100.0

[a] Does not include 254,492 tons shipped by tidewater.

CUMBERLAND-PIEDMONT-SOMERSET.

The coal from the Cumberland-Piedmont-Somerset district, from which come the well-known Somerset smokeless coal and the Georges Creek smithing coal, has a wide distribution, although a large portion, 37 per cent in 1917, was shipped to tidewater for bunker coal.

Distribution of coal mined in Cumberland-Piedmont-Somerset districts [a] in 1917.

	Quantity (net tons).	Percentage of total.
Used in West Virginia:		
Used at mines for steam and heat	39,431	
Sold to local trade, not shipped	22,007	
Made into coke at the mines	19,104	
Shipped to West Virginia points	117,000	
	197,542	1.43
Used in Maryland:		
Used at mines for steam and heat	58,910	
Sold to local trade, not shipped	104,578	
Shipped to Maryland points	1,792,413	
	1,955,901	14.13
Used in Pennsylvania:		
Used at mines for steam and heat	209,250	
Sold to local trade, not shipped	246,622	
Shipped to Pennsylvania points	2,315,294	
	2,771,166	19.98
Shipped to other States by rail:		
Delaware	96,000	
District of Columbia	448,000	
New England	339,000	
New Jersey	779,000	
New York	100,000	
Ohio	236,000	
Virginia	41,000	
Illinois	15,000	
Indiana	1,000	
Michigan	5,000	
Missouri	10,000	
Miscellaneous shipments	100,000	
	2,170,000	15.67
Used by railroads, all-rail delivery [b]	1,562,890	11.33
Exported by rail	7,000	.05
Shipped to tidewater	5,127,529	37.04
Shipped to Great Lakes for cargo	51,210	.37
	13,843,238	100.00

[a] Includes Somerset County, Pa., all of Maryland, and Grant, Mineral, and Tucker counties, W. Va.
[b] Does not include 145,397 tons shipped by tidewater and 21,706 tons route of shipment not specified.

FAIRMONT.

The principal markets for Fairmont coal are as railroad fuel, for tidewater shipments, in large cargoes, and for industries in eastern Pennsylvania. A third of the output in 1917 was delivered to railroads for fuel and in addition a portion of the tidewater shipments were taken by railroads in New England. The better grades of Fairmont gas coal enjoy a fairly wide distribution and in normal times enter into the foreign markets.

Distribution of coal mined in Fairmont district in 1917.[a]

	Quantity (net tons).	Percentage of total.
Used in West Virginia:		
Used at mines for steam and heat	346,393	
Sold to local trade, not shipped	563,559	
Made into coke at the mines	1,164,196	
Shipped to West Virginia points	526,778	
	2,600,926	14.8
Shipped to other States by rail:		
Delaware	48,000	
District of Columbia	140,000	
Illinois	30,000	
Indiana	60,000	
Maryland	410,000	
Michigan	261,000	
New England	81,000	
New Jersey	750,000	
New York	358,000	
Ohio	523,000	
Pennsylvania	2,553,000	
Virginia	32,000	
	5,246,000	29.8
Used by railroads, all-rail delivery [b]	5,862,206	33.4
Exported by rail	130,000	.7
Shipped to tidewater	2,699,242	15.4
Shipped to Great Lakes for cargo	1,029,201	5.9
	17,567,575	100.0

[a] Includes Barbour, Braxton, Gilmer, Harrison, Lewis, Marion, Monongahela, Nicholas (mines on the B. & O. R. R.), Preston, Randolph, Taylor, Upshur, and Webster counties.
[b] Does not include 1,587,425 tons shipped to Great Lakes and to tidewater.

KANAWHA AND KENOVA-THACKER.

The high-volatile coals from the fields of southern West Virginia (including also a portion of Pike County, Ky.) on the Chesapeake & Ohio, Norfolk & Western, Coal & Coke, and Kanawha & Michigan railways reach markets east, west, north, and south over a wide area. Michigan, Ohio, Illinois, Indiana, and Wisconsin constitute the inland western market reached by all-rail routes. The coals from this field reach tidewater at Hampton Roads and also are shipped in large quantity to the Northwest by way of the Lakes. Railroad fuel in 1917 represented 20 per cent of the output of these districts.

Distribution of coal mined in Kanawha and Kenova-Thacker districts in 1917.

	Quantity (net tons).	Percentage of total.
Used in West Virginia:		
Used at mines for steam and heat	270,274	
Sold to local trade, not shipped	423,429	
Made into coke at the mines	303,000	
Shipped to West Virginia points	286,615	
	1,283,318	4.6
Used in Kentucky:		
Used at mines for steam and heat	43,580	
Sold to local trade, not shipped	90,939	
Shipped to Kentucky points	569,000	
	703,519	2.5
Shipped to other States by rail:		
Delaware	3,000	
District of Columbia	3,000	
Illinois	543,000	
Indiana	897,000	
Iowa	165,000	
Michigan	3,510,000	
Minnesota	60,000	
Missouri	20,000	
Nebraska	6,000	
New Jersey	25,000	
New York	3,000	
North Carolina	338,000	
Ohio	4,987,000	
Pennsylvania	250,000	
South Carolina	110,000	
South Dakota	15,000	
Virginia	730,000	
Wisconsin	963,000	
	12,628,000	45.3
Used by railroads, all-rail delivery [a]	5,601,077	20.1
Exported by rail	185,000	.7
Shipped to tidewater	1,389,026	5.0
Shipped to Great Lakes for cargo	6,074,183	21.0
	27,864,123	100.0

[a] Does not include 912,653 tons shipped to Great Lakes and to tidewater.

POCAHONTAS AND TUG RIVER.

The "smokeless" coal of southern West Virginia and Virginia is sold principally for industrial use, including the manufacture of by-product coke, and for domestic use in the West, mainly in Illinois, Indiana, Ohio, and Michigan by all-rail delivery, to the Northwest by way of the Great Lakes, and to tidewater. One-fourth of the output of the Pocahontas and Tug River fields in 1917 was shipped to tidewater, mainly for export and for New England. Smokeless coal is used for railroad fuel to only a small extent—5 per cent of the total output in 1917.

Distribution of coal mined in Pocahontas and Tug River districts in 1917.

	Quantity (net tons).	Percentage of total.
Used in West Virginia:		
Used at mines for steam and heat	312,708	
Sold to local trade, not shipped	346,865	
Made into coke at the mines	2,820,384	
Shipped to West Virginia points	182,666	
	3,662,623	14.7
Used in Virginia:		
Used at mines for steam and heat	56,305	
Sold to local trade, not shipped	94,696	
Made into coke at the mines	80,606	
Shipped to Virginia points	1,826,000	
	2,057,607	8.3
Shipped to other States by rail:		
Smithing coal—miscellaneous shipments	20,000	
District of Columbia	2,000	
Illinois	2,650,000	
Indiana	1,947,000	
Kentucky	75,000	
Maryland	1,000	
Michigan	793,000	
Missouri	102,000	
North Carolina	311,000	
Ohio	2,592,000	
South Carolina	100,000	
Wisconsin	345,000	
	8,938,000	35.8
Used by railroads, all-rail delivery [a]	1,250,967	5.0
Exported by rail	168,000	.7
Shipped to tidewater	6,294,209	25.2
Shipped to Great Lakes for cargo	2,575,956	10.3
	24,947,362	100.0

[a] Does not include 85,383 tons shipped to tidewater.

NEW RIVER.

Coal originating on the Virginian Railway is shipped almost entirely east to Hampton Roads and to inland eastern points in Virginia and the Carolinas. Operations in the New River field on the Chesapeake & Ohio Railway may ship either east or west, but the shipments are largely east. Nearly 61 per cent of the total output of the New River field in 1917 was shipped to tidewater, most of which was destined for New England and the remainder largely for export and for steamship bunkers.

Distribution of coal mined in New River district.

	Quantity (net tons).	Percentage of total.
Used in West Virginia:		
Used at mines for steam and heat	166,878	
Sold to local trade, not shipped	319,182	
Made into coke at the mines	448,941	
Shipped to West Virginia points	209,645	
	1,144,646	7.6
Shipped to other States by rail:		
District of Columbia	244,000	
Illinois	275,000	
Indiana	260,000	
Kentucky	20,000	
Michigan	309,000	
North Carolina	357,000	
Ohio	950,000	
South Carolina	201,000	
Virginia	596,000	
Miscellaneous shipments	60,000	
	3,272,000	21.7
Used by railroads, all-rail delivery [a]	897,178	5.9
Exported by rail	2,000	.1
Shipped to tidewater	9,201,898	60.9
Shipped to Great Lakes for cargo	578,314	3.8
	15,096,036	100.0

[a] Does not include 88,446 tons shipped to tidewater.

HAZARD.

Coal from the Hazard field in Kentucky is shipped mainly to Ohio, Michigan, and Indiana, where it is used for steam and domestic purposes and to some extent in the manufacture of by-product coke. About 14 per cent of the output was taken by the railroads in 1917 and 8 per cent was shipped to the Lakes.

Distribution of coal mined in Hazard district [a] in 1917.

	Quantity (net tons).	Percentage of total.
Used in Kentucky:		
Used at mines for steam and heat	10,371	
Sold to local trade, not shipped	41,362	
Shipped to Kentucky points	102,018	
	153,751	8.4
Shipped to other States by rail:		
Illinois	25,000	
Indiana	172,000	
Michigan	295,000	
Ohio	784,000	
	1,276,000	69.5
Used by railroads, all-rail delivery	254,836	13.9
Exported by rail	3,000	.2
Shipped to Great Lakes for cargo	147,766	8.0
	1,835,353	100.0

[a] Includes Breathitt, Lee, and Perry counties, Ky.

NORTHEASTERN KENTUCKY.

Coal from northeastern Kentucky is widely used for special purposes, as in the manufacture of by-product coke and gas, and for steam and domestic fuel. Illinois, Indiana, and Ohio are the principal all-rail markets, although shipments were made in 1917 by all-rail routes to 14 States. Lake shipments represented 13 per cent of the output in 1917, and railroad fuel nearly 8 per cent.

Distribution of coal mined in northeastern Kentucky.[a]

	Quantity (net tons).	Percentage of total.
Used in Kentucky:		
Used at mines for steam and heat	128,077	
Sold to local trade, not shipped	103,779	
Made into coke at the mines	198,934	
Shipped to Kentucky points	384,611	
	815,401	12.6
Shipped to other States by rail:		
Florida	3,000	
Illinois	428,000	
Iowa	198,000	
Indiana	900,000	
Kansas	27,000	
Michigan	797,000	
Minnesota	195,000	
Missouri	270,000	
Nebraska	45,000	
North Carolina	15,000	
Ohio	1,265,000	
South Dakota	60,000	
Tennessee	2,000	
Wisconsin	25,000	
	4,230,000	65.6
Used by railroads, all-rail delivery [b]	514,675	7.9
Exported by rail	37,000	.6
Shipped to Great Lakes for cargo	856,603	13.3
	6,453,679	100.0

[a] Boyd, Carter, Floyd, Johnson, Knott, Lawrence, Letcher, Morgan, and Pike (except operations on the Norfolk & Western Ry.) counties, Ky.
[b] Does not include 1,375 tons shipped to Great Lakes.

SOUTHEASTERN KENTUCKY.

Shipments were made from the coal mines in southeastern Kentucky in 1917 by all-rail routes to 20 States, Kentucky included. Some of the coal produced in this section has earned a high reputation as domestic fuel, and one company in this field reported as many individual customers in Iowa as in all other States combined.

Distribution of coal mined in southeastern Kentucky[a] in 1917.

	Quantity (net tons).	Percentage of total.
Used in Kentucky:		
Used at mines for steam and heat	113,333	
Sold to local trade, not shipped	124,846	
Made into coke at the mines	279,623	
Shipped to Kentucky points	949,480	
	1,467,282	22.9
Shipped to other States by rail:		
Alabama	50,000	
Florida	44,000	
Georgia	1,070,000	
Illinois	228,000	
Indiana	338,000	
Iowa	36,000	
Kansas	27,000	
Louisiana	81,000	
Michigan	445,000	
Minnesota	33,000	
Missouri	16,000	
North Carolina	91,000	
Ohio	477,000	
South Carolina	72,000	
South Dakota	24,000	
Tennessee	459,000	
Texas	27,000	
Virginia	10,000	
Wisconsin	57,000	
	3,585,000	56.2
Used by railroads, all-rail delivery	1,103,865	17.3
Exported by rail	4,000	.1
Shipped to tidewater	36,600	.6
Shipped to Great Lakes for cargo	184,397	2.9
	6,381,144	100.00

[a] Includes Bell, Clay, Harlan, Knox, Laurel, McCreary, and Whitley counties, Ky.

TENNESSEE.

The coal from Tennessee and southeastern Kentucky, generally known as the southern Appalachian district, has a diversified market. Coal produced in Tennessee in 1917 was marketed in 18 States, including the originating State, and the quantity so shipped was 60 per cent of the total output, the remainder having been taken almost entirely by the railroads.

Distribution of coal mined in Tennessee in 1917.

	Quantity (net tons).	Percentage of total.
Used in Tennessee:		
Used at mines for steam and heat	164,698	
Sold to local trade, not shipped	135,348	
Made into coke at the mines	723,589	
Shipped to Tennessee points	1,184,383	
	2,208,018	35.6
Shipped to other States by rail:		
Alabama	66,000	
Arkansas	3,000	
Florida	25,000	
Georgia	642,145	
Illinois	45,000	
Indiana	45,000	
Iowa	9,000	
Kentucky	27,000	
Louisiana	12,000	
Michigan	57,000	
Minnesota	9,000	
Missouri	6,000	
North Carolina	233,000	
Ohio	188,000	
South Carolina	135,000	
Texas	3,000	
Wisconsin	9,000	
	1,514,145	24.5
Used by railroads, all-rail delivery	2,457,870	39.7
Shipped to tidewater	14,188	.2
	6,194,221	100.0

GEORGIA.

Coal produced in Georgia was used within the State largely by the companies producing it.

Distribution of coal mined in Georgia in 1917.

	Quantity (net tons).	Percentage of total.
Used in Georgia:		
Used at mines for steam and heat	7,200	
Sold to coal trade, not shipped	1,284	
Made into coke at the mines	72,689	
Shipped to Georgia points	37,855	
	119,028	100.0

SOUTHWESTERN VIRGINIA.

The coal field in southwestern Virginia, which includes the Clinch Valley and other important producing districts in the State other than the Pocahontas field, is a source of supply of adjacent territory south and east and for the railroads in the southeastern section of the United States. In addition, high-grade gas coal is supplied for gas and for the manufacture of by-product coke in the Middle West in and about Chicago and is shipped to tidewater at Charleston and Hampton Roads for use as steamship bunker fuel and for shipment to New England.

Distribution of coal mined in southwestern Virginia[a] in 1917.

	Quantity (net tons).	Percentage of total.
Used in Virginia:		
Used at mines for steam and heat	88,926	
Sold to local trade, not shipped	78,839	
Made into coke at the mines	1,954,093	
Shipped to Virginia points	883,371	
	3,005,229	34.9
Shipped to other States by rail:		
Alabama	15,000	
Florida	51,000	
Georgia	200,000	
Illinois	74,000	
Indiana	115,000	
Kentucky	11,000	
Michigan	84,000	
North Carolina	753,000	
Ohio	78,000	
South Carolina	560,000	
Tennessee	360,000	
Texas	2,000	
West Virginia	50,000	
	2,353,000	27.3
Used by railroads, all-rail delivery[b]	2,657,491	30.9
Shipped to tidewater	582,781	6.7
Shipped to Great Lakes for cargo	5,817	.2
	8,604,318	100.0

[a] Includes Buchanan, Lee, Dickinson, Russell, and Wise counties and western part of Tazewell County, Va.
[b] Does not include 420,671 tons shipped to tidewater.

ALABAMA.

The greater part of the coal produced in Alabama is used within the State or is taken by railroads in the South. Shipments to neighboring States represented in 1917 only 13 per cent and shipments to tidewater only 3 per cent of the total output.

Distribution of coal mined in Alabama in 1917.

	Quantity (net tons).	Percentage of total.
Used in Alabama:		
Used at mines for steam and heat	641,733	
Sold to local trade, not shipped	508,398	
Made into coke at the mines[a]	3,645,227	
Shipped to Alabama	6,427,558	
	11,222,916	55.9
Shipped to other States by rail:		
Arkansas	15,000	
Florida	115,000	
Georgia	585,000	
Louisiana	925,000	
Mississippi	750,000	
Missouri	7,000	
Tennessee	175,000	
Texas	50,000	
	2,622,000	13.1
Used by railroads, all-rail delivery	5,641,254	28.1
Shipped to tidewater	581,904	2.9
	20,068,074	100.0

[a] Includes 2,127,000 tons shipped to beehive coke ovens.

