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Photograph from Highest Altitude Ever Attained by Man

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THE NATIONAL GEOGRAPHIC MAGAZINE

UTAH, CARVED BY WINDS AND WATERS

The Beehive State, Settled Only 89 Years Ago, Stands a Monument to the Courage of Its Founders

BY LEO A. BORAH

AUTHOR OF "WASHINGTON, THE EVERGREEN STATE," "PATRIOTIC PILGRIMAGE TO EASTERN NATIONAL PARKS," "DIAMOND DELAWARE, COMMON STEEL," ETC., IN THE NATIONAL GEOGRAPHIC MAGAZINE

UTAH blazes with color.

Prismatic plateaus, vermilion and white and pink cliffs cut by rainbow canyons, forest-fringed lakes below snow peaks, purple deserts of sage, gray wastes of sand and salt, and, threaded among them all, a pattern of green valleys like the veining of moss agate—these combine to make it a kaleidoscopic tapestry that varies in hues with every fluctuation of light, with every change of weather or of season.

FOUR TIMES AN INLAND SEA

For eons it has been a battleground of Nature, where the elves of erosion have striven cunningly against the titans of the nether world. Four times, geologists tell us, the whole intermountain area has been cut away and inundated; four times subterranean forces have thrust it up again. Now the titans are in the midst of a few millenniums of supremacy, but they will need to gather their forces; the elves of wind and water, heat and frost, trees and grasses, and their modern ally, man, are relentlessly at their sculpturing.

Topographically, the land is young, its valleys youthfully V-shaped or only slightly more maturely weathered; geologically, it is as old as time. The informed traveler in Utah may read in outcroppings of schists, shales, and sandstones the story of geology from pre-Cambrian ages to the present. Here he finds relics of prehistoric man, there fossils of strange, gigantic beasts that roamed the earth when it was ooze. Some canyon depths reveal rocks that were laid down before animal life existed.

In contemplating the ages of these geological specimens, human imagination falters. A visiting professor at the Utah State Agricultural College in Logan declared in a lecture several summers ago that a seaweed imbedded in a bowlder he had studied in Logan Canyon was probably 20 million years old. He returned to the college three years later and repeated the remark. After the class one of the students asked timidly, "Professor, shouldn't that seaweed be 20 million and three years old this summer?"

The pioneers who settled Utah took for their guidance a page from the manual of tireless Nature. In the inhospitable wastes of a dangerous frontier they literally hewed out farms and built cities. Their simple accounts of everyday struggles are heroic sagas of the winning of the West.

So rapid has been the development of the wilderness they tamed that the State today presents a complete cross section of the history of American civilization, just as its canyons and fault cliffs reveal the successive

Photograph by Leo A. Borah

SMOOTH YOUR OWN LINE TO THE CUP ON THIS CEDAR CITY "GREEN"

Water is too precious to be used for grass on the golf course, so a mixture of sand, sawdust, and oil makes the putting surface (see below). A piece of lead pipe attached to a rake handle "irons out the wrinkles" that might deflect the ball.

ages of geology. It is only a half-day drive from metropolitan Salt Lake City to desert and mountain shack towns such as Bret Harte described in his stories. One autumn day only a year or two ago, an observer, standing at a window in the magnificent State Capitol, counted 46 wild deer browsing unscared on the hillside overlooking populous Salt Lake Valley.

THE PIONEER SPIRIT STILL LIVES

Cedar City, gateway to the southern Utah parks, has a golf course which symbolizes the Utah pioneer spirit. Several miles from town it lies, in an arid valley crowded by craggy hills. Its "greens" are a mixture of sand, sawdust, and oil; its teeing places bristle doormats set in wooden frames; its fairways barren stretches from which sagebrush has been laboriously dug.

Randall Jones and I went out to the course with a club member, who explained with a chuckle as we jounced over the rough trail from the highway to the links that the jolts were "warming-up" exercises for the game. In front of the "shake" clubhouse beside a clump of scraggly juniper trees an iron mine owner and a West Point cadet were toiling in the hot sun to set an additional doormat for teeing. The mining man was left-handed, he said, and could not get the proper stance at the other tee.

The course lacks nothing in "rough." As if the hazards of cliffs, gullies, sagebrush, and thickets were not sufficient, there is an occasional rattlesnake for the player to kill with his club, or an inquisitive deer to chase out of the way of his shots.

Some girls in bright-hued pajamas were taking lessons from the club professional.

Dauntless Utah! That wild valley looks as little like a possible place for a golf course as the trackless desert the pioneers settled looked like farmland.

Back in Cedar City, we went to the creamery building of the Branch Agricultural College for a drink of buttermilk. The instructor in charge explained its excellence by showing us through his ultra-modern plant and taking us out to see the college herd of fine Holstein cows, which were grazing in the lush grass of an irrigated meadow.

Neighborliness is the keynote in Utah communities. Everywhere the warm-handed friendliness of the people makes the visitor feel at home. The only person we met who did not address Randall by his first name was an elderly Indian woman at Kanab, who called him "Mrs. Jones's man."

FARMERS OBEY THE GOLDEN RULE

When drought casts its blight over the land, the farmers help one another, the holders of primary irrigation rights willingly sacrificing a part of their own crops to release precious water for the burning fields of their less fortunate neighbors.

This spirit of mutual helpfulness makes community enterprises successful. When southern Utah scenery began to attract visitors from afar, Cedar City folk joined forces and almost without capital started the building of a hundred-thousand-dollar hotel. Some were able to contribute a little money, others only their services. For their shares shopkeepers gave clothing, groceries, and meat; and farmers brought in vegetables. Artisans and skilled laborers accepted these goods as wages for such time as they did not donate. A doctor paid a mason by attending the man's wife and infant. When the hotel was half completed, the railway company bought it from the community.

Before dawn of a clear summer day we drove out of Cedar City toward Utah's "Dixie" and Zion National Park. Drought had been parching the country for weeks, and we wished to avoid a little of the blistering heat that would come with the sun.

Utah has excellent roads, the main highways and many of the laterals paved with concrete or surfaced with crushed rock and heavy oil. Even the dirt roads are smooth, broad, and straight, and some of them, crossing the prismatic plateaus or cutting boldly through sandstone hills, gleam like ribbons with the colors of rainbow canyons.

As light began to break, amorphous masses along the way took shape as forest-crowned cliffs and gigantic rock towers carved by erosion into weird figures. The scene was so extraordinary that it seemed a figment of a fantastic dream. Everywhere I looked there was a glow of pink, deepening to dark red, as if the earth had been suffused with the flames of sunrise.

A short detour took us to some open-cut iron mines, one of which was operated by our left-handed golfer. He was abroad early, and his trucks were thundering down into a huge circular excavation, where steam shovels were loading them. The whole mountain he is working seems to be iron ore, which needs only to be shoveled into the trucks and hauled to a railroad for shipment to a smelter at Provo.

In 1851 Brigham Young sent a company of English and Scottish settlers into this region to mine and manufacture iron. After establishing Cedar City and setting up a furnace, they labored for eight years; but though they made thousands of tons of castings and pig iron, their equipment was inadequate to produce a good malleable metal. Today the iron industry in Utah has assumed important proportions, for there are vast deposits in the State, with a bountiful supply of coking coal for smelting.

As we sped down the highway, we came to the "ghost town" of Silver Reef, once the largest and most prosperous city in southern Utah. Only the old Wells-Fargo bank remains standing, the other buildings having been sold for taxes after the boom days and torn down by eager purchasers in search of silver caches.

"HE WHO LAUGHS LAST—"

The pioneers who settled Utah's "Dixie" were farmers not much interested in mining; but they opened near Silver Reef a quarry of sandstone from which they manufactured grindstones. The village assayer was the target of many gibes because he identified as ore almost every odd bit of rock he found. One day a joker handed him a piece of broken grindstone. Townsfolk guffawed when he pronounced it one of the richest samples of silver ore he had ever assayed.

The assayer had the last laugh, however, for not long afterward, in 1876, the "grindstone quarry" became the Silver Reef mine, from which more than 9,800,000 ounces of silver were taken in a few years. Even now a profit is being realized by a company which is reworking the old dumps.

IDAHO

WYOMING

COLORADO

UTAH

Malad
Weston
Preston
Franklin
Lewiston
Richmond
Bear Lake
Smithfield
Logan Canyon
Garland
Tremonton
Logan
Providence
Hyrum
Bear River City
Wellsville
Brigham
Bear River Bay
Marshes
Willard
Dolphin Island
Great Salt Lake
Lucin
Cutler Dam
Cub Island
Gunnison Islands
Fremont Island
Lake
Lakeside
Promontory Pt.
Ogden Canyon
Huntsville
Ogden
Hooper
Layton
Morgan
Echo Canyon
Davis Canyon
Echo Reservoir
Coalville
Carrington Island
Bird I.
Antelope Island
Parrish Canyon
Stansbury Island
Bountiful
City Creek
Emigration Canyon
Salt Lake City
Magna
Murray
Park City
Mill Creek Canyon
Big Cottonwood Canyon
Little Cottonwood Canyon
Granger
Granstville
Copperton
Tooele
American Fk. Canyon
West Jordan
Lehi
Mount Timpanogos
American Fork
Provo
Springville
Spanish Fork
Payson
Utah Lake
Jordan Narrows
Bingham Canyon
Oquirrh Mts.
Gold Hill
Eureka
Santaquin
Goshen
Nephi
Fountain Green
Fairview
Levan
Maple Canyon
Moroni
Mt. Pleasant
Spring City
Spring Canyon
Castlegate
Helper
Price
Sunnyside
Wattis
Hiawatha
Green River
Kings Peak
Grandaddy Lake
Vernal
Jensen
Dinosaur Nat. Mon.
Roosevelt
Fort Duchesne
Strawberry Reservoir
Uncompahgre Indian Reservation
Ute Indian Reservation
Timpanogos Cave Nat. Monument
Watson
Bonneville Salt Flats
Wendover
Great Salt Lake Desert
Deep Creek Mts.
Goshen Valley
Utah Valley
Provo River
Weber River
Duchesne River
Uinta Mts.