SOUTHERN OHIO.

Southern Ohio, with which in these statistics is included Mason County, W. Va., finds its principal markets in western and northwestern Ohio and Michigan, in the Northwest by way of the Lakes, and with the railroads.

Distribution of coal mined in southern Ohio [a] in 1917.

	Quantity (net tons).	Percentage of total.
Used in Ohio:		
Used at mines for steam and heat	280,237	
Sold to local trade, not shipped	614,684	
Shipped to Ohio points	3,412,417	
	4,307,338	30.5
Used in West Vigrinia:		
Used at mines for steam and heat	9,751	
Sold to local trade, not shipped	26,665	
Shipped to West Virginia points	35,000	
	71,416	.5
Shipped to other States by rail:		
Illinois	65,000	
Indiana	162,000	
Michigan	1,969,000	
Wisconsin	25,000	
	2,221,000	15.8
Used by railroads, all-rail delivery [b]	4,485,023	31.8
Exported by rail	106,000	.8
Shipped to Great Lakes for cargo	2,907,625	20.6
	14,098,407	100.0

[a] Includes Athens, Gallia, Hocking, Jackson, Lawrence, Meigs, Monroe, Morgan, Muskingum, Perry, Scioto, Vinton, Washington counties, Ohio; Mason County, W. Va.
[b] Does not include 90.160 tons shipped to the Lakes.

NORTHERN OHIO.

Northern Ohio coal does not reach to such an extent as southern Ohio coal the all-rail inland markets outside of Ohio, but in the northeastern section of Ohio it finds a better market than the coal of the southern field. Like the southern field, northern Ohio ships much coal to the Lakes and is an important source of railroad fuel.

Distribution of coal mined in northern Ohio [a] in 1917.

	Quantity (net tons).	Percentage of total.
Used in Ohio:		
Used at mines for steam and heat	471,044	
Sold to local trade, not shipped	1,919,660	
Made into coke at the mines	630	
Shipped to Ohio points	8,922,713	
	11,314,047	43.6
Shipped to other States by rail:		
Illinois	25,000	
Indiana	146,000	
Michigan	810,000	
Minnesota	50,000	
New York	350,000	
Pennsylvania	160,000	
West Virginia	10,000	
Wisconsin	25,000	
	1,576,000	5.9
Used by railroads, all rail delivery [b]	7,088,626	26.4
Exported by rail	1,921,000	5.7
Shipped to tidewater	36,059	
Shipped to Great Lakes for cargo	4,913,771	18.4
	26,849,503	100.0

[a] Includes Belmont, Carroll, Columbiana, Coshocton, Guernsey, Harrison, Jefferson, Mahoning, Noble, Portage, Stark, Tuscarawas, and Wayne counties, Ohio.
[b] Does not include 1,563,801 tons shipped to the Lakes.

MICHIGAN.

The coal produced in Michigan is used within the State or taken by local railroads.

Distribution of coal mined in Michigan in 1917.

	Quantity (net tons).	Percentage of total.
Used in Michigan:		
Used at mines for steam and heat	47,965	
Sold to local trade, not shipped	82,045	
Shipped to Michigan points	883,948	
	1,013,958	73.8
Used by railroads	360,847	26.2
	1,374,805	100.0

WESTERN KENTUCKY.

Western Kentucky, although surrounded by other important coal-producing fields, finds a good market in Kentucky and the Mississippi Valley territory and also supplies coal to points as far north as Wisconsin. In all, 16 States used coal from Western Kentucky in 1917. Railroads are also large users of coal from western Kentucky.

Distribution of coal mined in western Kentucky in 1917.

	Quantity (net tons).	Percentage of total.
Used in Kentucky:		
Used at mines for steam and heat	344,616	
Sold to local trade, not shipped	532,654	
Made into coke at the mines	121,059	
Shipped to Kentucky points	1,988,171	
	2,986,500	29.1
Shipped to other States by rail:		
Alabama	100,000	
Arkansas	102,000	
Illinois	447,000	
Indiana	720,000	
Iowa	63,000	
Kansas	15,000	
Louisiana	669,000	
Mississippi	551,000	
Missouri	214,000	
Nebraska	36,000	
Ohio	30,000	
South Dakota	3,000	
Tennessee	1,192,000	
Texas	42,000	
Wisconsin	110,000	
	4,294,000	41.9
Used by railroads, all-rail delivery	2,966,930	29.0
Shipped to tidewater	2,050	.0
	10,249,480	100.0

INDIANA.

The principal markets for coal from Indiana are in Illinois (the Chicago district mainly), Indiana, and Wisconsin, and the railroads for fuel.

Distribution of coal mined in Indiana in 1917.

	Quantity (net tons).	Percentage of total.
Used in Indiana:		
Used at mines for steam and heat	642,551	
Sold to local trade, not shipped	905,601	
Shipped to Indiana points	10,293,146	
	11,841,298	44.6
Shipped to other States by rail:		
Illinois	5,165,000	
Iowa	247,000	
Kentucky	136,000	
Michigan	674,000	
Minnesota	199,000	
Missouri	54,000	
Nebraska	9,000	
North Dakota	3,000	
Ohio	134,000	
South Dakota	15,000	
Wisconsin	564,000	
	7,200,000	27.1
Used by railroads, all-rail delivery	7,498,031	28.3
	26,539,329	100.0

ILLINOIS.

Illinois coal is used largely as railroad fuel, and in 1917 nearly 35,500,000 tons, or 41 per cent of the total output, was so used. About 37 per cent of the total production was used within the State and 22 per cent was shipped to other States, Missouri, Iowa, Indiana, Wisconsin, Minnesota, and Michigan being the largest users.

Distribution of coal mined in Illinois in 1917.

	Quantity (net tons).	Percentage of total.
Used in Illinois:		
Used at mines for steam and heat	2,374,250	
Sold to local trade, not shipped	3,541,792	
Shipped to Illinois points	25,780,675	
	31,696,717	36.7
Shipped to other States by rail:		
Arkansas	96,000	
Indiana	2,255,000	
Iowa	4,026,000	
Kansas	107,000	
Kentucky	18,000	
Louisiana	102,000	
Michigan	706,000	
Minnesota	1,801,000	
Missouri	6,806,000	
Mississippi	55,000	
Nebraska	661,000	
North Dakota	43,000	
Ohio	63,000	
South Dakota	231,000	
Tennessee	50,000	
Texas	63,000	
Wisconsin	1,936,000	
	19,019,000	22.1
Used by railroads, all-rail delivery	35,431,220	41.1
Exported by rail	50,000	.1
Shipped to tidewater	2,450	
	86,199,387	100.0

IOWA.

Coal produced in Iowa is used within the State or is taken by railroads, only 5 per cent of the total in 1917 having been shipped to consumers outside of Iowa.

Distribution of coal mined in Iowa in 1917.

	Quantity (net tons).	Percentage of total.
Used in Iowa:		
Used at mines for steam and heat	226,394	
Sold to local trade, not shipped	784,970	
Shipped to Iowa	2,876,137	
	3,887,501	43.4
Shipped to other States by rail:		
Nebraska	130,000	
Missouri	239,000	
Kansas	15,000	
South Dakota	30,000	
Minnesota	31,000	
	445,000	5.0
Used by railroads, all-rail delivery	4,633,329	51.6
	8,965,830	100.0

MISSOURI.

Coal produced in Missouri finds little market outside the State. Nearly 55 per cent of the total output in 1917 was used in Missouri, 37 per cent was taken by railroads, and 8 per cent was shipped to other States, principally to Iowa and Kansas.

Distribution of coal mined in Missouri in 1917.

	Quantity (net tons).	Percentage of total.
Used in Missouri:		
Used at mines for steam and heat	151,781	
Sold to local trade, not shipped	576,079	
Shipped to Missouri points	2,386,733	
	3,114,593	54.9
Shipped to other States by rail:		
Colorado	4,000	
Iowa	58,000	
Kansas	261,000	
Nebraska	119,000	
Oklahoma	20,000	
	462,000	8.2
Used by railroads, all-rail delivery	2,093,956	36.9
	5,670,549	100.0

KANSAS.

Kansas supplies coal to a considerable part of the Mississippi Valley section from Omaha south. Nearly 34 per cent of the output in 1917 was used in Kansas, mainly in the eastern half of the State, and 22 per cent went to other States, largely to Missouri and Nebraska. The railroads took the remainder, 44 per cent of the total.

Distribution of coal mined in Kansas in 1917.

	Quantity (net tons).	Percentage of total.
Used in Kansas:		
Used at mines for steam and heat	185,464	
Sold to local trade, not shipped	161,004	
Shipped to Kansas points	2,090,326	
	2,436,794	33.9
Shipped to other States by rail:		
Arkansas	2.000	
Colorado	1,000	
Iowa	81,000	
Missouri	792,000	
Nebraska	556,000	
Oklahoma	116,000	
	1,548,000	21.6
Used by railroads, all-rail delivery	3,200,181	44.5
	7,184,975	100.0

ARKANSAS.

Coal ranking from bituminous to what is locally known as anthracite is produced in Arkansas. The high-grade coals from this field were marketed in 1917 from Minneapolis and St. Paul on the north to New Orleans on the south and from Tennessee to Kansas and Nebraska. About 34 per cent of the output was shipped to 10 States other than Arkansas, and an equal quantity, principally from the westernmost district in the State, was used by the railroads.

Distribution of coal mined in Arkansas in 1917.

	Quantity (net tons).	Percentage of total.
Used in Arkansas:		
Used at mines for steam and heat	75,067	
Sold to local trade, not shipped	59,104	
Shipped to Arkansas points	537,297	
	671,468	31.3
Shipped to other States by rail:		
Illinois	20,000	
Iowa	9,000	
Kansas	117,000	
Louisiana	31,000	
Minnesota	6,000	
Missouri	250,000	
Nebraska	50,000	
Oklahoma	89,000	
Tennessee	36,000	
Texas	127,000	
	735,000	34.3
Used by railroads, all-rail delivery	737,111	34.4
	2,143,579	100.0

OKLAHOMA.

More than half the coal produced in Oklahoma in 1917 was used by the railroads, a third of the total was used in the State and the remainder, 13 per cent, was shipped to eight neighboring States, mainly to Texas.

Distribution of coal mined in Oklahoma in 1917.

	Quantity (net tons).	Percentage of total.
Used in Oklahoma:		
Used at mines for steam and heat	189,190	
Sold to local trade, not shipped	45,492	
Shipped to Oklahoma points	1,244,331	
	1,479,013	33.7
Shipped to other States by rail:		
Arkansas	10,000	
Iowa	2,000	
Kansas	51,000	
Louisiana	2,000	
Missouri	91,000	
Nebraska	12,000	
New Mexico	4,000	
Texas	408,000	
	580,000	13.2
Used by railroads, all-rail delivery	2,327,831	53.1
	4,386,844	100.0

TEXAS.

With the exception of very small shipments to New Mexico and to Oklahoma—doubtless during the severe shortage in the later part of 1917—and of small quantities used at tidewater or shipped to Mexico from mines on the border, the coal produced in Texas in 1917 was used within the State or by the railroads.

Distribution of coal mined in Texas in 1917.

	Quantity (net tons).	Percentage of total.
Used in Texas:		
Used at mines for steam and heat	49,355	
Sold to local trade, not shipped	14,102	
Shipped to Texas points	1,172,576	
	1,236,033	52.5
Shipped to other States by rail:		
New Mexico	2,000	
Oklahoma	5,000	
	7,000	.3
Used by railroads, all-rail delivery	952,051	40.4
Exported by rail	93,331	3.9
Shipped to tidewater	67,400	2.9
	2,355,815	100.0

NORTH DAKOTA.

Lignite produced in North Dakota finds very little market outside of the State and, except for station use, is not taken by the railroads. More than 95 per cent of the total output in 1917 was used for domestic fuel, for raising steam, or in brickyards within the State.

Distribution of coal mined in North Dakota in 1917.

	Quantity (net tons).	Percentage of total.
Used in North Dakota:		
Used at mines for steam and heat	34,077	
Sold to local trade, not shipped	196,900	
Shipped to North Dakota points	521,216	
	752,193	95.2
Shipped to other States by rail:		
South Dakota	12,000	
	12,000	1.5
Used by railroads, all-rail delivery	26,355	3.3
	790,548	100.0

SOUTH DAKOTA.

The small quantity of lignite produced in South Dakota is used within the State.

MONTANA AND NORTHERN WYOMING.

More than half the coal produced in Montana and northern Wyoming is used by the railroads traversing these States. Both steam and domestic coal are supplied from these fields to the Missouri Valley territory, and Iowa, Nebraska, and South Dakota obtained in 1917 quantities ranging from 200,000 to 600,000 tons.

Distribution of coal mined in Montana and northern Wyoming in 1917.[a]

	Quantity (net tons).	Percentage of total.
Used in Montana:		
Used at mines for steam and heat	167,704	
Sold to local trade, not shipped	176,066	
Shipped to Montana points	1,230,000	
	1,573,770	22.4
Used in Wyoming:		
Used at mines for steam and heat	97,803	
Sold to local trade, not shipped	64,162	
Shipped to Wyoming points	123,233	
	285,198	4.0
Shipped to other States by rail:		
Idaho	28,000	
Iowa	324,000	
Missouri	20,000	
Nebraska	681,000	
North Dakota	96,000	
South Dakota	191,000	
Washington	121,000	
	1,461,000	20.8
Used by railroads, all-rail delivery	3,707,562	52.8
Exported by rail	1,000	
	7,028,530	100.0

[a] Include all of Montana and Wyoming, except Carbon, Lincoln, Sweetwater, and Uinta counties, Wyo.

UTAH AND SOUTHERN WYOMING.

The principal market for coal from Utah is with the railroads, and 47 per cent of the output in 1917 was used as railroad fuel. In 1917, because of the unusual conditions, coal from Utah was shipped as far east as Iowa, Kansas, and Nebraska, but the logical and principal commercial markets for this coal are on the west and north. A small quantity (23,000 tons, or less than a quarter of 1 per cent of the production) was shipped to tidewater at San Francisco.

Distribution of coal mined in Utah and southern Wyoming [a] in 1917.

	Quantity (net tons).	Percentage of total.
Used in Utah:		
Used at mines for steam and heat	86,128	
Sold to local trade, not shipped	77,028	
Made into coke at the mines	669,316	
Shipped to Utah points	1,378,000	
	2,210,472	22.3
Used in Wyoming:		
Used at mines for steam and heat	172,638	
Sold to local trade, not shipped	61,322	
Shipped to Wyoming points	159,737	
	393,697	4.0
Shipped to other States by rail:		
California	590,000	
Colorado	6,000	
Idaho	499,000	
Iowa	54,000	
Kansas	10,000	
Montana	365,000	
Nebraska	353,000	
Nevada	362,000	
Oregon	220,000	
Washington	137,000	
	2,596,000	26.2
Used by railroads, all-rail delivery	4,675,978	47.3
Shipped to tidewater	22,861	.2
	9,899,008	100.0

a Includes all of Utah and Carbon, Lincoln, Sweetwater, and Uinta counties, Wyo.

COLORADO.

In the iron and base metal industry of Colorado is found the principal market for coal produced in the fields of this State. More than 58 per cent of the product in 1917 was used in Colorado, and although commercial shipments were made to 11 other States the total so shipped was only 17 per cent of the output. Kansas and Nebraska on the east and Texas on the south represent the most important markets outside of the State. The railroads used nearly 25 per cent of the output in 1917, and a small quantity, 10,000 tons, was exported to Mexico.

Distribution of coal mined in Colorado in 1917.

	Quantity (net tons).	Percentage of total.
Used in Colorado:		
Used at mines for steam and heat	304,492	
Sold to local trade, not shipped	450,392	
Made into coke at the mines [a]	1,957,923	
Shipped to Colorado points	4,584,232	
	7,297,039	58.5
Shipped to other States by rail:		
Arizona	10,000	
California	30,000	
Iowa	15,000	
Kansas	600,000	
Nebraska	749,000	
New Mexico	168,000	
Oklahoma	90,000	
South Dakota	20,000	
Texas	378,000	
Wyoming	75,000	
Utah	3,000	
	2,138,000	17.1
Used by railroads, all-rail delivery	3,038,297	24.4
Exported by rail	10,000	
	12,483,336	100.0

[a] Includes approximately 1,215,000 tons coal shipped to beehive coke ovens.

NEW MEXICO.

About half the coal produced in New Mexico is used for railroad fuel and nearly one-third is consumed within the State, mainly in the production of beehive coke that is later shipped outside of New Mexico for consumption. Arizona and Texas are the principal outside commercial markets. Coal from New Mexico is also exported to Mexico and is shipped to tidewater at Gulf ports.

Distribution of coal mined in New Mexico in 1917.

	Quantity (net tons).	Percentage of total.
Used in New Mexico:		
Used at mines for steam and heat	36,449	
Sold to local trade, not shipped	44,636	
Made into coke at the mines [a]	991,488	
Shipped to New Mexico points	199,424	
	1,271,997	31.8
Shipped to other States by rail:		
Arizona	102,000	
California	85,000	
Colorado	72,000	
Kansas	94,000	
Oklahoma	24,000	
Texas	157,000	
	534,000	13.3
Used by railroads, all-rail delivery	1,991,066	49.8
Exported by rail	60,464	1.5
Shipped to tidewater	143,000	3.6
	4,000,527	100.0

[a] Includes approximately 533,000 tons of coal shipped to beehive coke ovens.

OREGON.

Coal produced in Oregon is used locally, the producing field in the vicinity of Coos Bay having no adequate outlet or substantial market territory.

WASHINGTON.

Of a production of coal in Washington in 1917 of more than 4,000,000 net tons 31 per cent was used within the State and 50 per cent was taken by railroads. Small shipments were made to Canada, Idaho, and California, and 345,000 tons was shipped to Oregon. About 300,000 tons, or nearly 8 per cent of the output in 1917, was shipped to tidewater points on Puget Sound and used largely for steamship bunker.

Distribution of coal mined in Washington in 1917.

	Quantity (net tons).	Percentage of total.
Used in Washington:		
Used at mines for steam and heat	166,399	
Sold to local trade, not shipped	71,606	
Made into coke at the mines	157,568	
Shipped to Washington points	843,127	
	1,238,700	30.9
Shipped to other States by rail:		
California	50,000	
Idaho	45,000	
Oregon	345,000	
	440,000	10.9
Used by railroads, all-rail delivery	2,002,615	50.0
Exported by rail	15,000	.4
Shipped to tidewater	313,587	7.8
	4,009,902	100.0

CALIFORNIA, IDAHO, AND ALASKA.

Coal produced in California and in Idaho is used locally, and that produced in Alaska is also used within the Territory, mainly at tidewater points.

DISTRIBUTION OF PENNSYLVANIA ANTHRACITE.

Data collected by the anthracite committee of the Fuel Administration, covering the distribution of Pennsylvania anthracite in the coal year 1916–17, are the only statistics available covering any part of the year 1917. The quantity distributed in this period, both domestic and steam sizes, was 80,568,000 net tons. Shipments in the same period originating at the mines, as reported by the Anthracite Bureau of Information, were about 76,000,000 net tons. About half of the difference is accounted for by local sales in the anthracite region. The remainder is not accounted for.

Pennsylvania anthracite sold in coal year Apr. 1, 1916, to Mar. 31, 1917, in net tons.

Consuming States.	Domestic sizes, including pea.	Steam sizes.	Total.	Percentage of total.
Middle Atlantic States:				
Pennsylvania	8,109,089	5,512,244	13,621,333	....
New York	15,870,681	6,780,216	22,650,897	....
New Jersey	5,320,870	4,594,287	9,915,157	....
	29,300,640	16,886,747	46,187,387	57.3
New England States:				
Maine	630,808	3,725	634,533	....
New Hampshire	352,326	173,207	525,533	....
Vermont	349,374	47,779	397,153	....
Massachusetts	5,636,662	396,282	6,032,944	....
Rhode Island	739,652	79,458	819,110	....
Connecticut	2,240,041	108,970	2,349,011	....
	9,948,863	809,421	10,758,284	13.4
South Atlantic and Southern States:				
Alabama	1,084	....	1,084	....
Arkansas	998	....	998	....
Delaware	250,779	23,890	274,669	....
District of Columbia	590,087	18,020	608,107	....
Florida	9,586	9,009	18,595	....
Georgia	24,977	52	25,029	....
Kentucky	10,154	....	10,154	....
Louisiana	7,007	....	7,007	....
Maryland	1,045,557	36,261	1,081,818	....
Mississippi	681	....	681	....
North Carolina	29,910	123	30,033	....
Oklahoma	808	....	808	....
South Carolina	26,290	....	26,290	....
Tennessee	4,423	638	5,061	....
Texas	7,781	....	7,781	....
Virginia	265,868	5,093	270,961	....
West Virginia	17,490	47,807	65,297	....
	2,293,480	140,893	2,434,373	3.0
North Central States:				
Illinois	2,639,102	167,265	2,806,367	....
Indiana	512,234	5,056	517,290	....
Iowa	469,010	2,684	471,694	....
Kansas	19,746	928	20,674	....
Michigan	1,782,145	15,930	1,798,075	....
Minnesota	1,177,898	149,152	1,327,050	....
Missouri	197,882	660	198,542	....
Nebraska	177,610	215	177,825	....
North Dakota	271,509	11,750	283,259	....
Ohio	649,914	18,144	668,058	....
South Dakota	236,835	3,463	240,298	....
Wisconsin	1,343,953	201,537	1,545,490	....
	9,477,838	576,784	10,054,622	12.5
Western States:				
California	1,175	....	1,175	....
Colorado	477	....	477	....
Idaho	460	....	460	....
Montana	9,887	67	9,954	....
Oregon	143	....	143	....
Washington	1,845	....	1,845	....
Wyoming	159	....	159	....
	14,146	67	14,213	....
Total distribution in United States for purposes other than railroad fuel	51,034,967	18,413,912	69,448,879	....
Used for railroad fuel	2,779,564	3,653,978	6,433,542	7.9
Miscellaneous	10,656	37,238	47,894	.1
Total distribution in United States	53,825,187	22,105,128	75,930,315	....
Exports:				
Canada	4,318,744	271,849	4,590,593	....
Newfoundland	5,419	....	5,419	....
Other exports	42,087	....	42,087	....
	4,366,250	271,849	4,638,099	5.8
Total distribution	58,191,437	22,376,977	80,568,414	100.0
Total shipments by railroad companies	....	....	75,909,780	....

EXPORTS AND IMPORTS.

The statistics of exports contained in the accompanying tables are taken from the records of the Bureau of Foreign and Domestic Commerce of the Department of Commerce.

Coal exported from the United States in 1915–1917, by countries, in net tons.

Country.	Bituminous.			Anthracite.		
	1915	1916	1917	1915	1916	1917
Europe:						
Azores and Madeira Islands	11,882	16,334	2,269			
Belgium						28
Denmark	2,999		11	95	36	
France	251,811	100,249	51,172	220		150
Greece	82,025	65,495	3,741	1,002	1,352	
Iceland and Faroe Islands		4,849			20	
Italy	3,283,371	1,943,281	627,903	27,965	12,119	399
Malta and Gozo					271	
Netherlands	42,800					
Norway	58,830	86,750	24,497		113	6
Portugal	22,118	19,425	49,428			291
Russia in Europe		6,376				
Serbia and Montenegro	160	50,723				
Spain	223,586	151,988	176,406	1,374	4	
Sweden	263,345	79,504		4,798		
Switzerland			4,546			42
United Kingdom:						
England	3,809	3,258	56,984	1	56	829
Ireland	700	352		358		782
	4,247,436	2,528,584	996,957	35,813	13,971	2,527
North America:						
Bermuda	30,161	38,265	44,526	2,885	3,161	1,956
British Honduras	429	1,073	1,346		90	45
Canada	9,356,872	13,260,180	18,117,377	3,852,894	4,556,375	5,915,074
Costa Rica	25,133	25,729	4,781	85	84	78
Guatemala	16,264	14,310	1,158	48	8	7
Honduras	20,558	14,286	12,488	69	1	
Nicaragua	1,074	2,867	3,249		11	
Panama	577,182	479,060	693,237	671	858	101
Salvador	26	2	2	7	14	3
Greenland	897	784	4,188			
Mexico	312,495	220,133	206,429	757	1,652	2,326
Miquelon, etc				607	598	225
Newfoundland and Labrador	2,518	15,042	3,919	14,020	24,733	11,599
West Indies:						
Barbados	98,285	107,405	62,604	195	525	325
Jamaica	49,528	64,570	79,866	249	115	22
Trinidad and Tobago	97,772	53,824	26,809	288	375	498
Other British West Indies	119,705	85,454	83,932	672	671	386
Cuba	1,305,976	1,438,263	1,579,865	37,679	43,314	43,355
Danish	29,630	30,800	37,986	209		37
Dominican Republic	15,043	22,262	19,142	8,709	8,302	13,148
Dutch	63,050	40,148	49,068		4	
French	95,150	91,916	89,252		11	3
Haiti	797	4	2,491	40	395	327
	12,218,345	16,006,377	21,123,715	3,920,084	4,641,297	5,989,515
South America:						
Argentina	881,403	1,032,605	355,671	2,830	1,713	10,718
Bolivia					310	112
Brazil	726,089	875,945	767,359	2,705	1,202	1,104
Chile	80,117	295,017	354,340	1,089	578	1,789
Colombia	4,425	9,629	13,250	177	1,674	21
Ecuador	6,741	25,264	17,833			28
Falkland Islands		1,966	5,424			
Guiana:						
British	22,549	11,224	2,129	114		6
Dutch	7,862	4,395	3,116			
Peru	16,681	45,824	18,304	199	259	222
Uruguay	177,185	171,060	67,411	678		224
Venezuela	9,456	3,430	944	1,496	2,195	993
	1,932,508	2,476,359	1,605,821	9,288	8,051	15,217

Coal exported from the United States in 1915–1917, etc.—Continued.

Country.	Bituminous.			Anthracite.		
	1915	1916	1917	1915	1916	1917
Asia:						
Dutch East Indies	18,101	17,846				
Russia in Asia		1				
	18,101	17,847				
Oceania:						
Australia		307		48		
Other British	11	1	113			1
Philippine Islands		43	73			
	11	351	186	48		1
Africa:						
British Africa:						
West	12,264	11	2,150			43
South					1,495	
East		1,247				
Canary Islands	26,862	6,892	1,412	21	716	
Egypt	178,436	101,608				
French Africa	123,306	114,205	95,258			
Morocco	7,233	1,146				
Portuguese Africa	12,138		14,059	1		3
	360,239	225,109	112,879	22	2,211	46
Grand total	18,776,640	21,254,627	23,839,558	3,965,255	4,665,530	6,007,306
Recapitulation:						
Europe	4,247,436	2,528,584	996,957	35,813	13,971	2,527
North America	12,218,345	16,006,377	21,123,715	3,920,084	4,641,297	5,989,515
South America	1,932,508	2,476,359	1,605,821	9,288	8,051	15,217
Asia	18,101	17,847				
Oceania	11	351	186	48		1
Africa	360,239	225,109	112,879	22	2,211	46
Grand total	18,776,640	21,254,627	23,839,558	3,965,255	4,665,530	6,007,306

Bituminous coal exported from the United States, 1915–1917, by customs districts and ports, in net tons.

Customs district.	Ocean port or rail gateway.	1915	1916	1917
North Atlantic:				
Massachusetts	Boston	160	478	272
New York	New York	37,092	47,372	16,070
Philadelphia	Philadelphia	1,166,858	993,833	560,358
Maryland	Baltimore	2,129,642	980,864	280,197
Virginia	Hampton Roads	5,804,787	5,695,868	4,659,009
		9,138,539	7,718,415	5,515,906
South Atlantic:				
North Carolina			9,930	
South Carolina	Charleston	7,293	64,390	12,537
Georgia	Savannah		688	6,502
Florida	Pensacola	1,909	7,213	23,173
Mobile	Mobile	6,599	10,940	17,054
New Orleans	New Orleans	12,132	17,713	22,169
Galveston				41
Sabine				2
		27,933	110,874	81,478
Mexican border:				
Arizona		33,188	62,502	60,464
Eagle Pass		524	12,114	
El Paso		196,020	61,716	69,761
Laredo		23,502	42,427	
San Antonio				33,570
		253,234	178,759	163,795
Pacific coast:				
Washington[a]		12,171	12,484	21,477
San Francisco		479	244	193
Southern California		286	690	227
		12,936	13,418	21,897
Lake Erie ports:				
Ohio lower Lake docks[b]		5,204,817	6,756,221	7,459,894
Rail gateways on Canadian border:				
Eastern:				
Maine and New Hampshire		120	477	203
Vermont		5,150	44,709	282,849
Buffalo		2,485,631	2,770,653	3,273,216
Michigan		613,377	923,709	1,920,644
Rochester[c]		645,671	1,466,939	1,596,000
St. Lawrence		300,418	1,137,795	3,031,028
		4,050,367	6,344,282	10,103,940
Western:				
Duluth and Superior-International Falls.		43,119	77,521	93,029
Dakota		43,602	54,280	398,761
Montana			53	512
		86,721	131,854	492,302
Miscellaneous:				
Hawaii		11	1	113
Porto Rico		1,995	575	114
Alaska		87	228	119
Total		18,776,640	21,254,627	23,839,558

[a] Rail to Canada and tidewater ports.
[b] Lower Lake docks as follows: Toledo, Sandusky, Huron, Lorain, Cleveland, Fairport, Ashtabula, Conneaut, Erie.
[c] Both rail-car ferry and Lake Ontario.

Anthracite exported from the United States in 1915–1917, by customs districts and ports, in net tons.

Customs district.	Ocean port or rail gateway.	1915	1916	1917
North Atlantic:				
Massachusetts	Boston	1,259	2,065	3,632
New York	New York	220,931	228,946	151,234
Philadelphia	Philadelphia	95,846	70,030	43,132
Maryland	Baltimore	3,533	1,590	426
Virginia	Hampton Roads	690	395	8,630
		322,259	302,926	207,054
South Atlantic:				
South Carolina	Charleston		56	
Georgia	Savannah			224
Florida	Pensacola	422	1,145	90
Mobile	Mobile	72		
New Orleans	New Orleans	215	192	188
Galveston			10	49
Sabine		103		
		812	1,403	551
Mexican border:				
Arizona		2		40
Eagle Pass				
El Paso			640	545
Laredo			261	588
San Antonio				
		2	901	1,173
Pacific coast:				
Washington [a]		85	240	268
San Francisco		7	19	29
Southern California		67	57	47
		159	316	344
Lake Erie ports:				
Ohio, [b] lower Lake Erie docks		64,419	185,688	84,301
Rail gateways on Canadian border:				
Eastern:				
Maine and New Hampshire		10,641	4,179	4,915
Vermont		12,092	14,523	25,427
Buffalo		1,859,892	2,345,676	3,097,892
Michigan		303	3,763	1,037
Rochester [c]		606,631	546,564	778,118
St. Lawrence		1,063,904	1,224,815	1,784,871
		3,553,463	4,139,520	5,692,260
Western:				
Duluth and Superior - International Falls-Soo		8,453	8,100	5,445
Dakota		15,688	26,675	16,177
		24,141	34,775	21,622
Miscellaneous:				
Hawaii				1
Porto Rico				
Alaska			1	
Total		3,965,255	4,665,530	6,007,306

a Rail to Canada and tidewater ports.
b Lower Lake docks as follows: Toledo, Sandusky, Huron, Lorain, Cleveland, Fairport, Ashtabula, Conneaut, and Erie.
c Rail-car ferry and Lake Ontario.

Coal exported from the United States in 1917, in net tons.

Year.	Anthracite.	Bituminous.	Year.	Anthracite.	Bituminous.
1910	3,384,222	12,078,348	1914	4,289,873	15,458,072
1911	3,980,479	15,544,204	1915	3,965,255	18,776,640
1912	4,131,444	16,195,175	1916	4,665,530	21,254,627
1913	4,652,912	20,145,168	1917	6,007,306	23,839,558

Bituminous coal imported into the United States in 1917 in net tons.

	Net tons.
Commercial, United States:	
California	43,927
Idaho	49,425
Illinois	9,520
Louisiana	448
Maryland	1,232
Michigan	372
Minnesota	1,071
Montana	98,851
New England	119,884
New York	3,310
North Dakota	1,164
Oregon	127
Commercial, United States—Continued.	
Pennsylvania	1,400
Texas	1,534
Virginia	1,182
Washington	154,636
	488,083
Railroad fuel	586,218
Bunker coal	252,057
Reexported	227
	1,326,585

Bituminous coal imported into the United States, 1915–1917, by custom districts in net tons.