BRYCE CANYON

Bryce Canyon Lodge
Bald Mtn.
Sunrise
Tropic
Queens Garden
The Cathedral
Wall of Windows
Sunset
Inspiration Pt.
Paunsaugunt Plateau
Pink Cliffs
Natural Bridge
Statute Miles

ZION CANYON

Mountain of Mystery
Temple of Sinawava
The Organ
Angels Landing
Three Patriarchs
The Sentinel
Altar of Sacrifice
The West Temple
Spring dale
The Watchman
Zion Canyon
Pine Cr. Highway Tunnel
Statute Miles

Drawn by Newman Bumstead and Arthur J. Hazes

BESIDES 210 USEFUL MINERALS AND AGRICULTURAL WEALTH, UTAH HAS TWO NATIONAL PARKS AND SEVEN NATIONAL MONUMENTS

A maze of green gorges among mountains and deserts, the State is a cross section of American geology and civilization (page 577). Insets show Bryce and Zion Canyons.

For some distance beyond Silver Reef the country is a red waste of sand and cliffs and rocks tortured into grotesque shapes; then suddenly the desert bursts into bloom. Irrigation ditches fed by the Virgin River and other streams have made of the valley a fertile agricultural area on which its settlers boast that, with the possible exception of citrus fruit, they can grow any farm product produced elsewhere in North America.

Dreaming of establishing a vast State, "Deseret" (Honey Bee), that would include, besides what is now Utah, all of Arizona north of the Gila River, a corner of New Mexico, western Colorado, some of Wyoming and southern Idaho, most of Nevada, and about one-third of the present California, Brigham Young sent colonists into this semi-tropical region, and they established the town of Santa Clara in 1854. Before 1860 Washington and Toquerville had been founded, and St. George, now the largest town in the Virgin River Valley, followed in 1861.

UTAH'S "DIXIE" PRODUCED COTTON

Because of the Civil War, cotton was virtually unobtainable—its price in Utah had been $3.40 a pound in 1858—and the colonists set about raising a supply that would serve the needs of their own people. They produced in 1861 about 100,000 pounds of cotton on land that had been arid desert before their coming.

Today cotton is no longer planted in Utah's "Dixie"; fruit has taken its place. We were hailed all along the road by children who offered us melons, grapes, cherries, and peaches at ridiculously low prices. A few weeks later, they said, they would have figs for sale.

At St. George the coolness of an electrically fanned hotel lobby was welcome, for the thermometer was registering close to 110 degrees. I told the president of the Rotary Club, which was meeting there, of the Cedar City golf club. He said if we had time he would take us out to an even rougher course St. George enthusiasts were building.

Brigham Young made St. George his winter headquarters, and his home is still standing. Near it is the old tithing house to which the settlers brought for their church every tenth egg, or ear of corn, or basket of fruit. Another old adobe structure of interest is the agricultural station where the farmers brought for examination the exotic produce they were constantly trying.

The pioneers were indeed "wilderness breakers." Although they went into that desolate land with nothing save their few household belongings and their oxen, they not only quickly established farms and produced their food and clothing, but hauled slabs of red sandstone from the surrounding hills and built a massive temple and a commodious chapel. There must have been skilled artisans among them, for the spiral stairway they erected in the chapel is one of the finest examples of its kind I have seen; and the architecture of both places of worship is outstanding.

As I looked around the thriving town and remembered some of the waterless valleys we had traversed, I marveled at the courage and resourcefulness of those early settlers. Brigham Young displayed amazing genius as a colonizer.

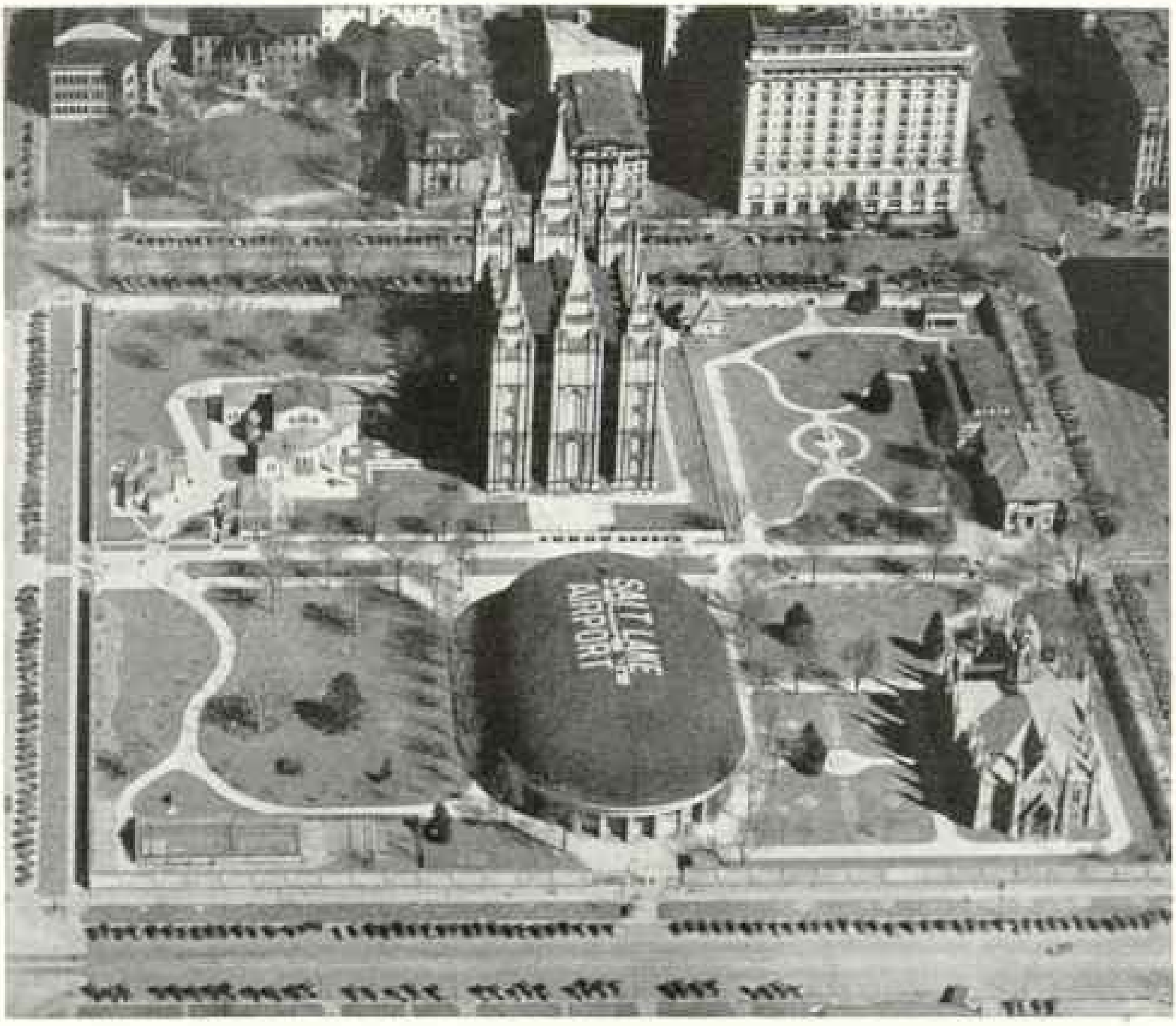
On the way from St. George to Zion Canyon we took a new road that passes through Hurricane, named for the mighty Hurricane Cliff, formed by faulting, which towers across Utah's southern boundary as a sheer red wall in some places fully 2,000 feet high. The view from the top is stupendous. Volcanic forces perhaps millions of years ago broke the earth's crust here and tilted a portion of it so high that it is an eyrie from which the visitor gazes spellbound. The fancy came to me that once when Mother Nature left her most talented but erratic children alone with paint pots and sculpturing chisels, they wrought this topsy-turvy scene out of pure mischief.

Because floods of the Virgin River menaced many farms in its valley, the early settlers undertook the digging of an irrigation ditch in the face of the Hurricane Cliff to supply water for a town to be located far above any possible floods. They were 20 years at the task, but they succeeded at last and established their town of Hurricane.

We found Hurricane a pleasant oasis of gardens, berry fields, orchards, and shade trees. The peaches we bought at a wayside market were particularly luscious.

WATER MAKES THE DESERT GREEN

Wherever water is available, there are green fields and prosperous villages, but not more than eight per cent of the 52,597,760 acres of land in Utah is adaptable to crop farming, and less than half of that, both irrigated and dry farms included, is so utilized now. The total irrigable acreage is probably not five per cent.