Custom districts.	1915	1916	1917
Eastern and Gulf coasts:			
Massachusetts	501,443	388,821	349,496
Maryland	252	493	1,232
Florida	515		
Galveston	392	829	1,534
New Orleans		389	448
New York	12,176	7,172	3,310
Philadelphia	991		1,400
Porto Rico			333
Virginia	661		1,182
	516,430	397,704	358,935
Canadian border:			
Buffalo	1,319	1,306	
Chicago		1,680	9,520
Dakota	1,626	1,860	1,164
Duluth-Superior			1,971
Maine and New Hampshire	143,833	143,801	74,405
Michigan	837	46	372
Montana and Idaho	432,721	493,237	348,276
Vermont	9,427	32,384	1,551
Washington	128,207	217,755	234,386
	717,970	892,369	671,645
Pacific coast:			
Oregon	793	3,829	127
San Francisco	274,564	240,444	296,211
Southern California	9,661		
Alaska	29,457	53,672	56,549
Hawaii	160,330	126,119	64,986
	474,805	423,764	417,873
Grand total	1,709,205	1,713,837	1,448,453

CONSUMPTION OF BITUMINOUS COAL AND LIGNITE, BY INDUSTRIES, ACCORDING TO SOURCES.

COAL USED BY RAILROADS.

The statistics of the consumption of coal by railroads were collected on a basis for 1917 different from that for 1915 and 1916. To increase both the ease of compilation of the data by the railroads and the accuracy of the figures, the origin of the coal delivered for consumption was requested rather than the origin of the coal consumed.

Consumption of bituminous coal by railroads increased from 122,000,000 tons in 1915 to 136,000,000 tons in 1916 and to 153,700,000 tons in 1917. Stocks of bituminous coal in the hands of railroads, for which data were for the first time collected for 1917, were 6,694,000 tons at the beginning of the year and 9,167,000 tons at the end of the year. The gain was largely in the western district—that is, on roads west of Chicago, which are shown to carry a larger proportion of the current needs in stock than roads in either the eastern or the southern districts.

Bituminous coal used for railroad fuel in the United States, 1915-1917, in net tons.

State in which coal was produced.	1915[a]	1916[a]	1917[b]
Alabama	5,072,435	4,626,240	5,641,254
Arkansas	803,295	593,956	737,111
Colorado	2,388,515	2,415,779	3,038,297
Georgia	5,000	2,396	....
Illinois	18,928,022	22,818,833	35,431,220
Indiana	6,188,550	6,529,195	7,498,031
Iowa	4,415,832	4,314,135	4,633,329
Kansas	3,154,501	3,237,580	3,200,181
Kentucky	4,649,823	4,187,541	4,841,681
Maryland	387,121	251,910	571,013
Michigan	394,921	341,693	360,847
Missouri	2,351,940	1,676,150	2,093,956
Montana	1,050,319	1,967,574	2,127,243
New Mexico	1,635,752	1,567,269	1,991,066
North Dakota	3,109	3,329	26,355
Ohio	8,206,128	11,082,187	13,226,615
Oklahoma	2,573,750	2,254,160	2,327,831
Oregon	5,000	4,789	2,101
Pennsylvania	34,175,299	33,693,939	36,330,868
Tennessee	3,375,461	2,819,439	2,457,870
Texas	1,037,249	994,530	952,051
Utah	565,489	693,138	930,659
Virginia	2,826,716	2,747,336	3,078,162
Washington	1,149,446	1,601,274	2,003,965
West Virginia	12,054,954	17,115,908	14,838,314
Wyoming	4,223,290	4,963,440	5,325,638
Imports	378,083	424,802	586,218
Source not known (rail and lake)	....	3,071,478	23,889
Source not known (confiscated)	....	....	1,866,101
Total bituminous coal	122,000,000	136,000,000	156,141,866

[a] Represents consumption as reported by the railroads.
[b] Represents deliveries to railroads and differs from consumption in so far as stocks differed at beginning and end of year.

The statistics of deliveries in 1917 to classes of roads, classified by originating fields, are given in the table opposite this page.

Stocks, deliveries, and consumption of bituminous coal for railroad fuel in 1917, by districts, in net tons.

	Eastern district.	Southern district.	Western district.	Total.
Stocks on hand, Jan. 1, 1917	3,991,666	459,711	2,242,925	6,694,302
Deliveries, 1917	70,764,301	27,362,062	56,149,402	154,275,765
Coal confiscated, 1917	1,481,317	200,686	184,098	1,866,101
Stocks on hand, Dec. 31, 1917	4,294,852	898,647	3,973,812	9,167,311
Consumption, 1917	71,942,432	27,123,812	54,602,613	153,668,857

COAL USED BY STEAMSHIPS.

The following statistics of bunker coal supplied to steamships engaged in foreign commerce are derived from the records of the Bureau of Foreign and Domestic Commerce. The statistics of total bituminous coal shipped to tidewater and used for bunkers are derived from records furnished by the railroads.

Fuel or bunker coal supplied to steamers engaged in foreign trade at ports of United States, 1915–1917, in net tons.

Customs district.	Principal port.	1915	1916	1917
North Atlantic:				
Maine and New Hampshire	Portland	8,346	33,527	7,831
Massachusetts	Boston	155,725	177,523	144,295
New York	New York	3,667,265	3,809,112	3,042,417
Philadelphia	Philadelphia	479,036	463,292	322,209
Maryland	Baltimore	653,665	547,057	373,679
Virginia	Hampton Roads	1,907,927	2,197,113	2,203,425
		6,871,964	7,227,624	6,093,856
South Atlantic and Gulf ports:				
North Carolina		3,838	39,811	500
South Carolina	Charleston	8,904	69,832	56,655
Georgia	Savannah	52,301	35,193	28,133
Florida		117,261	112,948	58,225
Mobile		94,821	68,745	54,736
New Orleans		546,020	414,364	413,140
Texas (includes Sabine)		53,756	55,256	48,545
Porto Rico		26,764	61,190	67,255
		903,665	857,339	727,189
Great Lakes:				
St. Lawrence		8,319	10,779	23,429
Rochester		34,504	42,388	46,221
Buffalo	Buffalo	44,299	29,501	31,700
Ohio	Lake Erie ports	187,647	244,223	281,149
Michigan		41,507	54,271	71,231
Wisconsin		269	1,935	3,501
Chicago	Chicago	23,581	17,657	14,669
Duluth	Duluth	2,602	2,417	2,552
		342,728	403,171	474,452
Pacific coast:				
Washington	Seattle	47,316	38,401	67,627
Oregon	Portland	3,517	6,015	4,603
San Francisco	San Francisco	128,631	193,055	297,748
Alaska		130	364	17
Hawaii		69,556	38,850	43,663
		249,150	276,685	413,658
Grand total		8,367,507	8,764,819	7,709,155

Bituminous fuel coal delivered to railroads by producing districts, 1917, in net tons.

Production district.	Southern district. Class 1.	Class 2.	Class 3.	Switching and terminal.	Total.	Eastern district. Class 1.	Class 2.	Class 3.	Switching and terminal.	Total.	Western district. Class 1.	Class 2.	Class 3.	Switching and terminal.	Total.	Grand total.
Alabama	4,865,178	187,777	21,686	70,471	5,147,115						116,670	15,357	9,207	22,896	494,130	5,641,254
Arkansas											663,089	21,206	46,065	3,751	737,111	737,111
Colorado											2,967,819	58,513	10,001	761	3,038,297	3,038,297
Illinois	4,734,232	3,117	3,151	12,588	4,753,091	8,738,013	117,070	2,170	530,189	9,387,772	20,224,238	180,514	31,210	848,360	21,290,357	36,431,220
Indiana	510,707				510,707	6,216,529	75,929	2,910	284,334	6,579,702	311,082	5,521	3,573	87,351	407,532	7,198,031
Iowa						13,297				13,297	1,356,185	2,301	90,133	171,113	1,620,032	1,633,329
Kansas											3,131,470	21,103	9,651	44,951	3,207,181	3,207,181
Kentucky:																
Hazard, rail	250,000		4,788		254,788				48	48						254,836
Northeastern:																
Rail	470,079		10,558	18,156	498,811		15,862			15,862						514,075
Lake														1,375	1,375	1,375
Southeastern, rail	990,528	243	17,245	182	1,011,198	75,143	560	100	11,729	87,538			1,829		1,829	1,100,565
Western:																
Rail	2,531,234	11,395	8,732	77,750	2,662,111	107,690				107,690	80,461	31,186	6,012	368	118,037	2,887,858
River								432		432	78,610				78,610	79,072
Total:																
Rail	4,247,851	44,638	41,323	96,088	4,429,910	183,133	16,428	100	11,777	211,438	80,461	31,186	7,871	368	119,886	4,761,234
Lake														1,375	1,375	1,375
River								432		432	78,610				78,610	79,072
Total Kentucky	4,247,851	44,638	41,323	96,088	4,429,910	183,133	16,428	532	11,777	211,870	159,101	31,186	7,871	1,743	199,901	4,841,681
Maryland:																
Cumberland-Piedmont	101				101	422,561	43,205	2,761	522	469,112						469,213
Tidewater						101,797				101,797						101,797
Total Maryland	101				101	524,358	43,205	2,761	522	570,909						571,013
Michigan						345,115	15,111		321	360,547						360,547
Missouri						181,658				181,658	1,789,538	91,225	2,159	29,076	1,912,298	2,093,956
Montana											2,109,728	13,701	3,811		2,127,211	2,127,243
New Mexico											1,970,673	229	10,807	257	1,991,966	1,991,966
North Dakota											26,355				26,355	26,355
Ohio:																
Northern:																
Rail						6,880,191	81,279	25,015	97,141	7,085,626						7,085,626
Lake											1,548,487	5,221	2,709	6,381	1,562,801	1,562,801
Southern																
Rail						4,385,057	35,313	5,625	59,033	4,485,028						4,485,028
Lake											47,000	41,057		1,203	90,160	90,160
Total:																
Rail						11,274,218	116,592	30,640	152,174	11,573,654						11,573,654
Lake											1,595,487	47,181	2,709	7,584	1,652,961	1,652,961
Total Ohio						11,274,218	116,592	30,640	152,174	11,573,654	1,595,487	47,181	2,709	7,584	1,652,961	13,226,615
Oklahoma											2,233,022	75,958	18,851		2,327,831	2,327,831
Oregon											2,101				2,101	2,101
Pennsylvania:																
Central:																
Rail						17,705,409	175,430	92,302	50,565	18,023,706						18,023,706
Tidewater						262,658			1,221	263,879						263,879
Lake Ontario						195,581				195,581						195,581
						18,163,708	175,430	92,302	51,786	18,483,226						18,483,226
Connellsville:																
Rail						1,223,472	310		22,955	1,246,737						1,246,737
Tidewater						254,492				254,492						254,492
						1,477,964	310		22,955	1,501,229						1,501,229
Greensburg, Westmoreland, Latrobe, and Ligonier:																
Rail						4,809,032	16,691	7,571	2,196	4,835,493						4,835,493
Tidewater						414,927				414,927						414,927
						5,223,959	16,691	7,571	2,196	5,250,420						5,250,420
Northern:																
Rail						1,545,256	38,250	10,019	33,565	1,627,090						1,627,090
Lake											15,000				15,000	15,000
						1,545,256	38,250	10,019	33,565	1,627,090	15,000				15,000	1,642,090
Pittsburgh:																
Rail						4,402,423	71,762	12,804	286,424	4,863,413						4,863,413
Lake						99,117				99,117	1,625,295	55,762	16,177	18,915	1,749,179	1,848,296
River									126,626	126,626						126,626
						4,501,540	71,762	12,804	413,050	5,089,156	1,625,295	55,762	16,177	18,915	1,749,197	6,838,353
Somerset and Meyersdale:																
Rail						2,532,017		2,444	37,477	2,571,968						2,571,968
Tidewater						43,600				43,600						43,600
						2,575,617		2,444	37,477	2,615,568						2,615,568
Total:																
Rail						32,307,609	302,446	125,140	433,182	33,168,467						33,168,467
Tidewater						975,677			1,221	976,898						976,898
Lake						294,698				294,698	1,643,295	55,762	16,177	18,945	1,764,179	2,058,877
River									126,626	126,626						126,626
Total Pennsylvania						33,578,074	302,446	125,140	561,029	34,566,689	1,643,295	55,762	16,177	18,945	1,764,179	36,330,868
Tennessee	2,377,881	51,107	20,988	3,444	2,453,723								4,147		4,147	2,457,870
Texas											910,311	37,419	4,321		952,051	952,051
Utah											912,700	7,082	11,077		930,859	930,859
Virginia (southwestern):																
Rail	2,470,375	112,517	46,000	9,156	2,638,078	18,847	566			19,413						2,657,491
Tidewater						420,671				420,671						420,671
Total Virginia	2,470,375	112,517	46,000	9,156	2,638,078	439,518	566			440,084						3,078,162
Washington:																
Rail											1,951,818	35,369	3,428		2,002,615	2,002,615
Tidewater													1,350		1,350	1,350
Total Washington											1,951,818	35,369	4,778		2,003,965	2,003,965
West Virginia:																
Fairmont:																
Rail	134,948	3,932	4,900		143,780	4,119,313	55,369	17,102	25,013	4,216,797						4,360,577
Tidewater						915,287		250		915,537						915,537
Lake											670,419	1,439			671,858	671,858
River									1,619	1,619						1,619
	134,948	3,932	4,900		143,780	5,034,600	55,369	17,352	26,632	5,133,953	670,419	1,439			671,858	5,949,591
New River:																
Rail	885,712	4,081	4,386	2,279	896,458			600		600						897,178
Tidewater						55,346	33,100			88,446						88,446
	885,712	4,081	4,386	2,279	896,458	55,346	33,100	600		89,046						985,504
Pocahontas:																
Rail	1,192,215	651	15,184	23,495	1,231,547	7,702	7,236	4,011	412	19,421						1,250,967
Tidewater						83,383				83,383						83,383
	1,192,215	651	15,184	23,495	1,231,547	91,092	7,236	4,011	412	102,804						1,334,350
Kanawha and Kenova-Thacker:																
Rail	5,083,812	41,219	27,583		5,152,614	375,145	36,937	30,678	5,474	448,234	65				65	5,600,943
Tidewater						792,800				792,800						792,800
Lake											130,185	46,921	2,747		179,853	179,853
River									134	134						134
	5,083,812	41,219	27,583		5,152,614	1,167,945	36,937	30,678	5,608	1,181,168	130,250	46,921	2,747		179,918	6,513,730
Panhandle, rail						40,341		1,218	13,420	54,979						54,979
Total:																
Rail	7,296,717	49,925	52,053	25,774	7,424,469	4,542,508	99,542	51,761	44,339	4,740,120	65				65	12,164,654
Tidewater						1,786,818	33,100	250		1,820,198						1,820,198
Lake											800,604	48,360	2,747		851,711	851,711
River									1,753	1,753						1,753
Total West Virginia	7,296,717	49,925	52,053	25,774	7,424,469	6,329,321	132,642	51,011	46,092	6,562,009	800,669	48,360	2,747		851,776	14,838,314
Wyoming											5,279,437	22,409	15,756	27,876	5,325,638	5,325,638
IMPORTS.																
Canada:																
Rail								179		179	270,672				270,672	270,851
Tidewater						305,389				305,389	9,078				9,078	314,467
Lake													900		900	900
						305,389		179		305,568	279,750		900		280,650	586,218
Source unknown:																
Rail		2,938	1,837		4,775			4,855	5,327	10,182			2,914	3,835	6,749	21,706
Lake													407	1,776	2,183	2,183
Confiscated	192,462	4,366	2,950	908	200,686	1,355,651	12,788	2,696	110,182	1,481,317	137,633	6,479	1,168	38,818	184,098	1,866,101
	192,462	7,304	4,787	908	205,461	1,355,651	12,788	7,551	115,509	1,491,499	137,633	6,479	4,489	44,429	193,030	1,889,990
Total bituminous coal[a]	26,695,610	456,715	191,991	218,412	27,562,748	69,454,637	842,837	220,197	1,701,047	72,218,618	53,903,280	666,357	311,758	1,309,105	56,333,500	156,141,866
SUMMARY.																
Shipped by—																
Rail	26,503,148	452,349	189,041	217,524	27,362,062	64,213,918	796,940	222,789	1,462,165	66,715,811	49,638,541	621,575	286,300	1,240,607	51,787,023	145,864,923
Tidewater						3,590,170	33,160	250	1,221	3,624,951	9,078		1,350		10,428	3,635,379
Lake						294,698				294,698	4,032,386	181,303	22,940	29,680	4,273,309	4,568,107
River								432	128,379	128,811	78,640				78,640	207,451
Confiscated, origin unknown	192,462	4,366	2,950	908	200,686	1,355,651	12,788	2,696	110,182	1,481,317	137,633	6,479	1,168	38,818	184,098	1,866,101
Grand total	26,695,610	456,715	191,991	218,412	27,562,748	69,454,637	842,837	220,197	1,701,047	72,218,618	53,903,280	666,357	311,758	1,309,105	56,333,500	156,141,866

[a] Excludes fuel coal used on lines in United States operated by Canadian railroads.

Bunker coal loaded at Atlantic, Gulf, and Pacific coast ports, 1917, in net tons.

Producing district.	New York.	Philadelphia.	Baltimore.	Hampton Roads.	South Atlantic and Gulf ports.	Pacific coast ports.	New England ports.	Total.
Central Pennsylvania..	2,659,813	372,590	269,272	....	....	....	49,204	3,350,879
Greensburg..........	43,600	12,895	14,760	....	....	....	....	71,255
Westmoreland..........	71,600	12,109	13,494	....	....	....	....	97,203
Pittsburgh..........	84,000	9,450	2,786	....	....	....	....	96,236
Somerset and Meyersdale..........	769,000	106,103	324,803	....	....	....	....	1,199,906
Cumberland-Piedmont.	883,400	16,673	....	....	....	....	....	900,073
Fairmont..........	141,240	83,837	120,034	....	....	....	5,126	350,237
Ohio No. 8..........	1,154	1,330	576	....	....	....	....	3,060
Pocahontas..........	....	....	....	1,165,370	....	....	....	1,165,370
Tug River..........	....	....	....	199,681	....	....	....	199,681
Clinch Valley and southwestern Virginia	....	....	....	48,935	70,500	....	222,524	341,859
Thacker..........	....	....	....	24,174	....	....	....	24,174
Kenova..........	....	....	....	368	....	....	....	368
Radford..........	....	....	....	829	....	....	....	829
New River..........	....	....	....	1,720,930	....	....	....	1,720,930
Kanawha..........	....	....	....	57,595	....	....	....	57,595
Southeastern Kentucky	....	....	....	....	28,100	....	....	28,100
Tennessee..........	....	....	....	....	12,988	....	....	12,988
Alabama..........	....	....	....	....	532,008	....	....	532,008
Texas..........	....	....	....	....	67,357	....	....	67,357
New Mexico..........	....	....	....	....	143,000	....	....	143,000
Washington..........	....	....	....	....	....	220,416	....	220,416
Utah and southern Wyoming..........	....	....	....	....	....	22,668	....	22,668
Imports..........	....	....	....	....	....	252,057	25,272	277,329
	4,653,807	614,987	745,725	3,217,882	853,953	495,141	302,126	10,883,621

COAL USED BY INDUSTRIES.

The statistics given in the following table, except those of coal used by domestic consumers and industries, are based on the results of inquiries directed to the consumers. The statistics of consumption by domestic users and industries are estimates based on a number of investigations made by the Fuel Administration. The estimates of coal used for domestic purposes include only coal used by householders, hotels, office buildings, and so on and do not include the small steam trade included in a similar set of statistics published for 1915.

Bituminous coal of domestic origin consumed in the United States, 1917, in net tons.

[Railroad fuel and bunker fuel for ocean vessels not included in this table.]

State.	Used at mines for steam and heat.	Used in manufacture of beehive coke.	Used in manufacture of by-product coke.	Used in manufacture of coal gas.	Used by electrical utilities.	Used for domestic purposes.	Used for industrial purposes.	Total coal consumed.
Alabama	641,733	3,658,598	3,980,243	90,886	299,966	651,000	2,131,490	11,453,916
Arizona					2,635	65,000	44,365	112,000
Arkansas	75,067			1,330	108,116	300,000	414,955	899,468
California	240			280		355,000	535,174	890,694
Colorado	304,492	1,784,631		122,494	515,243	1,450,000	3,203,179	7,380,039
Delaware				1,009	142,542	20,000	452,617	616,168
District of Columbia				7,193	158,410	250,000	451,397	867,000
Florida				33,167	32,803	90,000	147,030	303,000
Georgia	7,200	72,689		78,877	195,388	871,000	1,391,019	2,616,173
Idaho				8,171	1,621	300,000	311,676	621,468
Illinois	2,374,250		3,233,669	275,597	4,232,557	9,721,000	23,061,385	42,898,458
Indiana	642,551		4,817,942	168,338	2,088,978	3,500,000	9,341,339	20,559,148
Iowa	226,394			62,267	1,023,501	2,912,000	5,221,899	9,446,061
Kansas	185,464			4,728	426,043	1,800,000	1,344,589	3,760,824
Kentucky	639,977	599,626	742,162	14,759	586,586	1,864,000	1,966,343	6,413,453
Louisiana				3,230	160,663	370,000	1,288,555	1,822,448
Maryland	58,910		733,184	10,976	361,746	352,000	2,785,202	4,302,018
Michigan	47,965		1,220,030	737,874	1,481,854	2,974,000	8,438,538	14,900,261
Minnesota			676,881	99,959	739,483	2,637,000	2,382,880	6,536,203
Mississippi				15,907	283,835	300,000	756,258	1,356,000
Missouri	151,781		351,755	564,864	1,021,789	3,000,000	6,921,404	12,011,593
Montana	167,704			12,037	106,334	885,000	895,835	2,066,910
Nebraska				1,089	511,364	1,425,000	1,524,389	3,461,842
Nevada					2,025	100,000	259,975	362,000
New England			738,873	893,488	2,890,733	1,655,000	12,026,293	18,204,387
New Jersey			621,699	125,730	1,100,448	90,000	4,919,631	6,857,508
New Mexico	36,449	936,411		1,803	43,453	175,000	252,881	1,445,997
New York			1,401,458	639,882	3,141,311	1,242,000	13,269,515	19,694,166
North Carolina				47,583	204,016	820,000	1,026,401	2,098,000
North Dakota	34,077			17,612	215,141	655,000	591,658	1,513,488
Ohio	761,032	224,952	5,141,046	30,665	3,606,893	4,900,000	[a]23,344,968	[a]38,009,556
Oklahoma	189,190			950	108,995	775,000	748,878	1,823,013
Oregon	5,504			3,961		225,000	373,813	608,278
Pennsylvania	3,499,727	36,594,563	5,716,221	260,743	2,486,286	1,836,000	29,720,070	80,113,610
South Carolina				7,430	177,138	480,000	513,432	1,178,000
South Dakota				2,340	185,612	570,000	329,051	1,087,003
Tennessee	164,698	695,841	63,793	71,128	402,825	1,211,000	1,872,733	4,482,018
Texas	49,355			15,068	414,895	650,000	1,365,249	2,494,567
Utah	86,128	670,492		35,331	9,575	815,000	596,946	2,213,472
Virginia	145,231	2,093,943		111,534	597,562	906,000	2,618,748	6,473,018
Washington	166,399	160,550	45,025	87,285	136,752	650,000	405,360	1,651,371
West Virginia	1,185,200	4,754,316	727,778	2,244	495,133	475,000	3,123,002	10,762,673
Wisconsin			1,294,000	286,897	822,369	2,532,000	3,626,502	8,561,768
Wyoming	270,441			2,991	170,103	250,000	60,360	753,895
Alaska							53,955	53,955
Miscellaneous, smithing							255,000	255,000
	12,117,159	52,246,612	31,505,759	4,959,697	31,692,722	57,104,000	176,365,939	[b]365,991,888

[a] Includes 488,083 tons imports and 1,253,000 tons used out of storage.
[b] Includes 1,643,000 tons vessel fuel for steamships on the Great Lakes.

CONSUMPTION OF BITUMINOUS COAL, BY STATES.

The statistics given below showing the source and quantity of coal received in each State do not represent consumption but rather quantities delivered and available for consumption. Consumption was greater or less than deliveries by the quantity of coal put into or taken from storage, and, as adequate statistics of stocks at the beginning and end of 1917 are not available, the statistics of coal delivered must be considered to represent consumption:

Coal consumed in different States in 1917, in net tons.

[Fuel for railroads and steamships not included.]

Source.	Quantity.
Alabama.	
Alabama	11,222,916
Kentucky, southern	50,000
Kentucky, western	100,000
Tennessee	66,000
Virginia, southwestern	15,000
	11,453,916
Arizona.	
Colorado	10,000
New Mexico	102,000
	112,000
Arkansas.	
Alabama	15,000
Arkansas	671,468
Illinois	96,000
Kansas	2,000
Kentucky, western	102,000
Oklahoma	10,000
Tennessee	3,000
	899,468
California.	
California and Idaho	6,423
Colorado	30,000
New Mexico	85,000
Utah and southern Wyoming	590,000
Washington	50,000
Tidewater	85,344
	846,767
Imports	43,927
	890,694
Colorado.	
Colorado	7,297,039
Kansas	1,000
Missouri	4,000
New Mexico	72,000
Utah and southern Wyoming	6,000
	7,380,039

Source.	Quantity.
Delaware.	
Pennsylvania, central	190,000
Pennsylvania, Greensburg, Westmoreland-Latrobe, and Ligonier	75,000
Pennsylvania, Connellsville	30,000
Pennsylvania, Cumberland-Piedmont, Somerset, and Meyersdale	96,000
West Virginia, Pittsburgh and Panhandle	10,000
West Virginia, Fairmont	48,000
West Virginia, Kanawha and Kenova-Thacker	3,000
Tidewater	164,168
	616,168
District of Columbia.	
Pennsylvania, central	30,000
Pennsylvania, Cumberland-Piedmont, Somerset, and Meyersdale	448,000
West Virginia, Fairmont	140,000
West Virginia, Kanawha and Kenova-Thacker	3,000
West Virginia, Pocahontas and Tug River	2,000
West Virginia, New River	244,000
	867,000
Florida.	
Alabama	115,000
Kentucky, northeast	3,000
Kentucky, southeast	44,000
Tennessee	25,000
Virginia, southwestern	51,000
Tidewater	65,000
	303,000
Georgia.	
Alabama	585,000
Georgia	119,028
Kentucky, southeastern	1,070,000
Tennessee	642,145
Virginia, southwestern	200,000
	2,616,173

Coal consumed in different States in 1917, in net tons—Continued.

Idaho.

Source.	Quantity.
Montana and northern Wyoming	28,000
Utah and southern Wyoming	499,000
Washington	45,000
Lake docks	43
	572,043
Imports	49,425
	621,468

Illinois.

Source.	Quantity.
Arkansas	20,000
Illinois	31,696,717
Indiana	5,165,000
Kentucky, Hazard	25,000
Kentucky, northeastern	428,000
Kentucky, southeastern	228,000
Kentucky, western	447,000
Ohio, northern	25,000
Ohio, southern	65,000
Pennsylvania, central	52,000
Pennsylvania, Cumberland, Piedmont, Somerset, and Meyersdale	15,000
Tennessee	45,000
Virginia, southwestern	74,000
West Virginia, Fairmont	30,000
West Virginia, Kanawha and Kenova-Thacker	543,000
West Virginia, Pittsburgh and Panhandle	55,000
West Virginia, Pocahontas and Tug River	2,650,000
West Virginia, New River	275,000
Lake docks	1,050,221
	42,888,938
Imports	9,520
	42,898,458

Indiana.

Source.	Quantity.
Illinois	2,255,000
Indiana	11,841,298
Kentucky, Hazard	172,000
Kentucky, northeastern	900,000
Kentucky, southeastern	338,000
Kentucky, western	720,000
Ohio, northern	146,000
Ohio, southern	162,000
Pennsylvania, central	25,000
Pennsylvania, Cumberland, Piedmont, Somerset, and Meyersdale	1,000
Tennessee	45,000
Virginia, southwestern	115,000
West Virginia, Fairmont	60,000
West Virginia, Kanawha and Kenova-Thacker	897,000
West Virginia, Pittsburgh and Panhandle	112,000
West Virginia, Pocahontas and Tug River	1,947,000
West Virginia, New River	260,000
Lake docks	562,850
	20,559,148

Iowa.

Source.	Quantity.
Arkansas	9,000
Colorado	15,000
Illinois	4,026,000
Indiana	247,000
Iowa	3,887,501
Kansas	81,000
Kentucky, northeastern	198,000
Kentucky, southeastern	36,000
Kentucky, western	63,000
Missouri	58,000
Oklahoma	2,000
Tennessee	9,000
West Virginia, Kanawha and Kenova-Thacker	165,000
Montana and northern Wyoming	324,000
Utah and southern Wyoming	54,000
Lake docks	271,560
	9,446,061

Kansas.

Source.	Quantity.
Arkansas	117,000
Colorado	600,000
Illinois	107,000
Iowa	15,000
Kansas	2,436,794
Kentucky, northesatern	27,000
Kentucky, southeastern	27,000
Kentucky, western	15,000
Missouri	261,000
New Mexico	94,000
Oklahoma	51,000
Utah and southern Wyoming	10,000
Lake docks	30
	3,760,824

Kentucky.

Source.	Quantity.
Illinois	18,000
Indiana	136,000
Kentucky, Hazard	153,751
Kentucky, Kanawha and Kenova-Thacker	703,519
Kentucky, northeastern	815,401
Kentucky, southeastern	1,467,282
Kentucky, western	2,986,500
Tennessee	27,000
Virginia, southwestern	11,000
West Virginia, New River	20,000
West Virginia, Pocahontas and Tug River	75,000
	6,413,453

Louisiana.

Source.	Quantity.
Alabama	925,000
Arkansas	31,000
Illinois	102,000
Kentucky, southeastern	81,000
Kentucky, western	669,000
Oklakoma	2,000
Tennessee	12,000
	1,822,000
Imports	448
	1,822,448

Coal consumed in different States in 1917, in net tons—Continued.

Maryland.

Source.	Quantity.
Pennsylvania, central	104,000
Pennsylvania, Greensburg, Westmoreland, Latrobe, and Ligonier	25,000
Pennsylvania, Connellsville	149,000
Pennsylvania, Cumberland, Piedmont, Somerset, and Meyersdale	1,955,901
West Virginia, Fairmont	410,000
West Virginia, Pocahontas and Tug River	1,000
Tidewater	1,655,885
	4,300,786
Imports	1,232
	4,302,018

Michigan.

Source.	Quantity.
Illinois	706,000
Indiana	674,000
Kentucky, Hazard	295,000
Kentucky, northeastern	797,000
Kentucky, southeastern	445,000
Michigan	1,013,958
Ohio, northern	810,000
Ohio, southern	1,969,000
Pennsylvania, central	25,000
Pennsylvania, Cumberland, Piedmont, Somerset, and Meyersdale	5,000
Tennessee	57,000
Virginia, southwestern	84,000
West Virginia, Fairmont	261,000
West Virginia, Kanawha and Kenova-Thacker	3,510,000
West Virginia, Pittsburgh-Panhandle	290,000
West Virginia, Pocahontas and Tug River	793,000
West Virginia, New River	309,000
Lake docks	2,726,931
	14,770,889
Coal from storage	129,000
Imports	372
	14,900,261

Minnesota.

Source.	Quantity.
Arkansas	6,000
Illinois	1,801,000
Indiana	199,000
Iowa	31,000
Kentucky, northeastern	195,000
Kentucky, southeastern	33,000
Ohio, northern	50,000
Tennessee	9,000
West Virginia, Kanawha and Kenova-Thacker	60,000
Lake docks	4,151,132
	6,535,132
Imports	1,071
	6,536,203

Mississippi.

Source.	Quantity.
Alabama	750,000
Illinois	55,000
Kentucky, western	551,000
	1,356,000

Missouri.

Source.	Quantity.
Alabama	7,000
Arkansas	250,000
Illinois	6,806,000
Indiana	54,000
Iowa	239,000
Kansas	792,000
Kentucky, northeastern	270,000
Kentucky, southeastern	16,000
Missouri	3,114,593
Kentucky, western	214,000
Montana and northern Wyoming	20,000
Oklahoma	91,000
Pennsylvania, Cumberland-Piedmont Somerset, and Meyersdale	10 000
Tennessee	6,000
West Virginia, Kanawha and Kenova-Thacker	20 000
West Virginia, Pocahontas and Tug River	102,000
	12,011,593

Montana.

Source.	Quantity.
Montana and northern Wyoming	1,573,770
Utah and southern Wyoming	365,000
Lake docks	29,289
	1,968,059
Imports	98,851
	2,066,910

Nebraska.

Source.	Quantity.
Arkansas	50,000
Colorado	749,000
Illinois	661,000
Indiana	9,000
Iowa	130,000
Kansas	556,000
Kentucky, northeastern	45,000
Kentucky, western	36,000
Missouri	119,000
Montana and northern Wyoming	681,000
Oklahoma	12,000
Utah and southern Wyoming	353,000
West Virginia, Kanawha and Kenova-Thacker	6,000
Lake docks	54,842
	3,461,842

Nevada.

Source.	Quantity.
Utah and southern Wyoming	362,000

New England.

Source.	Quantity.
Pennsylvania, central	5,847,367
Pennsylvania, northern	350,000
Pennsylvania: Greensburg, Westmoreland, Latrobe, and Ligonier	543,000
Pennsylvania, Connellsville	400,000
Pennsylvania, Cumberland, Piedmont, Somerset, and Meyersdale	339,000
West Virginia, Pittsburgh and Panhandle	450,000
West Virginia, Fairmont	81,000
Tidewater	8,950,139
	16,960,593
Imports	119,884
Coal from storage	1,124,000
	18,204,387

Coal consumed in different States in 1917, in net tons—Continued.