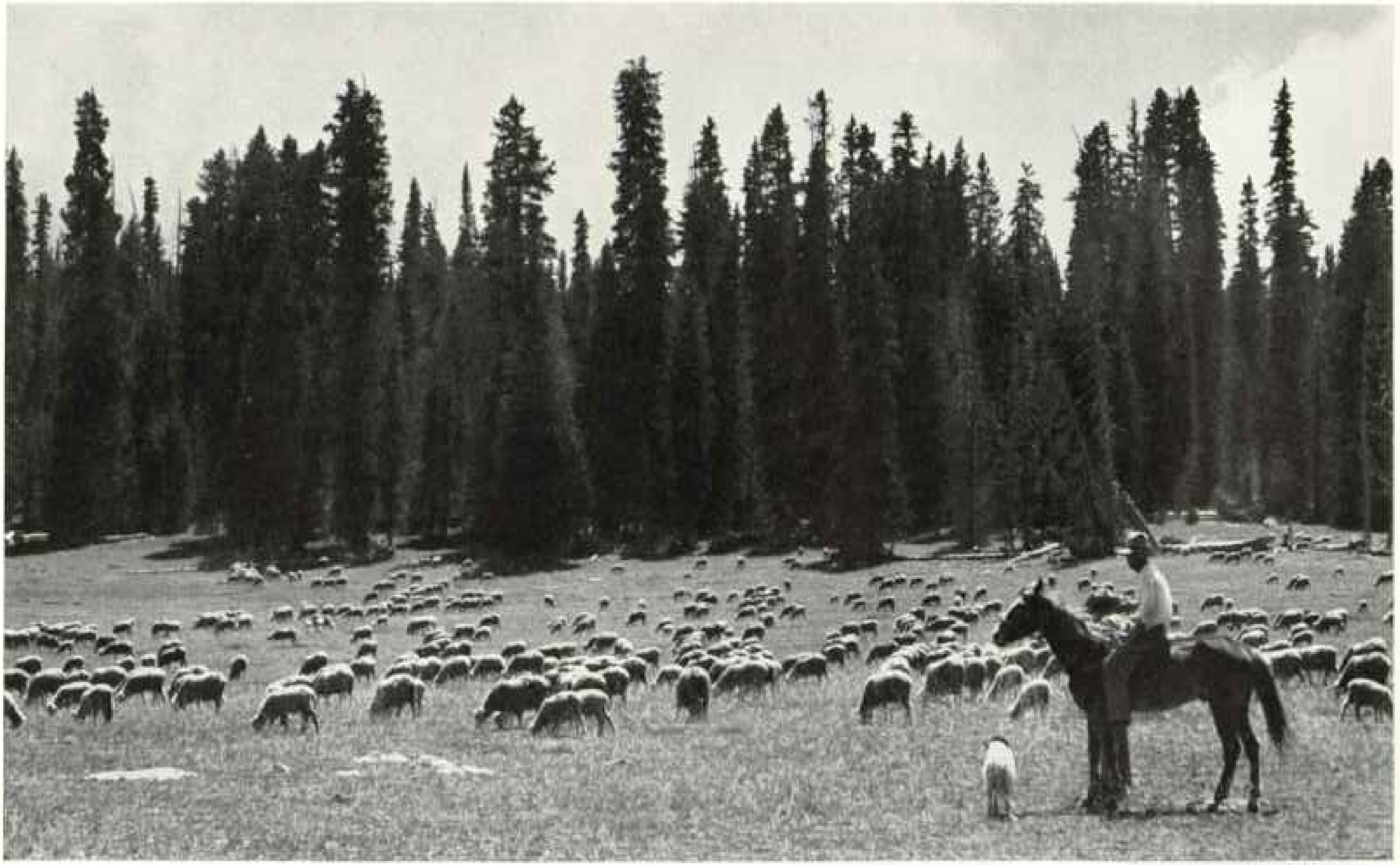
THE PAINTED ARROW ON THE TABERNACLE ROOF GUIDES FLYERS TO THE AIRPORT

To Temple Square each October and April come thousands of devout Mormons from all over the intermountain West and from many foreign countries (page 603). They assemble in "General Conference" at the Tabernacle and the Assembly Hall (right foreground). The Bureau of Information stands at the right of the spired Temple, and the Temple Annex is at the left.

Most of the non-tillable portions of the State, however, furnish excellent grazing for sheep, which are driven up to high plateaus and mountain sides for spring and summer feeding and brought back in the autumn to lower ground to winter on naturally cured desert growth. How the sheep industry advanced is evident from the livestock census, which recorded 450,000 sheep in Utah in 1883, 2,866,000 in 1929, and, despite business depression, 2,168,000 in 1935 (page 584).

As we passed Springdale and neared the entrance to Zion National Park, I wished for a pair of dark glasses. The intense sunlight on the red sandstone peaks and cliffs was dazzling. I sought to rest my eyes by looking toward a mighty, tree-fringed escarpment that thrust up on the horizon. Though it was 40 miles away, it seemed hardly a twentieth of that distance, the red of its base glowing scarcely less brilliantly than the rocks and towers at the roadside. To describe the colors of southern Utah, one would need to translate the most vivid adjectives into verbs, for under an afternoon sun those reds and pinks and yellows are violent forces that fairly crash upon the vision.

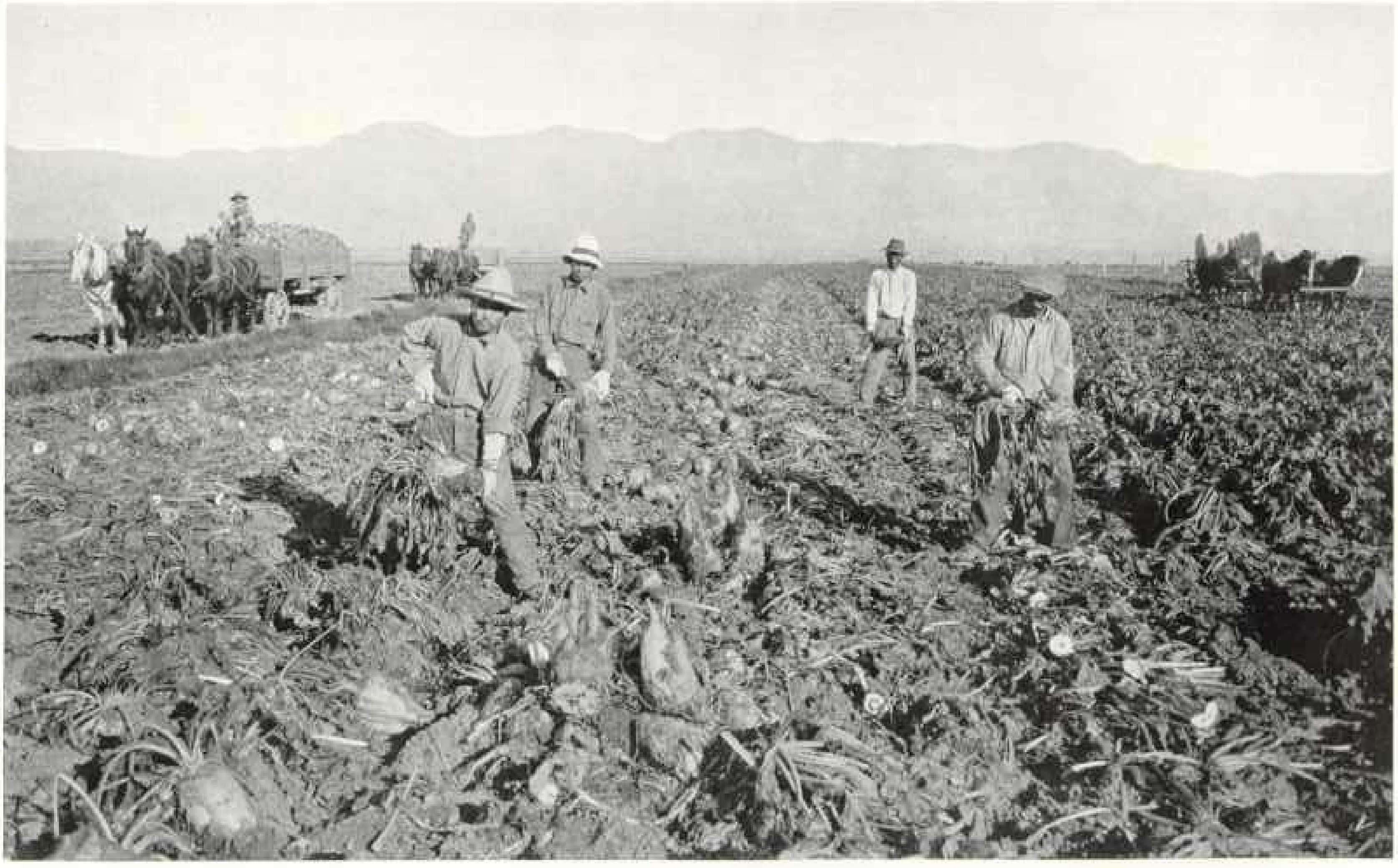
We were now on the floor of a deep gorge walled by cliffs and massive sandstone monoliths that suggested to me rough-hewn Ajaxes supporting a blue canopy of sky. To our left we saw the majestic West Temple lifting its forested plateau top nearly 4,000 feet above us; to our right the East Temple, almost as high. The Watchman, an enormous red spearhead at the gates of Zion, stabs its point more than a half mile above