New Jersey.

Source.	Quantity.
Pennsylvania, central	1,951,000
Pennsylvania, northern	283,000
Pennsylvania, Greensburg, Westmoreland, Latrobe, and Ligonier	505,000
Pennsylvania, Connellsville	300,000
Pennsylvania, Cumberland, Piedmont, Somerset, and Meyersdale	779,000
West Virginia, Pittsburgh and Panhandle	1,170,000
West Virginia, Fairmont	750,000
West Virginia, Kanawha and Kenova-Thacker	25,000
Tidewater	1,094,508
	6,857,508

New Mexico.

Source.	Quantity.
Colorado	168,000
New Mexico	1,271,997
Oklahoma	4,000
Texas	2,000
	1,445,997

New York.

Source.	Quantity.
Ohio, northern	350,000
Pennsylvania, central	5,950,000
Pennsylvania, northern	1,647,000
Pennsylvania, Greensburg, Westmoreland, Latrobe and Ligonier	353,000
Pennsylvania, Connellsville	350,000
Pennsylvania, Cumberland, Piedmont, Somerset and Meyersdale	100,000
West Virginia, Pittsburgh and Panhandle	4,130,000
West Virginia, Fairmont	358,000
West Virginia, Kanawha and Kenova-Thacker	3,000
Tidewater	6,294,711
Lake docks	155,145
	19,190,856
Imports	3,310
	19,694,166

North Carolina.

Source.	Quantity.
Kentucky, northeastern	15,000
Kentucky, southeastern	91,000
Tennessee	233,000
Virginia, southwestern	753,000
West Virginia, Kanawha and Kenova-Thacker	338,000
West Virginia, New River	357,000
West Virginia, Pocahontas and Tug River	311,000
	2,098,000

North Dakota.

Source.	Quantity.
Illinois	43,000
Indiana	3,000
Montana and northern Wyoming	96,000
North Dakota	752,193
Lake docks	618,131
	1,512,324
Imports	1,164
	1,513,488

Ohio.

Source.	Quantity.
Illinois	63,000
Indiana	134,000
Kentucky, Hazard	784,000
Kentucky, northeastern	1,265,000
Kentucky, southeastern	477,000
Kentucky, western	30,000
Ohio, southern	4,307,338
Ohio, northern	11,314,047
Pennsylvania, central	175,000
Pennsylvania, northern	281,000
Pennsylvania, Greensburg, Westmoreland, Latrobe, and Ligonier	750,000
Pennsylvania, Connellsville	2,000,000
Pennsylvania, Cumberland, Piedmont, Somerset, and Meyersdale	236,000
Tennessee	188,000
Virginia, southwestern	78,000
West Virginia, Pittsburgh and Panhandle	6,819,000
West Virginia, Fairmont	523,000
West Virginia, Kanawha and Kenova-Thacker	4,987,000
West Virginia, Pocahontas and Tug River	2,592,000
West Virginia, New River	950,000
Lake docks	56,171
	38,009,556

Oklahoma.

Source.	Quantity.
Arkansas	89,000
Colorado	90,000
Kansas	116,000
Missouri	20,000
New Mexico	24,000
Oklahoma	1,479,013
Texas	5,000
	1,823,013

Oregon.

Source.	Quantity.
Oregon	26,226
Utah and southern Wyoming	220,000
Washington	345,000
Lake docks	16,925
	608,151
Imports	127
	608,278

Pennsylvania.

Source.	Quantity.
Ohio, northern	160,000
Pennsylvania, central	12,905,235
Pennsylvania, northern	2,445,772
Pennsylvania, Greensburg, Westmoreland, Latrobe, and Ligonier	7,825,741
Pennsylvania, Connellsville	29,355,674
Pennsylvania, Cumberland-Piedmont, Somerset, and Myersdale	2,771,166
West Virginia, Pittsburg and Panhandle	20,868,664
West Virginia, Fairmont	2,553,000
West Virginia, Kanawha and Kenova-Thacker	250,000
Tidewater	976,958
	80,612,210
Imports	1,400
	80,113,610

Coal consumed in different States in 1917, in net tons—Continued.

South Carolina.

Source.	Quantity.
Kentucky, southeastern	72,000
Tennessee	135,000
Virginia	560,000
West Virginia, Kanawha and Kenova-Thacker	110,000
West Virginia, Pocahontas and Tug River	100,000
West Virginia, New River	201,000
	1,178,000

South Dakota.

Source.	Quantity.
Colorado	20,000
Illinois	231,000
Indiana	15,000
Iowa	30,000
Kentucky, northeastern	60,000
Kentucky, southeastern	24,000
Kentucky, western	3,000
Montana and northern Wyoming	191,000
North Dakota	12,000
South Dakota	8,042
West Virginia, Kanawha and Kenova-Thacker	15,000
Lake docks	477,961
	1,087,003

Tennessee.

Source.	Quantity.
Alabama	175,000
Arkansas	36,000
Illinois	50,000
Kentucky, northeastern	2,000
Kentucky, southeastern	459,000
Kentucky, western	1,192,000
Tennessee	2,208,018
Virginia, southwestern	360,000
	4,482,018

Texas.

Source.	Quantity.
Alabama	50,000
Arkansas	127,000
Colorado	378,000
Illinois	63,000
Kentucky, southeastern	27,000
Kentucky, western	42,000
New Mexico	157,000
Oklahoma	408,000
Tennessee	3,000
Texas	1,236,033
Virginia, southwestern	2,000
	2,493,033
Imports	1,534
	2,494,567

Utah.

Source.	Quantity.
Utah and southern Wyoming	2,210,472
Colorado	3,000
	2,213,472

Virginia.

Source.	Quantity.
Kentucky, southeastern	10,000
Pennsylvania, Cumberland, Piedmont, Somerset, and Meyersdale	41,000
Virginia, Pocahontas and Tug River	2,057,607
Virginia, southwestern	3,005,229
West Virginia, Fairmont	32,000
West Virginia, Kanawha and Kenova-Thacker	730,000
West Virginia, New River	596,000
	6,471,836
Imports	1,182
	6,473,018

Washington.

Source.	Quantity.
Montana and northern Wyoming	121,000
Utah and southern Wyoming	137,000
Washington	1,238,700
Lake docks	35
	1,496,735
Imports	154,636
	1,651,371

West Virginia.

Source.	Quantity.
Ohio, southern	71,416
Ohio, northern	10,000
Pennsylvania, Connellsville	150,000
Pennsylvania, Cumberland	197,542
Virginia, southwestern	50,000
West Virginia, Pittsburgh and Panhandle	1,592,202
West Virginia, Fairmont	2,600,926
West Virginia, Kanawha and Kenova-Thacker	1,283,318
West Virginia, Pocahontas	3,662,623
West Virginia, New River	1,144,646
	10,762,673

Wisconsin.

Source.	Quantity.
Illinois	1,936,000
Indiana	564,000
Kentucky, northeastern	25,000
Kentucky, southeastern	57,000
Kentucky, western	110,000
Ohio, southern	25,000
Ohio, northern	25,000
Tennessee	9,000
West Virginia, Pittsburgh and Panhandle	18,000
West Virginia, Kanawha and Kenova-Thacker	963,000
West Virginia, Pocahontas and Tug River	345,000
Lake docks	4,484,768
	8,561,768

Wyoming.

Source.	Quantity.
Colorado	75,000
Montana and northern Wyoming	285,198
Utah and southern Wyoming	393,697
	753,895

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DEPARTMENT OF THE INTERIOR
Franklin K. Lane, Secretary

UNITED STATES GEOLOGICAL SURVEY
George Otis Smith, Director

COKE PRODUCED IN THE UNITED STATES, 1880-1917

(Net tons.)

Year.	Alabama.	Colorado.	Georgia.	Illinois.	Indiana.	Kansas.	Kentucky.	Maryland.	Massachusetts.	Michigan.	Minnesota.	Missouri.	Montana.	New Jersey.	New Mexico.
1880	60,781	25,568	38,041	12,700	....	3,070	4,250	....	....	....	....	....	....	....	....
1881	109,033	48,587	41,376	14,800	....	5,670	4,370	....	....	....	....	....	....	....	....
1882	152,940	102,105	46,602	11,400	....	6,080	4,070	....	....	....	....	....	....	....	1,000
1883	217,531	133,997	67,012	13,400	....	8,430	5,025	....	....	....	....	....	....	....	3,905
1884	244,009	115,719	79,268	13,095	....	7,190	2,223	....	....	....	....	....	75	....	18,282
1885	301,180	131,960	70,669	10,350	....	8,050	2,704	....	....	....	....	....	175	....	17,940
1886	375,054	142,797	82,680	8,103	6,124	12,493	4,528	....	....	....	....	....	0	....	10,236
1887	325,020	170,698	79,241	9,198	17,658	14,950	14,565	....	....	....	....	2,970	7,200	....	13,710
1888	508,511	179,682	83,721	7,410	11,956	14,831	23,150	....	....	....	....	2,600	12,000	....	8,540
1889	1,030,510	187,638	94,727	11,583	8,301	13,910	13,021	....	....	....	....	5,275	14,043	....	3,460
1890	1,072,942	245,756	102,233	5,000	6,013	12,311	12,343	....	....	....	....	6,136	14,427	....	2,050
1891	1,282,496	277,074	103,057	5,200	3,798	14,174	33,777	....	....	....	....	6,872	29,009	....	2,300
1892	1,501,571	[a] 373,229	81,807	3,170	3,207	9,132	36,123	....	....	....	....	7,299	34,557	....	0
1893	1,168,085	[a] 362,986	90,726	2,200	5,724	8,565	48,619	....	....	....	....	5,905	29,945	....	5,803
1894	923,817	[a] 317,196	93,029	2,200	6,551	8,439	29,748	....	....	....	....	2,250	17,388	....	6,529
1895	1,444,339	[a] 340,357	60,212	2,250	4,804	5,287	25,460	....	....	....	....	2,028	25,337	....	14,663
1896	1,479,437	[a] 363,760	53,673	2,600	4,353	4,785	27,107	....	....	....	....	2,500	60,078	....	24,228
1897	1,443 017	[a] 342,653	33,000	1,519	2,904	6,181	32,117	....	....	....	....	2,593	67,849	....	1,438
1898	1,663,020	[a] 174,808	49,529	2,325	1,825	4,180	22,242	....	....	....	....	740	52,009	....	6,980
1899	1,787,809	[a] 530,424	50,907	[e] 2,370	(f)	14,476	81,095	....	(c)	....	....	2,860	56,376	....	44,131
1900	2,110,837	[a] 618,755	73,928	(h)	(h)	5,948	95,532	....	(h)	(h)	....	2,087	54,731	....	44,774
1901	2,148,911	[a] 671,303	54,550	(h)	(h)	7,138	100,285	....	(h)	(h)	....	4,749	57,004	....	41,643
1902	2,552,246	[a] 1,003,393	82,064	(h)	(h)	20,902	126,879	....	(h)	(h)	....	5,780	53,463	....	23,296
1903	2,693,497	[a] 1,053,840	85,546	(h)	(h)	14,194	115,362	(h)	(h)	(h)	....	1,839	45,107	(h)	11,050
1904	2,340,219	[a] 789,060	75,812	4,439	(h)	9,460	64,112	(h)	(h)	(h)	(h)	2,446	41,497	(h)	58,259
1905	2,576,986	[a] 1,378,824	70,593	10,307	0	4,425	79,487	(h)	(h)	(h)	(h)	1,580	31,482	(h)	89,638
1906	3,034,501	[a] 1,455,905	70,280	268,693	0	1,698	74,064	(h)	(h)	(h)	(h)	0	38,182	(h)	147,747
1907	3,021,794	[a] 1,421,579	74,934	372,697	0	6,274	67,068	(h)	(h)	(h)	(h)	0	40,714	(h)	265,125
1908	2,362,666	[a] 982,291	39,422	362,182	(h)	2,497	37,827	(h)	(h)	(h)	(h)	0	(h)	(h)	274,565
1909	3,085,824	[a] 1,251,805	46,385	1,276,956	(h)	0	46,371	(h)	(h)	(h)	(h)	0	(h)	(h)	373,967
1910	3,249,027	[a] 1,346,211	43,814	1,514,504	(h)	(h)	53,857	(h)	(h)	(h)	(h)	0	(h)	(h)	401,616
1911	2,761,521	[a] 1,177,023	37,553	1,610,212	(h)	(h)	66,099	(h)	(h)	(h)	(h)	0	(h)	(h)	381,927
1912	2,975,489	972,941	43,158	1,764,944	2,616,339	(h)	191,555	(h)	(h)	(h)	(h)	0	0	(h)	413,906
1913	3,323,664	879,461	42,747	1,859,553	2,727,025	0	317,084	(h)	(h)	(h)	(h)	0	0	(h)	467,945
1914	3,084,149	666,083	24,517	1,425,168	2,276,652	0	443,959	87,852	(h)	(h)	(h)	0	0	(h)	362,572
1915	3,071,811	670,938	20,039	1,686,998	2,768,099	0	526,097	313,283	504,438	(h)	127,847	(h)	0	(h)	389,411
1916	4,298,417	1,053,553	47,127	2,320,400	3,489,660	0	802,526	489,982	563,048	(h)	431,319	(h)	0	(h)	502,812
1917	4,892,589	1,112,449	39,589	2,289,833	3,540,718	0	863,071	518,810	595,113	(h)	490,272	(h)	0	423,361	577,679
	70,675,250	....	2,373,568	16,907,789	....	....	4,497,772	....	....	....	....	....	....	....	5,013,160

Year.	New York.	Ohio.	Oklahoma (Indian Territory).	Pennsylvania.	Tennessee.	Texas.	Utah.	Virginia.	Washington.	West Virginia.	Wisconsin.	Wyoming.	Other States.	Total.	Year.
1880	....	100,596	1,546	2,821,384	130,609	....	1,000	....	....	138,755	....	....	....	3,338,300	1880
1881	....	119,469	1,768	3,437,708	143,853	....	0	....	....	187,126	....	....	....	4,113,760	1881
1882	....	103,722	2,025	3,945,034	187,695	....	250	....	....	230,398	....	....	....	4,793,321	1882
1883	....	87,834	2,573	4,438,461	203,691	....	0	25,340	....	257,519	....	....	....	5,464,721	1883
1884	....	62,709	1,912	3,822,128	219,723	....	0	63,600	400	223,472	....	....	....	4,873,805	1884
1885	....	39,416	3,584	3,991,805	218,812	....	0	49,139	311	260,571	....	....	....	5,106,696	1885
1886	....	34,932	6,351	5,406,597	368,139	....	0	122,352	825	264,158	....	....	....	6,845,369	1886
1887	....	93,004	10,060	5,832,849	396,979	....	0	166,947	14,625	442,031	....	....	....	7,611,705	1887
1888	....	67,194	7,502	6,545,779	385,693	....	0	149,199	0	531,762	500	....	....	8,540,030	1888
1889	....	75,124	6,639	7,659,055	359,710	....	761	146,528	3,841	607,880	16,016	....	....	10,258,022	1889
1890	....	74,633	6,639	8,560,245	348,728	....	8,528	165,847	5,837	833,377	24,976	....	....	11,508,021	1890
1891	....	38,718	9,464	6,954,846	364,318	....	7,949	167,516	6,000	1,009,051	34,387	2,682	....	10,352,688	1891
1892	....	51,818	3,569	8,327,612	354,096	....	(b)	147,912	7,177	1,034,750	33,800	0	....	12,010,829	1892
1893	12,850	22,436	7,135	6,229,051	265,777	....	(b)	125,092	6,731	1,062,076	14,958	2,916	....	9,477,580	1893
1894	16,500	32,640	3,051	6,063,777	292,646	....	(b)	180,091	5,245	1,193,933	4,250	4,352	....	9,203,632	1894
1895	18,521	29,050	5,175	9,404,215	396,790	286	(b)	244,738	15,129	1,285,206	4,972	4,895	....	13,333,714	1895
1896	(c)	80,868	21,021	[d] 7,356,502	339,202	0	(b)	268,081	25,949	1,649,755	5,332	19,542	....	11,788,773	1896
1897	(c)	95,087	30,364	[d] 8,966,924	368,769	394	(b)	354,067	26,189	1,472,666	17,216	24,007	....	13,288,984	1897
1898	(c)	85,535	34,110	[d] 10,715,302	394,545	0	(b)	531,161	30,197	1,925,071	35,280	18,350	....	16,047,209	1898
1899	(c)	83,878	24,339	[g] 13,577,870	435,308	0	(b)	618,707	30,372	2,278,577	33,437	15,630	....	19,668,569	1899
1900	(h)	72,116	38,141	13,357,295	475,432	0	(b)	685,156	33,387	2,358,499	(h)	(h)	506,730	20,533,348	1900
1901	(h)	108,774	37,374	14,355,917	404,017	0	(b)	907,130	49,197	2,283,700	(h)	(h)	564,191	21,795,883	1901
1902	(h)	146,099	49,441	16,497,910	560,006	0	(b)	1,124,572	40,305	2,516,505	(h)	(h)	598,869	25,401,730	1902
1903	(h)	143,913	49,818	15,650,932	546,875	0	(b)	1,176,439	45,623	2,707,818	(h)	(h)	932,428	25,274,281	1903
1904	(h)	109,284	44,808	14,861,064	379,240	0	(b)	1,101,716	45,432	2,283,086	(h)	(h)	1,451,172	23,661,106	1904
1905	(h)	277,130	54,781	20,573,736	468,092	0	(b)	1,499,481	53,137	3,400,593	(h)	(h)	1,660,857	32,231,129	1905
1906	(h)	293,994	49,782	23,060,511	483,428	0	(b)	1,577,659	45,642	3,713,514	(h)	(h)	2,085,617	36,401,217	1906
1907	(h)	270,634	19,089	26,513,214	467,499	0	(b)	1,545,280	52,028	4,112,896	(h)	0	2,528,739	40,779,564	1907
1908	(h)	159,578	2,944	15,511,634	214,528	0	(b)	1,162,051	38,889	2,637,123	(h)	0	2,245,321	26,033,518	1908
1909	(h)	222,711	(h)	24,905,525	261,808	0	(b)	1,317,478	42,981	3,943,948	(h)	0	2,509,306	39,315,065	1909
1910	652,459	282,315	(h)	26,315,607	322,756	0	(b)	1,493,655	59,337	3,803,850	(h)	0	2,169,772	41,708,810	1910
1911	686,172	311,382	0	21,923,935	330,418	0	(b)	910,411	40,180	2,291,049	(h)	0	3,023,607	35,551,489	1911
1912	794,618	388,669	0	27,438,693	370,076	0	(h)	967,947	49,260	2,465,986	(h)	0	2,530,018	43,983,599	1912
1913	758,486	351,846	0	28,753,444	361,578	0	(h)	1,303,603	76,221	2,472,752	(h)	0	2,601,121	46,299,530	1913
1914	457,370	521,638	0	20,258,393	264,127	0	(h)	780,984	84,923	1,427,962	(h)	0	2,389,565	34,555,914	1914
1915	684,461	684,658	0	25,622,862	256,973	0	(h)	629,807	136,552	1,391,446	(h)	0	2,095,430	41,581,150	1915
1916	775,014	1,803,268	0	31,279,695	382,175	0	(i)	1,242,332	[j] 534,653	2,521,309	(h)	0	1,996,295	54,533,585	1916
1917	993,184	3,691,302	0	27,912,025	111,326	0	(i)	1,304,230	[j] 497,533	3,349,761	(h)	0	2,100,983	55,606,828	1917
	....	11,220,974	535,005	528,849,539	13,138,467	680	....	24,286,248	2,104,108	66,569,931	....	....	....	832,873,474	