Photograph by Richard H. Stewart

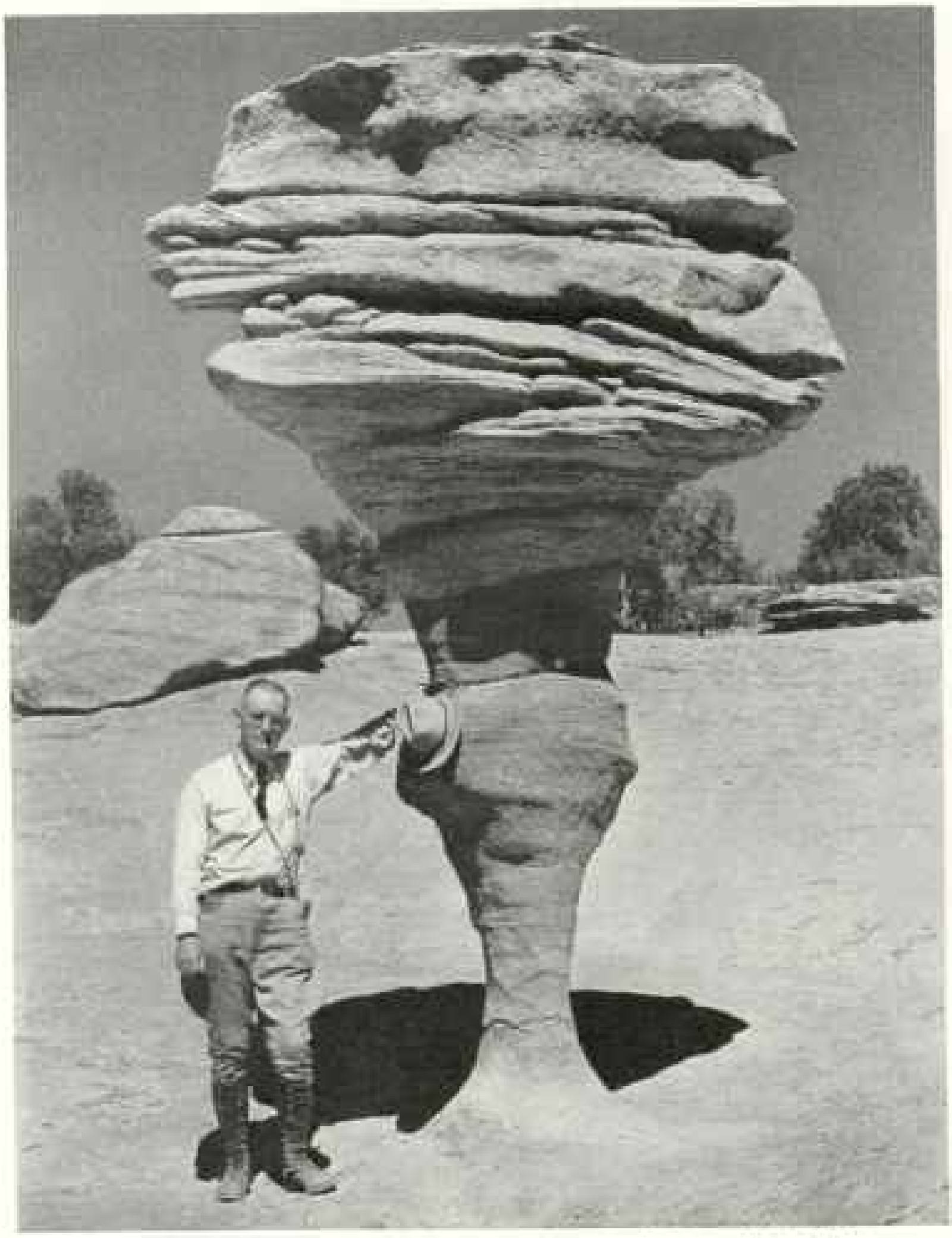
MORE THAN TWO MILLION SHEEP ARE AT HOME ON THE RANGES OF UTAH

This flock grazes all summer high in the hills of Dixie National Forest near Cedar Breaks. Before snow flies, the animals will be driven to shelter in the valleys. Herds sometimes migrate 300 miles from their summer ranges to winter quarters. Fine wool breeds, like the Hampshire and Rambouillet, rather than mutton-producing kinds have found preference in the State. A Rambouillet ram recently brought $6,200 at the annual international show in Salt Lake City (page 583).



GIANT BEETS ARE THE SOURCE OF ONE OF THE BIGGEST INDUSTRIES IN UTAH

This far-reaching field near Logan yielded 30 tons to the acre. In 1851-53 Mormon pioneers purchased in France machinery for manufacturing sugar, brought it to the United States, and hauled it across the desert at a freight cost of $500 a ton; yet they found that they could produce only a syrup. But failure of this, the third recorded attempt to make beet sugar in this country, was only temporary; there are now sixteen factories in the State.



Photograph by Zeke Johnson

WIND GODS FASHIONED THE GOBLET OF VENUS

Some strata of rock being softer than others, the wind removes them quickly, leaving the harder portions standing in queer figures. The carving is particularly rapid after rain has loosened the grains of sand of which the stone is composed. This freak is west of Blanding, in southeastern Utah.

the road; and The Sentinel, on the west rim near the checking station, overtops it. Strangely, all these giants appear equal in height when viewed from the bottom of the canyon. One must see them from Cedar Mountain or from the skyline trails to appreciate their differences in altitude.

For purposes of identification and location the names given to these monarchs are useful, but the names are pitifully inadequate to convey any true conception of their awesome grandeur. Through my mind kept running Coleridge's line, "In Xanadu did Kubla Khan a stately pleasure-dome decree." The deep red of the vermilion cliffs dominates the bases of the walls, but fades above to ever lighter shades until it gives way to broad bands of white crested by pinks and golds fringed with forests.

Farther up the road I almost shuddered at sight of the Altar of Sacrifice with its realistic blood-red stains, and the superstition of the Indians, who feared to enter the canyon after nightfall, became understandable. The Twin Brothers off to the right looked more cheerful, and the Mountain of the Sun blazed with glory in the westering light.

ONE LITTLE RIVER CARVED ZION

The tireless little North Fork of the Virgin River, which has carved the gorge, has made a garden spot of the valley floor, where grow many kinds of deciduous trees as well as conifers. Green meadows dotted with a bewildering array of wild flowers are pleasant to eyes dazzled by a long journey across sunlit wastes of red rock.

We rested for a while at the lodge, a rambling rustic structure in keeping with its surroundings; and then, leaving our bags at one of the comfortable cabins, drove on up the canyon to watch sunset bring out the colors on the Three Patriarchs and The Great White Throne.

The Great White Throne, also called El Gobernador, is a colossal truncated pyramid of rock rising about 2,500 feet above the river. Because its base and the cliffs near it are red, its upper part, shading from rose to chalky white, looks like a stupendous mass of white marble. Its top is forest covered, and here and there on its sheer sides clumps of trees have found footing. It is seen at its best from a circular vale of almost tropical green known as the Temple of Sinawava, where the canyon road ends at The Narrows, the knife-gash gorge cut to a depth of some 1,500 feet by the North Fork.

Standing at the bottom of The Narrows, one can see the stars in daytime as from the bottom of a well. I was reminded of John D. Whiting's description of the entrance to Petra, the "rose-red city, half as old as time" (see NATIONAL GEOGRAPHIC MAGAZINE for February, 1935), but words were lacking to express my thoughts.

My companion said, "Wait; there will be a full moon late tonight."

After a dinner of mountain trout at the lodge, we went for a long walk up the road. The college students who work during the summer as attendants were presenting a stage program in the assembly hall, and when this was ended their orchestra would play for dancing. We were in no mood, however, for such entertainment and hastened beyond the sound of the dance music. Only a fugue from Bach could have furnished fitting accompaniment for the pageant Nature was enacting.

Around us the huge monoliths gloomed as blacker shapes against the night; overhead was such a blaze of stars as I had never imagined. "The heavens declare the glory of God; and the firmament sheweth His handiwork . . ." Unbidden, the words of the nineteenth Psalm came to my mind.

MOONLIGHT IS A MAGICIAN

A little after midnight we drove up the canyon to the Temple of Sinawava and stood on the bank of the North Fork to await the moonlight. There was no sound save the murmur of the stream and the faint whisper of the ever-quivering leaves. An exotic fragrance filled the air, the perfume of the datura, a creamy night flower resembling the morning-glory. Within the vast, tower-walled circle ineffable peace engulfed us, stealing all sense of reality.

I raised my eyes toward the heights that shut us in. At first I thought clouds had appeared suddenly in the clear sky; then I knew that the white wraiths that seemed to float far above us were the upper cliffs gleaming in the radiance of the rising moon.

The effect was unearthly. One by one the crags and peaks emerged from the darkness like giant actors in a medieval Mystery play. Beyond the inverted arch, between The Organ and Angels Landing, The Great White Throne shone with ethereal splendor. It was a sight to make the least imaginative feel like falling on his knees.

We turned a little way up The Narrows to see the white shaft of the Mountain of Mystery. Like an ivory wand it seemed, held aloft by the magician Shelley called "that orbed maiden with white fire laden."

COLOR SEEN BY MOON RAYS

As the full moon cleared the canyon rim, the colors of the sandstone actually became visible, a phenomenon I had always supposed impossible. One wall, framed by darkling peaks, glowed like a fire opal set in black, its subdued but recognizable tints of red, pink, and gold shimmering in the direct moon rays.

We drove slowly the length of the canyon and back. At every turn appeared a new glory of the ever-changing panorama. Zion by moonlight is a vision never to be forgotten.

Joseph Black, a Mormon pioneer, homesteaded in Zion Canyon in the sixties and described it so poetically that his fellows who had not seen it dubbed it jocosely "Joseph's Glory." When they knew that he had done it no more than justice, they changed the name to Zion, in keeping with their thought of Utah as another "Holy Land." Brigham Young, however, demurred, and for years the gorge was referred to as "Not Zion."

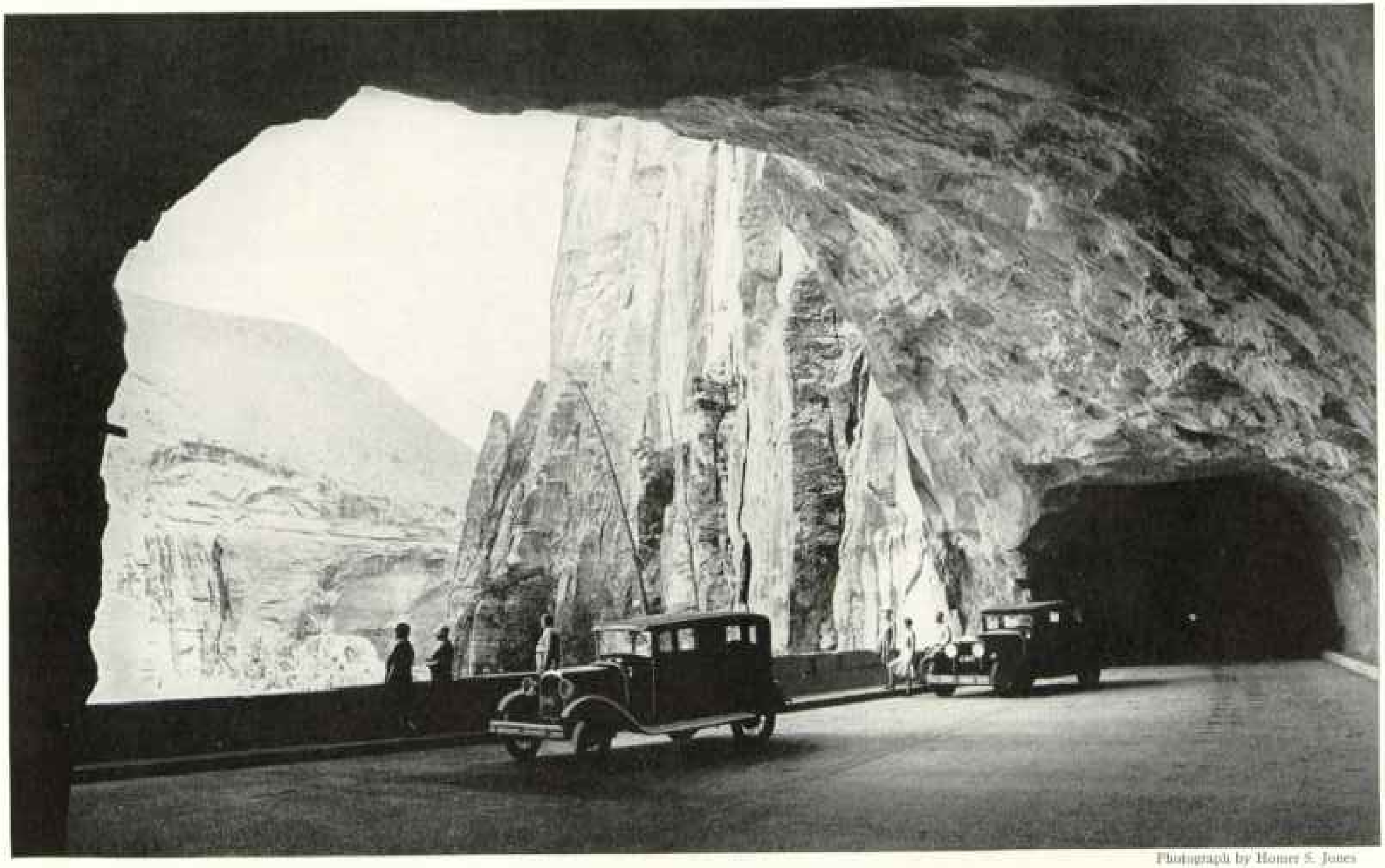
The Indian word for it was I-oo-goon (Arrow Quiver). In 1872 John Wesley Powell, explorer of the Grand Canyon of the Colorado, visited Zion and in an official report to the Government gave it the name Mukuntuweap from the river, now called North Fork of the Virgin. Under this title President Taft set aside the canyon in 1909 as a national monument; but later, with its sister canyons, the Parunuweap and the Great West, it became Zion National Park.