[a] Includes Utah. [b] Included with Colorado. [c] Included with Pennsylvania. [d] Includes New York. [e] Includes Indiana. [f] Included with Illinois. [g] Includes Massachusetts and New York. [h] Included with other States having less than three producers. [i] Included with Washington. [j] Includes Utah.

Division of Mineral Resources.

77740°—M R 1917, PT 2. (In pocket.)

DEPARTMENT OF THE INTERIOR

FRANKLIN K. LANE, Secretary

UNITED STATES GEOLOGICAL SURVEY

GEORGE OTIS SMITH, Director

Coal produced in the United States from 1807, the date of the earliest record, to the end of 1917.

(NET TONS.)

Year.	Pennsylvania. *Anthracite*	Virginia	Kentucky	Illinois	Ohio	Pennsylvania *Bituminous*	Missouri.	Indiana	Alabama.	Tennessee.	Iowa.	Arkansas.	North Carolina	Maryland.
1807-1820.	12,000													3,000
1821	1,322													
1822	4,583	54,000												
1823	8,583	60,000												
1824	13,685	67,040												
1825	42,988	75,000												
1826	59,194	88,720												
1827	78,151	94,000												
1828	95,500	100,080	328											
1829	138,086	100,000	2,000											
1830	215,272	102,800	2,000											
1831	217,842	118,000	2,100											
1832	447,550	132,000	3,500											12,000
1833	600,007	125,000	9,750	6,000										
1834	464,015	124,000	5,000	7,500										
1835	690,854	120,000	6,000	8,000										
1836	842,832	124,000	8,000	10,000										
1837	1,071,151	160,000	10,000	12,500										
1838	910,075	300,000	11,500	14,000	119,952									
1839	1,008,322	396,000	16,000	15,038	125,000									
1840	967,108	424,894	23,527	16,967	140,536	464,826	9,972	9,682	946	558	400	220	3	8,880
1841	1,182,441	379,600	35,000	35,000	160,000	475,000	12,000	10,000	1,000	600	500			
1842	1,365,563	373,040	50,000	58,000	225,000	500,000	15,000	18,000	1,000	1,000	750			2,104
1843	1,556,753	370,000	60,000	75,000	280,000	650,000	25,000	25,000	1,200	4,500	1,000			12,421
1844	2,009,207	365,000	75,000	120,000	340,000	675,000	35,000	30,000	1,200	10,000	2,500			18,345
1845	2,480,032	350,000	100,000	150,000	390,000	700,000	50,000	35,000	1,500	18,000	5,000			30,372
1846	2,887,815	340,000	115,000	165,000	420,000	760,000	68,000	40,000	1,500	25,000	6,500			36,707
1847	3,551,005	325,000	120,000	180,000	450,000	399,840	80,000	45,000	2,000	30,000	8,000			65,222
1848	3,805,942	318,000	125,000	200,000	540,000	500,000	85,000	50,000	2,000	40,000	10,000			98,032
1849	3,995,334	315,000	140,000	260,000	600,000	750,000	90,000	56,000	2,500	52,000	12,500			175,497
1850	4,138,164	310,000	150,000	300,000	640,000	1,000,000	100,000	60,000	2,500	60,000	15,000			242,517
1851	5,481,065	310,000	160,000	320,000	670,000	1,200,000	125,000	60,000	3,000	70,000	18,000			317,460
1852	6,151,957	325,000	175,000	340,000	700,000	1,400,000	140,000	75,000	3,000	75,000	20,000			411,707
1853	6,400,426	350,000	180,000	375,000	760,000	1,500,000	160,000	75,000	4,000	85,000	23,000			657,862
1854	7,394,875	370,000	190,000	385,000	800,000	1,650,000	175,000	80,000	4,500	90,000	25,000			812,727
1855	8,141,754	380,782	200,000	400,000	890,000	1,780,000	185,000	80,000	6,000	100,000	28,000			735,137
1856	8,534,779	352,087	215,000	410,000	930,000	1,850,000	200,000	85,000	6,800	115,000	30,000			817,659
1857	8,186,567	303,605	240,000	450,000	975,000	2,000,000	220,000	85,000	8,000	125,000	33,000			654,017
1858	8,426,102	377,690	250,000	490,000	1,000,000	2,200,000	240,000	87,000	8,500	135,000	37,500			722,686
1859	9,610,771	359,055	275,000	530,000	1,060,000	2,400,000	260,000	95,000	9,000	150,000	42,000			833,349
1860	8,115,842	473,360	285,760	728,400	1,265,600	2,690,786	280,000	101,280	10,200	165,300	41,920	200		438,000
1861	9,799,654	445,165	280,000	670,000	1,150,000	3,200,000	300,000	128,000	10,000	150,000	50,000			287,073
1862	9,695,110	445,124	275,000	760,000	1,200,000	4,000,000	320,000	150,000	12,500	140,000	53,000		30,000	346,201
1863	11,785,320	40,000	250,000	890,000	1,204,581	5,000,000	350,000	200,000	15,000	100,000	57,000		30,000	877,313
1864	12,538,649	40,000	250,000	1,000,000	1,815,622	5,839,000	375,000	250,000	15,000	100,000	63,000		33,000	755,764
1865	11,891,746	40,000	200,000	1,200,000	1,536,218	6,350,000	420,000	280,000	12,000	100,000	69,574		20,000	1,025,208
1866	15,651,183	40,000	150,000	1,580,000	1,887,424	6,800,000	450,000	320,000	12,000	100,000	99,320		20,000	1,217,668
1867	16,002,109	50,000	175,000	1,800,000	2,092,334	7,300,000	500,000	350,000	10,000	110,000	150,000		20,000	1,381,429
1868	17,003,405	59,051	160,000	2,000,000	2,475,844	7,500,000	541,000	375,000	10,000	125,000	241,453		18,000	1,529,879
1869	17,083,134	65,000	160,000	1,854,000	2,461,986	6,750,000	550,000	400,000	10,000	130,000	295,105		18,000	2,216,300
1870	15,664,275	61,803	150,582	2,624,163	2,527,285	7,798,518	621,930	437,870	11,000	133,418	263,487		15,000	1,819,824
1871	19,342,057	70,000	250,000	3,000,000	4,000,000	9,040,565	725,000	600,000	15,000	180,000	300,000		15,000	2,670,338
1872	24,233,166	60,440	380,800	3,360,000	5,315,294	11,695,040	784,000	896,000	16,800	224,000	336,000		12,000	2,647,156
1873	26,152,837	67,200	400,000	3,920,000	4,550,028	13,098,820	784,000	1,000,000	44,800	350,000	392,000		10,000	3,198,011
1874	24,818,790	70,000	360,000	4,203,000	3,267,585	12,320,000	789,680	812,000	50,400	350,000	799,936			2,899,392
1875	22,485,760	60,000	500,000	4,453,178	4,864,259	11,760,000	840,000	800,000	67,200	360,000	1,231,547			2,808,018
1876	22,793,245	55,000	650,000	5,000,000	3,500,000	12,880,000	1,008,000	950,000	112,000	550,000	1,250,000			2,126,873
1877	25,660,316	50,000	850,000	5,350,000	5,250,000	14,000,000	1,008,000	1,000,000	196,000	450,000	1,300,000			1,939,575
1878	21,689,682	50,000	900,000	5,700,000	5,500,000	15,120,000	1,008,000	1,000,000	224,000	375,000	1,350,000			2,068,925
1879	30,207,793	45,000	1,000,000	5,000,000	6,000,000	16,240,000	1,008,000	1,196,490	280,000	450,000	1,400,000			2,132,233
1880	28,649,812	43,079	946,288	6,115,377	6,008,595	18,425,163	844,304	1,454,327	323,972	495,131	1,461,116	14,778	350	2,228,917
1881	31,920,018	50,000	1,232,000	6,720,000	9,240,000	22,400,000	1,960,000	1,984,120	420,000	840,000	1,960,000	20,000	300	2,533,348
1882	35,121,256	112,000	1,300,000	9,115,653	9,450,000	24,640,000	2,240,000	1,976,470	896,000	850,000	3,920,000	25,000	400	1,555,445
1883	38,456,845	252,000	1,650,000	12,123,456	8,229,429	26,880,000	2,520,000	2,560,000	1,568,000	1,000,000	4,457,540	50,000	400	2,476,075
1884	37,156,847	330,000	1,550,000	12,208,075	7,640,062	25,000,000	2,600,000	2,260,000	2,240,000	1,200,000	4,370,566	75,000	500	2,765,617
1885	38,335,974	567,000	1,600,000	11,834,459	7,816,179	26,000,000	3,080,000	2,375,000	2,492,000	1,440,957	4,012,575	100,000	500	2,833,337

Year	Washington.	Michigan.	Georgia	California	West Virginia.	Colorado.	Wyoming.	Kansas	Utah	Oklahoma (Indian Territory).	Oregon	Montana	New Mexico	Texas	North Dakota	Miscellaneous	Total
1807-1820																	15,000
1821																	1,322
1822																	58,583
1823																	68,563
1824																	80,725
1825																	117,988
1826																	147,914
1827																	172,151
1828																	195,908
1829																	240,086
1830																	320,072
1831																	337,942
1832																	595,050
1833																	734,657
1834																	600,515
1835																	824,854
1836																	984,832
1837																	1,253,651
1838																	1,355,527
1839																	1,560,360
1840																1,520	2,070,039
1841																	2,291,141
1842																	2,610,057
1843																	3,060,874
1844																	3,681,252
1845																	4,309,904
1846																	4,865,522
1847																	5,256,067
1848																	5,773,074
1849																	6,448,831
1850																	7,018,181
1851																	8,734,525
1852																	9,816,664
1853																	10,570,238
1854																	11,977,102
1855																	12,926,673
1856																	13,546,325
1857																	13,340,189
1858																	13,974,478
1859																	15,613,175
1860	5,374	2,320	1,900													3,800	14,610,012
1861	6,000	3,000	2,500	6,620													16,488,012
1862	7,000	5,000	3,500	23,400													17,485,535
1863	8,000	8,000	6,000	43,200	444,648												21,319,062
1864	10,000	12,000	10,000	50,700	454,888	500											23,605,123
1865	12,000	15,000	10,000	60,530	487,897	1,200	800										23,792,173
1866	13,000	20,000	8,000	84,020	512,068	6,400	2,500										29,003,583
1867	14,500	25,000	8,000	124,690	589,360	17,000	5,000										30,724,422
1868	15,000	28,000	10,000	143,676	609,227	10,500	6,925										32,861,960
1869	16,200	29,980	12,000	157,234	603,148	8,000	49,382	36,891									32,904,360
1870	17,844	28,150	15,000	141,890	608,878	4,500	50,000	32,938	5,800							1,425	33,035,580
1871	20,000	32,000	20,000	152,493	618,830	15,000	147,328	41,000								5,629,869	46,885,080
1872	23,000	33,600	25,000	190,859	700,000	68,540	221,745	44,800								176,169	51,453,399
1873	26,000	56,000	40,000	186,611	1,000,000	69,997	259,700	56,000								1,939,567	57,602,480
1874	30,352	58,000	60,000	215,352	1,120,000	77,372	219,061	85,000									52,605,920
1875	99,568	62,500	80,000	166,638	1,120,000	98,838	300,808	150,000								40,000	52,348,320
1876	110,342	66,000	110,000	128,049	896,000	117,666	334,550	225,000	50,400							366,875	53,250,000
1877	120,896	69,197	120,000	107,789	1,120,000	160,000	342,853	300,000	50,400							1,056,734	60,501,760
1878	131,600	85,322	128,000	134,237	1,120,000	200,630	333,200	375,000	67,200							374,744	57,935,600
1879	142,666	82,015	140,000	147,879	1,400,000	322,732	400,991	450,000	50,000								68,105,799
1880	145,015	100,800	154,644	236,950	1,829,844	462,747	589,595	771,442	14,748	120,947	43,205	224				200	71,481,570
1881	196,000	112,000	165,000	140,000	1,680,000	706,744	420,000	810,000	32,000	150,000	33,600	5,000	21,000			76,900	85,881,030
1882	177,340	135,339	160,000	112,592	2,240,000	1,061,479	707,764	750,000	100,000	200,000	35,000	10,000	157,032			6,502,359	103,551,189
1883	244,990	71,296	155,000	76,162	2,335,833	1,229,593	779,689	900,000	200,000	350,000	40,000	19,795	211,347			6,870,075	115,707,525
1884	166,935	36,712	150,000	77,485	3,360,000	1,130,024	902,620	1,100,000	200,000	425,000	45,000	80,376	220,557	125,000	35,000	9,498,174	120,155,551
1885	380,250	45,178	150,000	71,615	3,369,062	1,356,062	807,328	1,212,057	213,120	500,000	50,000	86,440	306,202	100,000	25,000		111,160,295