Parunuweap and Great West Canyons are almost as remarkable as Zion, but at present they are accessible only by difficult pack and foot trails. In Parunuweap the ruins of a

Photograph by Homer S. Jones

ZION-MT. CARMEL HIGHWAY, CLIMBING TORTUOUSLY TO A TUNNEL (LEFT), SHORTENS DISTANCES BETWEEN NATIONAL PARKS

Before this miracle of modern engineering was built in Zion Canyon, the way from here to Bryce Canyon entailed a 74-mile detour (Color Plate XV).



Photograph by Homer S. Jones

AS FROM A THEATER BALCONY, VISITORS VIEW THE WONDERS OF ZION CANYON ALONG THE ZION-MT. CARMEL HIGHWAY

Six of these windows pierce the mile-long tunnel hewn through solid rock. Debris thrown from the openings when blasting was in progress filled the deep gorge of Pine Creek, but in two months freshets had carried away the mass of stones (page 590).

mansion built by a wealthy early settler stand on the site of a prehistoric village. Ranger naturalists, digging around the building, found intermingled there relics of an ancient civilization, pottery of a later Indian tribe, and fragments of the white man's china. In many places in the park are remnants of cliff dwellings.

Our way out of Zion was the new Zion-Mt. Carmel Highway (page 588 and Color Plate XV), which climbs by a series of six switch-backs 791 feet in three miles and plunges into a 5,607-foot tunnel drilled in the face of the sheer canyon wall. Piercing the tunnel side at intervals convenient for ventilation are six large, windowlike galleries affording entrancing views. We paused at these openings to look out, each time from a higher vantage point, for the tunnel rises at a five-per-cent grade (page 589). At the last gallery I asked my companion how the tunnel had been made and what had been done with the waste rock.

TORRENTS BROOK NO INTERFERENCE

"The windows were cut first," he said, "and the rocks from them and from the tunnel were thrown down there into Pine Creek." He pointed over the gallery ledge at a mere rivulet skirting the base of the cliff far below us.

"That sounds like a wild exaggeration to you now, because the creek is almost dry and its bed free of debris; but you would understand if you could be here when floods come down from the mountains. They took that whole gorgeful of rock away in less than two months and carried it down to the Colorado River. Water has been known to rise 30 feet in a few minutes in The Narrows above Sinawava, and it comes up almost as fast here."

The gorge carved by Pine Creek is so narrow that from the tunnel window we easily threw stones against its opposite side. One who attempts to explore such a stream in the "cloudburst season" plays a reckless game with death.

Scarcely less spectacular than Zion itself is the country along the 24-mile highway to Mt. Carmel. The road, an engineering marvel built in 1927-30 at a cost of nearly $2,000,000, winds around red stone peaks and through areas fantastically carved by erosion.

A surfaced road leads northeast from Mt. Carmel through Orderville and other villages that seem anachronistic survivals from pioneer days. For miles it follows the fertile valleys of the Virgin and Sevier Rivers. Signs still visible on old buildings in some of the larger southern Utah towns bear the legend "Deseret Telegraph," reminding the traveler that Brigham Young established one of the earliest telegraph lines to keep his colonists in touch with Salt Lake City.

North of Hillsdale a highway branching off to the right took us up to the Paunsaugunt Plateau and the Powell National Forest. We were now approaching Bryce Canyon National Park, and the burning heat which had scorched the lower levels gave way to a delightful coolness. At the canyon rim the altitude is 8,000 feet.

It was near sunset when we reached Bryce Canyon Lodge, a restful place with attractive log sleeping cabins scattered among pine trees. Somewhat to my puzzlement, we had caught no glimpse of the canyon on our way in, nor could we see it now from the wide veranda of the lodge. The builders of highway and lodge had felt that the sight ought to be kept as a surprise at journey's end.

A few minutes later I appreciated the wisdom of that decision. We walked perhaps 300 yards from our cabin up a gentle incline and came suddenly to the rim of Bryce.

What a sunburst of beauty!

It is not awe-inspiring like the Grand Canyon of the Colorado, not solemnly mysterious like Zion. It is glamorous as a poet's dream. With its Cathedral, castles, spires, statuary, Queens Garden, Wall of Windows, and "weirdly sculptured gates" glowing in the sunset, it is like Tennyson's fairy city, "many-towered Camelot."

BRYCE CANYON TRANSCENDS ADJECTIVES

Actually it is not a canyon but an amphitheater three miles long and two wide crowded with tall, fantastic shapes whittled from the Pink Cliffs formation by rain and frost and wind (Color Plates I-IV and IX). The long Indian name for it means "Bowl-shaped Canyon Filled with Red Rocks Standing Up Like Men."

To each beholder it reveals itself in a personal interpretation different from the impressions that it makes upon others, for it stirs the depths of imagination. Some visitors delight in comparing the sculptures to characters from history or to famous or even comic figures of today. Gleefully they

Photograph by Branson De Cou from Galloway

IT'S EASY TO FLOAT BUT DANGEROUS TO DIVE IN THE GREAT SALT LAKE

Laden with 28 per cent salt, the water is so heavy that an inexperienced diver might break his neck when striking the surface. It is impossible to sink, but the saline solution is so strong that the unwary person who gets it into his throat may meet death by strangulation. Recent investigation reveals that salt crystals are now precipitated over the entire lake bottom and even the tiny shrimps which formerly were the only animal life in the water are disappearing.

will point out "Queen Victoria" and, not far away from this dignified personage, "Gloomy Gus."

My personal preference is for Indian names, which have an orotund ring and mean whatever one wishes to make of them.

Horse and foot trails, leading down into the bottom of the bowl, permit the visitor to obtain many different perspectives. Everywhere the soft pastels of the limy sandstone charm the eye. There are red, orange, pink, yellow, mauve, and purple, all produced by the action of water on mineral deposits.

Because parts of the formation are much softer rock than others, these have been cut away, leaving the harder portions standing like strange bits from an oriental fantasy.

There are no constant streams in Bryce Canyon, but occasionally floods from torrential rains sweep the floor clean of debris. Erosion is going on without interruption, trees at the rim sometimes toppling over and crashing to the bottom. The edge of the cup is the dividing line between the Great Basin and the Colorado River watersheds; and, when two raindrops fall on it an inch apart, one may find its way to inland plains, the other to the Gulf of California.

It has been my good fortune to see Bryce Canyon many times—at sunset, at dawn, under a midday sun, in moonlight, and before, during, and after rains. Always its colors have been different. Heavy rain makes it particularly lovely, sending slender cataracts tumbling from every promontory.

Legend has it that Ebenezer Bryce, who established a farm at the lower gateway in 1875, founded the frontier village of Tropic (still a frontier village), and gave his name to the canyon, was so little impressed with the wonders of the scene that he described it merely as "a terrible place to lose a cow." Perhaps he had been forewarned by hearing the story of Joseph Black and Zion (p. 587).

We stayed at Bryce Canyon Lodge for several days, enjoying the cool, sparkling weather, and going on excursions to points of interest. Though the time was the beginning of July, evenings and mornings were chilly enough to justify jolly log fires in the huge fireplace.

Most entertaining were the fireside tales told by the cowboy guide (Color Plate IX). One night he wove for a group of girls a story of one of his experiences with horse thieves. It was intensely dramatic but ended unsatisfyingly with the hero backed up into a box canyon by a murderous band aiming their rifles at his breast. He could neither retreat nor advance.

"But what did they do to you?" gasped one of the innocent auditors.

"Oh, they killed me," he replied, without a suspicion of a smile.

"STEPS" BACK TO THE DAWN OF TIME

From the edge of the Paunsaugunt Plateau a geologist can trace the history of earth back to its beginnings. He stands on a Tertiary formation and looks down a mighty flight of steps breaking away toward the Colorado River. Each of those steps represents a different age, and if he could descend them he would pass through the Cretaceous, Jurassic, Triassic, and Permian before he was out of Utah.

Disregarding, then, the political boundary, he could follow the plateau across northern Arizona, go down into the Grand Canyon, and come to Archean rocks, the oldest formation exposed in the world. A journey of about 80 miles would take him back thousands of centuries in geologic history.

When we went from Bryce to the Kaibab National Forest and the North Rim of the Grand Canyon, I was at a loss to understand why Utah does not extend all the way. Fredonia, in northern Arizona north of the Grand Canyon, is wellnigh inaccessible from the Arizona side. It is a Mormon village settled by Utah colonists, but when Utah was ready for statehood the boundary was fixed by compromise just south of Kanab.

At Kanab we were graphically reminded of the age of the ground we trod. There were clearly defined dinosaur tracks in the flat red stones of the walk that leads to the hotel.

We went up from Bryce to Cedar Breaks for the Fourth of July ceremony dedicating Cedar Breaks as the 69th national monument. That word "up" is important, for the rim of the vast amphitheater known as Cedar Breaks is 10,400 feet above the sea.

On the way we passed a strip of broken rocks that had poured as lava out of one of the now extinct volcanoes of southern Utah. It brought to mind Poe's "scoriac rivers that roll their sulphurous currents down Yaanek," though now it is bordered by a lovely forest of white-boled aspen trees (Color Plate XIV).