1876	22,793,245	55,000	650,000	5,000,000	3,500,000	12,550,000	1,008,000	950,000	112,000	550,000	1,250,000	......	......	2,126,873	110,342	66,000	110,000	128,049	896,000	117,666	334,560	225,000	50,400							366,875	53,280,000	1876
1877	25,660,316	50,000	850,000	5,350,000	5,250,000	14,000,000	1,008,000	1,000,000	196,000	460,000	1,300,000	......	......	1,839,575	120,806	69,197	120,000	107,789	1,120,000	160,000	342,853	300,000	50,400							1,056,734	60,501,760	1877
1878	21,689,052	50,000	900,000	5,700,000	5,500,000	15,120,000	1,008,000	1,000,000	224,000	375,000	1,350,000	......	......	2,068,925	131,660	85,322	128,000	134,237	1,120,000	200,630	333,200	375,000	67,200							374,744	57,035,600	1878
1879	30,207,793	45,000	1,000,000	5,000,000	6,000,000	16,240,000	1,008,000	1,196,490	280,000	450,000	1,400,000	......	......	2,132,233	142,666	82,015	140,000	147,676	1,400,000	322,732	400,891	460,000	50,000								68,105,799	1879
1880	28,640,812	43,079	946,288	6,115,377	6,008,595	18,425,163	844,304	1,454,327	323,972	495,131	1,461,116	14,778	350	2,228,917	145,015	100,800	154,644	236,950	1,829,844	462,747	589,595	771,442	14,748	120,947	43,205	224				200	71,481,570	1880
1881	31,920,018	50,000	1,232,000	6,720,000	9,240,000	22,400,000	1,960,000	1,984,120	420,000	840,000	1,960,000	20,000	300	2,533,348	106,000	112,000	168,000	140,000	1,680,000	706,744	420,000	840,000	52,000	150,000	33,600	5,000	21,000			76,800	85,881,030	1881
1882	35,121,256	112,000	1,300,000	9,115,653	9,450,000	24,640,000	2,240,000	1,976,470	896,000	850,000	3,920,000	25,000	400	1,555,445	177,340	135,339	160,000	112,592	2,240,000	1,061,479	707,764	750,000	100,000	200,000	35,000	10,000	157,092			6,502,350	103,551,189	1882
1883	38,456,845	252,000	1,650,000	12,123,456	8,229,429	26,860,000	2,520,000	2,560,000	1,568,000	1,000,000	4,457,540	50,000	400	2,476,075	244,990	71,296	155,000	76,162	2,335,833	1,229,593	779,689	900,000	200,000	350,000	40,000	19,705	311,347			6,870,075	115,707,525	1883
1884	37,156,847	336,000	1,550,000	12,208,075	7,640,062	28,000,000	2,800,000	2,260,000	2,240,000	1,200,000	4,370,560	75,000	500	2,765,617	166,936	36,712	150,000	77,485	3,300,000	1,130,024	902,620	1,100,000	200,000	425,000	45,000	80,376	220,557	125,000	35,000	9,498,174	120,155,551	1884
1885	38,335,974	567,000	1,600,000	11,834,459	7,816,179	26,000,000	3,080,000	2,375,000	2,492,000	1,440,057	4,012,575	100,000	600	2,833,337	380,250	45,178	150,000	71,615	3,360,062	1,356,062	807,328	1,212,057	213,120	500,000	50,000	86,440	306,202	100,000	25,000	...	111,160,295	1885
1886	39,035,446	684,951	1,550,000	11,175,241	8,435,211	27,094,501	1,800,000	3,000,000	1,800,000	1,714,290	4,315,779	125,000	400	2,517,577	423,525	60,434	223,000	100,000	4,005,796	1,368,338	829,355	1,400,000	200,000	534,580	45,000	49,846	271,285	100,000	25,956	794,917	113,680,427	1886
1887	42,088,107	825,263	1,933,185	12,423,066	10,300,708	31,516,856	3,209,916	3,217,711	1,950,000	1,000,000	4,473,828	129,600	300	3,278,023	772,601	71,461	313,715	50,000	4,881,620	1,791,735	1,170,318	1,596,879	180,021	685,011	37,696	10,202	508,034	75,000	21,470	1,237,195	130,650,511	1887
1888	46,619,564	1,073,000	2,570,000	14,328,181	10,910,951	33,796,727	3,909,967	3,140,979	2,900,000	1,967,297	4,952,440	276,871	250	3,479,470	1,215,750	81,407	180,000	95,000	5,498,800	2,185,477	1,481,540	1,850,000	258,961	761,986	75,000	41,467	626,665	90,000	34,000	4,257,807	148,659,557	1888
1889	45,546,970	865,786	2,399,755	12,101,272	9,976,787	36,174,089	2,557,823	2,845,057	3,572,983	1,825,689	4,095,358	279,584	222	2,939,715	1,030,578	67,431	225,934	119,820	6,231,880	2,597,181	1,388,647	2,221,043	236,651	752,832	64,359	363,301	436,943	128,216	28,807	1,400	141,229,513	1889
1890	46,468,641	784,011	2,701,490	16,292,420	11,494,506	42,302,173	2,735,221	3,305,737	4,090,409	2,169,585	4,021,739	399,888	10,262	3,357,813	1,263,689	74,977	228,337	110,711	7,394,654	3,077,003	1,870,366	2,259,922	318,159	869,229	61,514	517,477	375,777	184,440	30,000	807	157,770,963	1890
1891	50,665,431	736,309	2,916,069	15,660,698	12,868,683	43,788,400	2,674,606	2,973,474	4,750,781	2,413,678	3,825,495	542,379	20,355	3,520,239	1,058,249	80,307	171,000	93,301	9,220,665	3,512,632	2,327,841	2,716,705	371,045	1,091,032	51,826	541,861	463,328	172,100	30,000	2,000	168,566,669	1891
1892	52,472,504	675,205	3,025,303	17,862,276	13,562,027	46,694,576	2,733,949	3,345,174	5,529,312	2,092,064	3,918,491	535,553	6,679	3,419,962	1,213,427	77,990	215,498	85,178	9,738,755	3,510,830	2,503,839	3,007,276	361,013	1,192,721	34,661	564,648	661,330	245,690	40,725	1,510	179,329,071	1892
1893	53,967,543	820,339	3,007,170	19,949,564	13,253,646	44,070,724	2,897,442	3,791,851	5,136,035	1,902,258	3,972,229	574,763	17,000	3,716,041	1,264,877	45,979	372,740	72,603	10,706,578	4,102,389	2,439,311	2,652,546	413,205	1,252,110	41,683	802,309	665,094	302,206	49,630	....	182,352,774	1893
1894	51,821,121	1,229,083	3,111,192	17,113,576	11,009,856	39,912,463	2,245,039	3,423,921	4,397,178	2,180,879	3,967,253	512,626	16,900	3,501,428	1,106,470	70,022	354,111	67,247	11,627,757	2,831,409	2,417,463	3,388,251	431,550	969,606	47,521	927,395	597,196	420,848	42,015	150	170,741,526	1894
1895	57,999,337	1,368,324	3,357,770	17,735,864	13,355,806	50,217,228	2,372,393	3,995,892	5,693,775	2,535,644	4,156,074	598,322	24,900	3,915,585	1,191,410	112,322	260,998	75,453	11,387,961	3,082,982	2,246,911	2,926,870	471,836	1,211,185	73,685	1,504,193	720,654	484,959	38,997	200	193,117,530	1895
1896	54,346,081	1,254,723	3,333,478	19,786,626	12,875,202	49,557,453	2,331,542	3,905,779	5,748,697	2,663,106	3,954,026	675,374	7,813	4,143,936	1,195,504	92,882	238,546	78,544	12,876,296	3,112,400	2,229,624	2,884,601	418,627	1,366,646	101,721	1,543,445	622,626	544,015	78,050	18,792	191,886,357	1896
1897	52,611,680	1,528,302	3,602,097	20,072,758	12,196,942	54,417,974	2,665,626	4,151,169	5,803,770	2,888,840	4,611,865	856,190	21,280	4,442,128	1,434,112	223,592	195,869	87,992	14,248,159	3,361,703	2,597,886	3,054,012	521,560	1,330,380	107,289	1,647,882	716,981	639,341	77,246	18,505	200,229,199	1897
1898	53,382,644	1,815,274	3,867,908	18,599,299	14,516,867	65,165,133	2,688,321	4,920,743	6,635,283	3,022,896	4,618,842	1,205,479	11,495	4,674,884	1,884,571	315,722	244,187	145,888	16,700,999	4,076,347	2,863,812	3,406,555	593,709	1,381,466	58,184	1,479,803	992,288	686,734	83,895	17,038	219,976,267	1898
1899	60,418,005	2,105,791	4,607,255	24,439,019	16,500,270	74,150,175	3,025,814	6,008,523	7,593,416	3,330,659	5,177,470	843,554	26,806	4,807,396	2,029,881	624,708	233,111	160,916	19,252,995	4,776,224	3,837,392	3,852,267	786,049	1,537,427	86,888	1,498,451	1,050,714	883,832	96,809	1,277	253,741,192	1899
1900	57,367,015	2,393,754	5,328,964	25,767,981	18,988,150	79,842,326	3,540,103	6,484,056	8,384,275	3,500,562	5,202,039	1,447,945	17,734	4,024,688	2,474,093	849,475	315,557	171,708	22,647,207	5,244,364	4,014,602	4,407,870	1,147,027	1,922,206	58,864	1,661,775	1,299,299	968,373	129,883	1,210	269,684,027	1900
1901	67,471,667	2,725,873	5,460,086	27,331,552	20,943,807	82,305,946	3,802,088	6,918,225	9,099,052	3,633,290	5,617,400	1,816,136	12,000	5,113,127	2,578,217	1,241,241	342,825	151,079	24,068,402	5,700,015	4,485,374	4,900,528	1,322,614	2,421,781	69,011	1,396,081	1,088,546	1,107,953	166,601	1,300	293,299,816	1901
1902	41,373,595	3,182,093	6,706,984	32,939,373	23,519,894	98,574,367	3,890,154	9,440,424	10,354,570	4,382,968	5,904,766	1,943,932	23,000	5,271,600	2,681,214	964,718	414,083	84,984	24,570,826	7,401,343	4,429,491	5,266,065	1,574,521	2,820,066	65,648	1,560,823	1,048,763	901,912	226,511	4,242	301,590,439	1902
1903	74,607,068	3,451,307	7,538,032	36,957,104	24,838,103	103,117,178	4,238,586	10,794,692	11,654,324	4,708,004	6,419,811	2,229,172	17,309	4,846,165	3,193,273	1,367,610	416,951	104,673	29,337,241	7,423,602	4,635,293	5,839,976	1,681,409	3,517,388	91,144	1,488,810	1,541,781	926,769	278,045	4,907	357,356,416	1903
1904	73,150,709	3,410,914	7,576,482	35,475,060	24,400,220	97,938,287	4,168,308	10,842,189	11,262,046	4,782,211	6,510,033	2,009,451	7,000	4,813,622	3,137,681	1,342,340	383,191	76,888	32,406,752	6,658,355	5,178,556	6,333,307	1,493,027	3,046,539	111,540	1,358,919	1,452,325	1,195,944	271,928	4,174	351,816,398	1904
1905	77,659,850	4,275,271	8,432,523	38,434,363	25,552,950	118,413,637	3,983,378	11,895,252	11,866,069	5,766,690	6,798,609	1,934,673	1,557	5,108,539	2,864,926	1,473,211	351,901	77,050	37,791,580	8,826,429	5,602,021	6,423,979	1,332,372	2,924,427	109,641	1,643,832	1,649,933	1,200,684	317,542	9,656	392,722,635	1905
1906	71,282,411	4,254,870	9,653,647	41,480,104	27,731,640	129,293,206	3,758,008	12,092,560	13,107,963	6,259,275	7,260,224	1,864,268	......	5,435,453	3,276,184	1,346,338	332,107	25,290	43,290,350	10,111,218	6,133,994	6,024,775	1,772,551	2,860,200	79,731	1,829,921	1,964,713	1,312,873	305,689	11,706	414,157,278	1906
1907	85,604,312	4,710,895	10,753,124	51,317,146	32,142,419	150,143,177	3,997,936	13,965,713	14,250,454	6,810,243	7,574,322	2,070,438	......	5,532,628	3,680,532	2,035,858	362,401	13,950	48,091,583	10,790,236	6,252,990	7,322,449	1,047,607	3,642,658	70,981	2,016,857	2,628,959	1,648,069	347,760	17,727	480,363,424	1907
1908	83,268,754	4,259,042	10,246,553	47,659,690	26,270,639	117,179,527	3,317,315	12,314,890	11,604,593	6,199,171	7,161,310	2,078,357	......	4,377,093	3,024,943	1,835,019	264,822	15,755	41,807,843	9,634,073	5,489,902	6,245,508	1,846,792	2,946,116	86,259	1,920,190	2,467,937	1,895,377	320,742	8,586	415,842,698	1908
1909	81,070,359	4,752,217	10,697,354	50,904,990	27,930,641	137,966,791	3,756,530	14,834,259	13,703,450	6,358,645	7,757,762	2,377,157	......	4,023,241	3,602,263	1,784,692	211,196	45,836	51,849,220	10,716,030	6,393,109	6,986,478	2,266,899	3,119,377	87,276	2,553,940	2,801,128	1,824,440	422,047	7,353	460,814,616	1909
1910	84,485,236	5,507,997	14,623,319	45,900,246	34,209,668	150,521,526	2,982,433	18,389,815	16,111,462	7,121,380	7,028,120	1,905,958	......	5,217,125	3,911,899	1,534,967	177,245	11,164	61,671,019	11,973,736	7,533,088	4,921,451	2,517,809	2,646,226	67,533	2,920,970	3,608,321	1,892,176	399,041	5,448	501,596,378	1910
1911	90,464,067	6,864,667	14,049,703	53,679,118	30,759,986	144,561,257	3,836,107	14,201,355	15,021,421	6,433,156	7,331,648	2,106,789	120	4,685,795	3,572,815	1,476,074	165,210	10,747	59,831,580	10,157,383	6,744,864	6,178,728	2,513,175	3,074,242	46,661	2,976,358	3,148,156	1,974,593	502,628	2,721	496,371,126	1911
1912	84,361,598	7,846,638	16,490,521	59,885,226	34,528,727	161,865,488	4,339,856	15,285,718	16,100,600	6,473,228	7,289,529	2,100,819	200	4,964,038	3,360,932	1,206,230	227,503	10,978	66,786,687	10,977,824	7,368,124	6,986,162	3,016,149	3,675,418	41,637	3,048,495	3,536,824	2,186,612	499,480	3,319	534,466,580	1912
1913	91,524,922	8,828,068	19,616,600	61,618,744	36,200,527	173,781,217	4,318,125	17,165,671	17,678,522	6,860,184	7,525,936	2,234,107	......	4,779,839	3,877,891	1,231,786	255,626	24,839	71,254,136	9,232,510	7,393,066	7,202,210	3,254,828	4,165,770	46,063	3,240,973	3,708,806	2,429,144	495,320	14,789	569,960,219	1913
1914	90,821,507	7,059,536	20,382,763	57,589,197	18,843,115	147,983,294	3,935,980	16,041,132	15,593,422	5,943,258	7,451,022	1,836,540	......	4,133,547	3,064,820	1,283,030	166,498	(b)	71,707,626	8,170,559	6,475,293	6,860,988	3,103,036	3,988,613	51,558	2,805,173	3,877,689	2,323,773	506,685	25,824	513,525,477	1914
1915	88,995,061	8,122,596	21,301,674	58,829,576	22,434,691	157,055,137	3,811,593	17,006,162	14,927,037	5,730,361	7,614,143	1,652,106	......	4,180,477	2,429,095	1,156,138	134,496	(b)	77,184,069	8,624,980	6,554,028	6,824,474	3,108,715	3,693,580	39,231	2,789,755	3,817,940	2,088,908	528,078	24,496	531,619,487	1915
1916	87,578,493	9,707,474	25,393,997	66,195,336	34,728,219	170,295,424	4,742,146	20,093,528	18,086,197	6,137,449	7,260,800	1,994,915	......	4,460,046	3,038,588	1,180,360	173,554	(b)	86,460,127	10,484,237	7,910,647	6,881,455	3,567,428	3,608,011	42,592	3,632,527	3,793,011	1,987,503	634,912	29,199	590,098,175	1916
1917	99,611,811	10,087,091	27,807,971	86,199,387	40,748,734	172,448,142	5,670,549	26,539,329	20,068,074	6,194,221	8,965,830	2,143,579	......	4,745,924	4,009,902	1,374,805	119,028	(b)	86,441,667	12,483,336	8,575,619	7,184,975	4,125,230	4,386,844	28,327	4,226,689	4,000,527	2,355,815	790,548	68,420	651,402,374	1917
Total	2,813,702,882	132,164,477	303,075,049	1,234,329,819	799,433,305	3,380,627,056	138,328,740	331,912,239	323,629,988	147,755,654	217,891,892	44,186,728	477,125	193,173,673	77,001,845	27,906,044	10,018,874	5,153,264	1,109,282,513	215,124,810	148,256,505	157,448,653	48,157,243	75,151,212	2,327,529	54,854,203	57,006,773	35,405,280	7,883,739	30,135,327	12,130,806,450	

[a] From 1871 to 1888, inclusive, production reported in this column is due principally to colliery consumption, which in some years was estimated and not included in the distribution by States. Since 1888 small, irregular production from several unimportant sources has been included in this column.

[b] Included under "Miscellaneous."

Division of Mineral Resources.

Compiled by Miss LIDA MANN, Statistical Clerk, under direction of C. E. LESHER.