Cedar Breaks, formed by the same agents that carved Bryce Canyon, is much larger than the better known amphitheater. Standing on its rim, one looks into the magnificent depths of a series of eroded bowls (Color Plate X), each peopled with red rock giants. As many as 60 colors have been identified by observers from the lookout point.

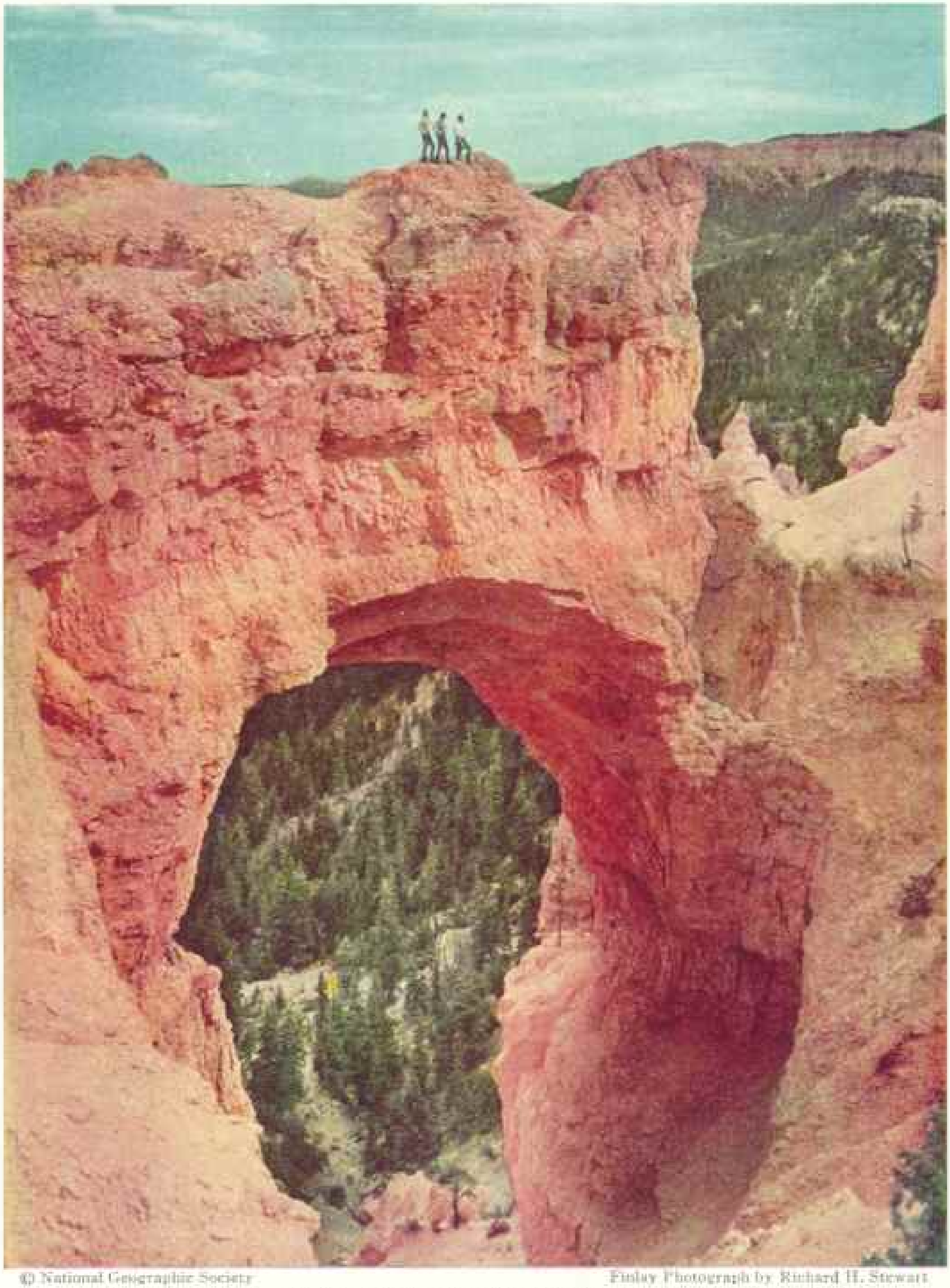
Again I was reminded of a Psalm of David, "Who shall ascend into the hill of the Lord?"

Glorious as is the scene, I was more interested in the Utah people who had come to the celebration. They sat on upended blocks sawed from trees and listened to a three-hour program of speeches and music. They are hardy folk!

Though the sun was at its height, the air was delightfully cool; and we sat hatless through the long ceremony. Next day we rued our politeness; for those of us who were bald or baldescent were treating our heads for sunburn. There is something unusual about sunburn in Utah; it causes the affected parts to swell most unbecomingly.

NEIGHBORS ALL IN UTAH

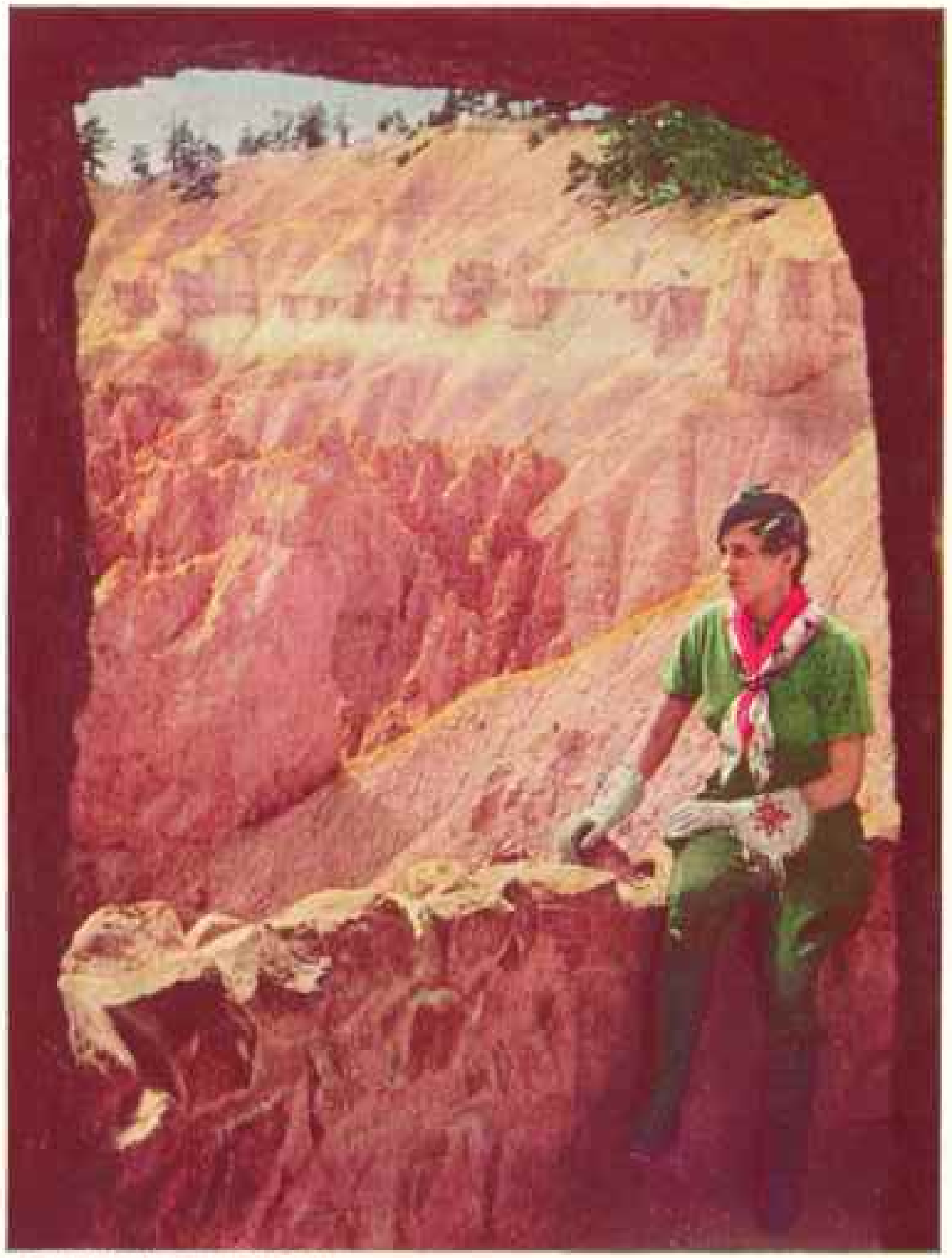
After the speeches there was a picnic, with barbecued beef served free to all comers. Scores of Piute Indians were on hand to take care of what was left. Everybody seemed happy and care-free, neighbors greeting one another and inviting their friends to share the baskets of home-cooked dainties. We tasted delicious cakes until out of regard for our waistlines we avoided approaching family groups before the luncheon had been



 Finlay Photograph by Richard H. Stewart

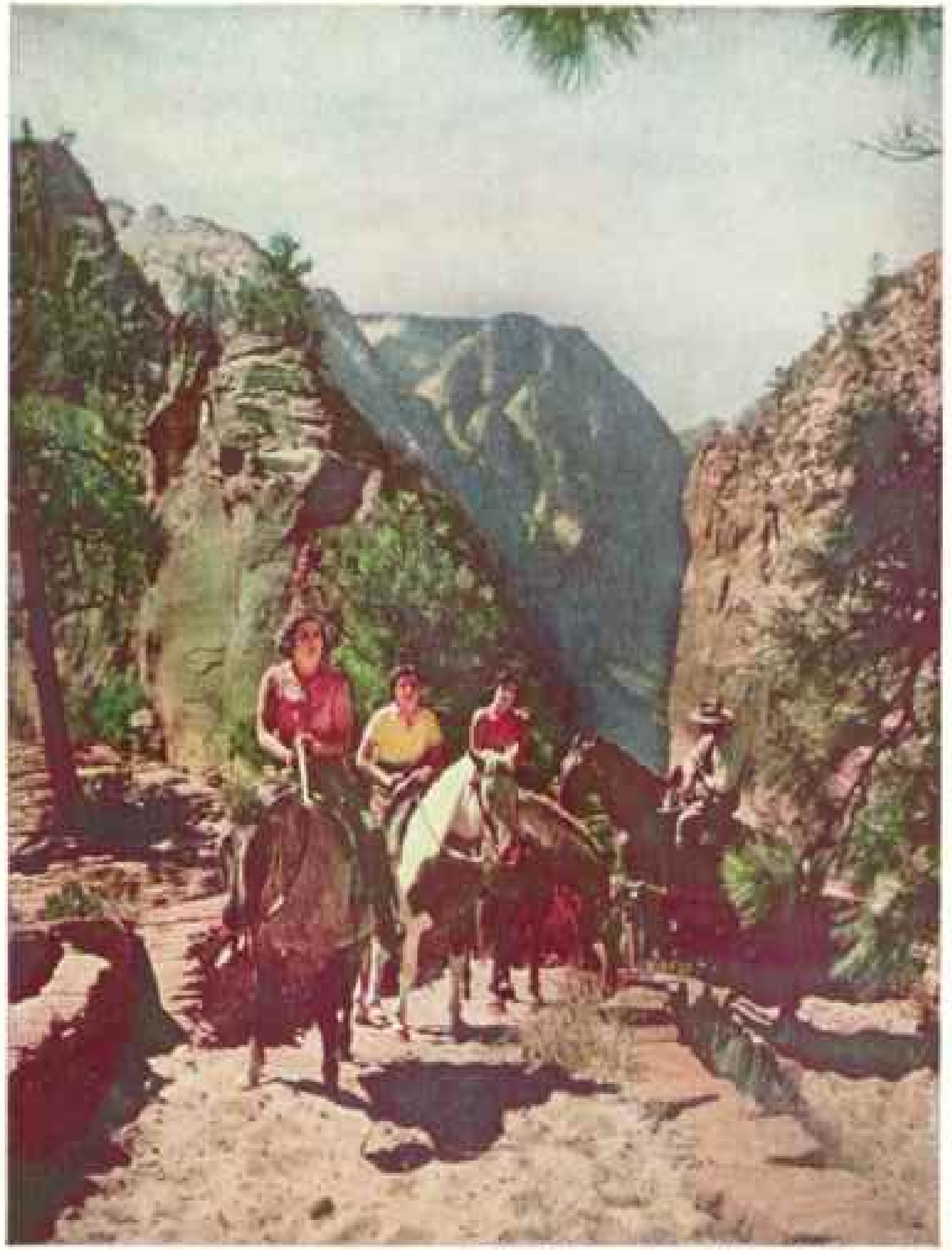
WIND AND WATER HAVE MADE LACE OF SANDSTONE IN BRYCE CANYON

Though a large office building could stand beneath the 165-foot arch of this Natural Bridge, sunlight and shadow, bringing out the delicate pastels of the rock, make it seem fragile. It is only a few steps from the highway leading to Sunrise Point. The three visitors' pedestal may appear dangerous, yet actually it is a broad platform.



A STAIRWAY WINDOW INVITES A PAUSE ON NAVAJO TRAIL

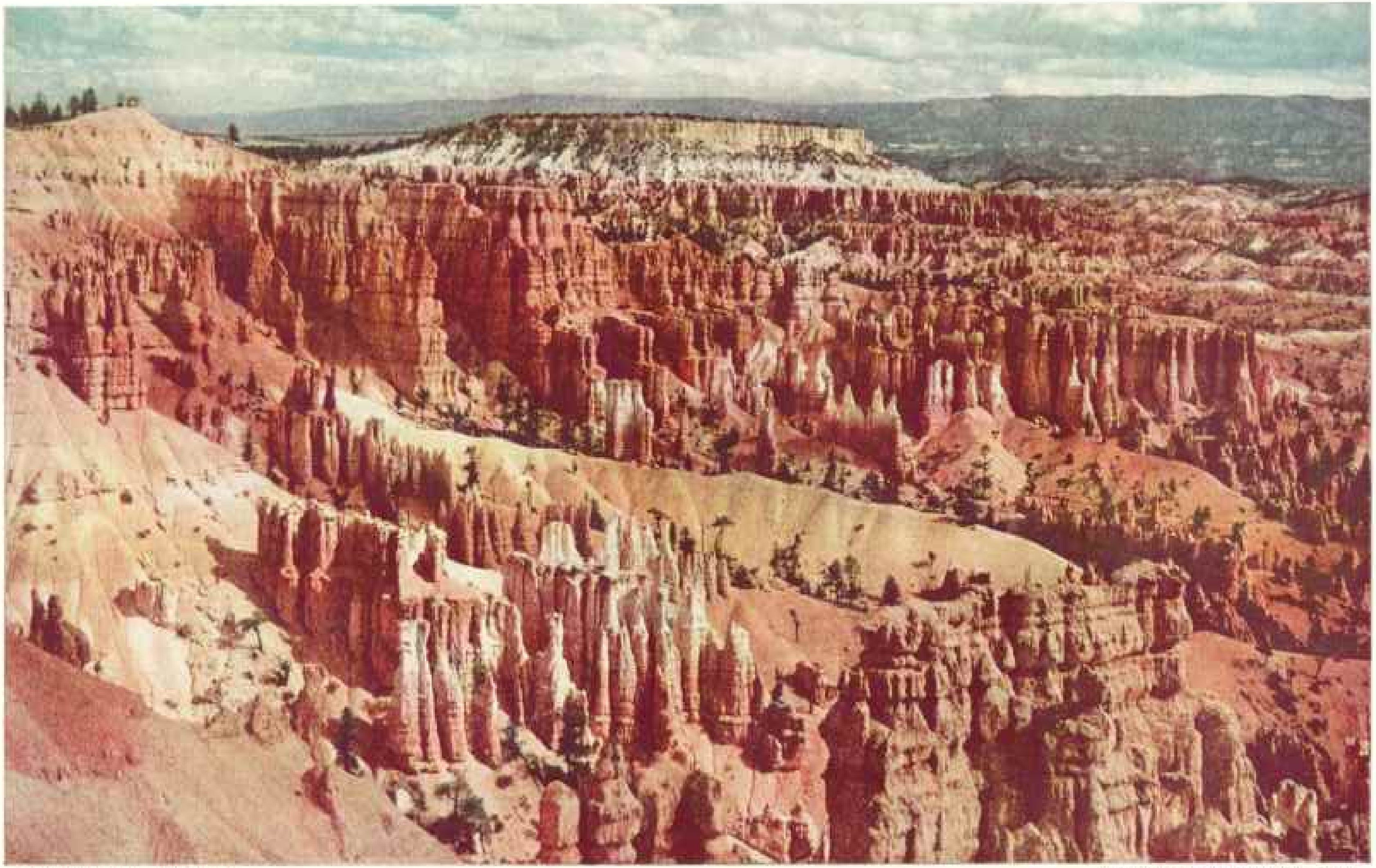
Cut through one of the dozens of thin walls that rise from the floor of Bryce Canyon to hem in the footpath leading down from the rim, the



Finlay Photographs by Richard H. Stewart

WEST RIM TRAIL AT ZION IS A "SKY PATH"

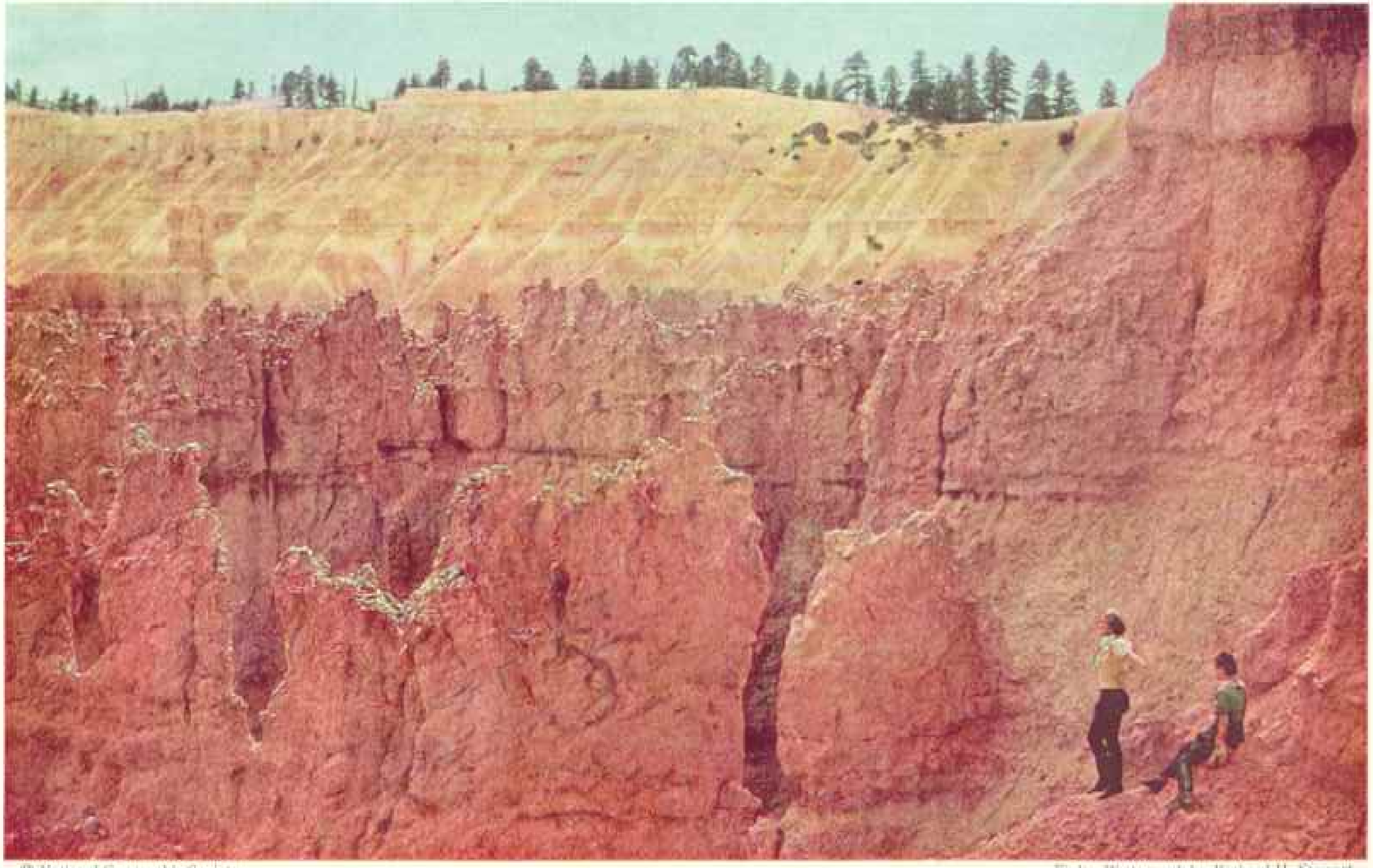
A little to their right, the riders can peep over the edge of a sheer cliff, 1,500 feet to the canyon bottom (see Plate XVI). The ledge behind,



Agfacolor Plate by Randall L. Jones

FROM SUNSET POINT THE NORTH PART OF BRYCE AMPHITHEATER GLEAMS LIKE A FAIRY CITY

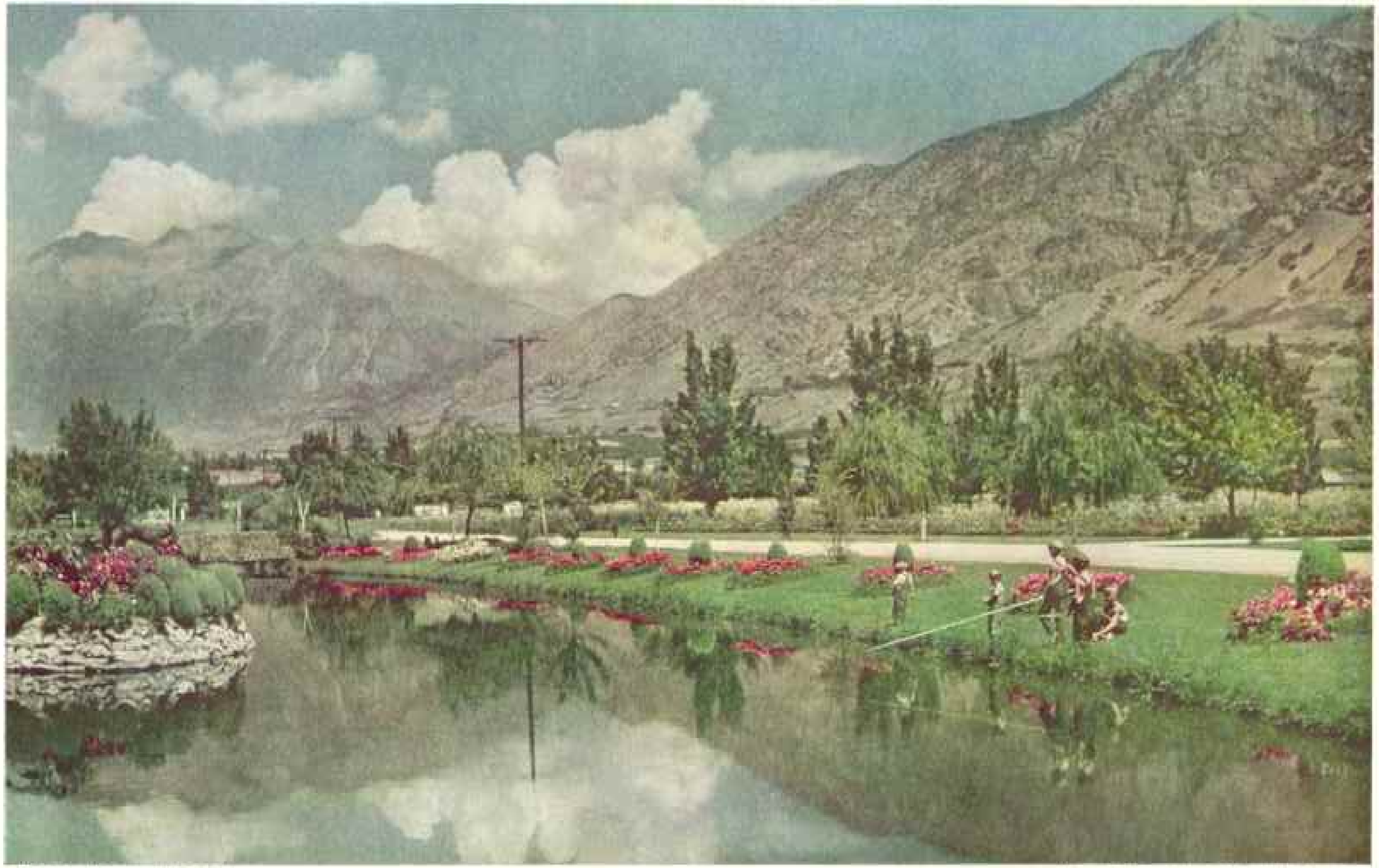
The flat-topped giant in the background is Boat Mountain, and the eminence in the upper left corner is Sunrise Point. Close examination of the figures sculptured by Nature reveals startling resemblances of some of them to people, animals, and castles. Erosion is almost imperceptibly cutting away these "phantom shapes." Since normally only the thickness of tissue paper is removed each year, they are likely to stand for many millenniums.



Finlay Photograph by Richard H. Stewart

REFLECTION AND CHANGES OF LIGHT MAKE A KALEIDOSCOPE OF BRYCE CANYON

Actually the colors in the corridor rocks are permanent, yet to the eye they never appear twice the same. Direct sun rays make them seem orange, gold, and yellow; shadow deepens them to pink, red, and purple. The brilliancy of the walls at the lower left is caused by their catching reflected hues from distant cliffs. This view is from the Navajo Trail (see Plate II).



Finlay Photograph by Richard H. Stewart

MEMORIAL PARK IN PROVO HONORS WORLD WAR HEROES

Each pine tree along the road is a monument to a man of the "Garden City" who gave his life for his country. In the distance Mount Timpanogos rises a mile and a half above the valley floor. Brigham Young University conducts its summer school in an aspen grove below a glacier on the farther shoulder of the mountain. Fishing is good in the park lake, though to obtain a real catch the boys would accompany their elders to Utah Lake near by.

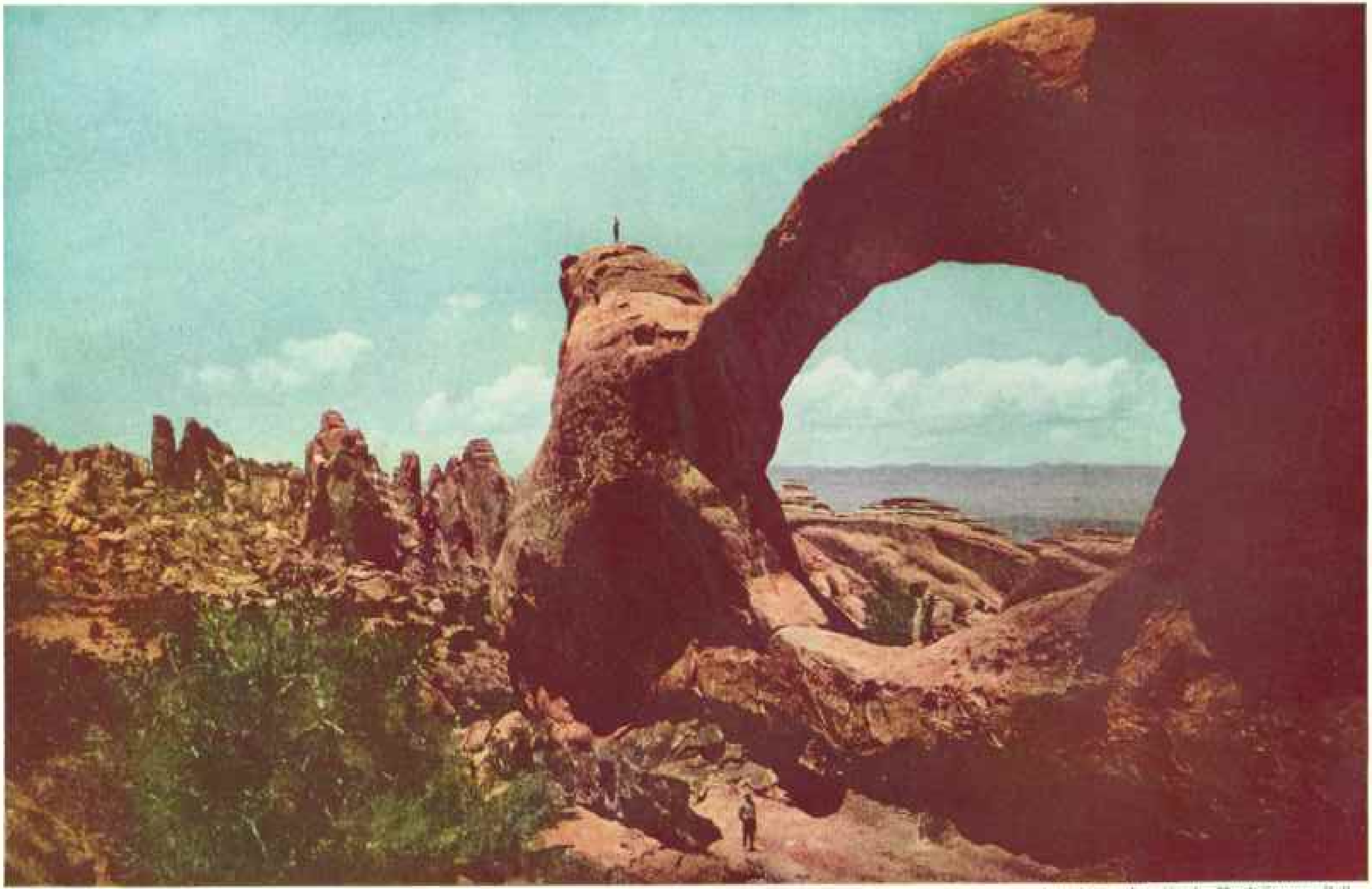
UNIVERSITY WARD CHAPEL SERVES MORMON STUDENTS

Besides an auditorium for religious services, this Latter Day Saints church, which faces the campus of the State University, contains a reception hall, classrooms, an amusement room with stage and dance floor, a large kitchen, offices, and dressing and shower rooms.

Finlay Photographs by Richard H. Stewart

THE SEA GULL MONUMENT COMMEMORATES A "MIRACLE"

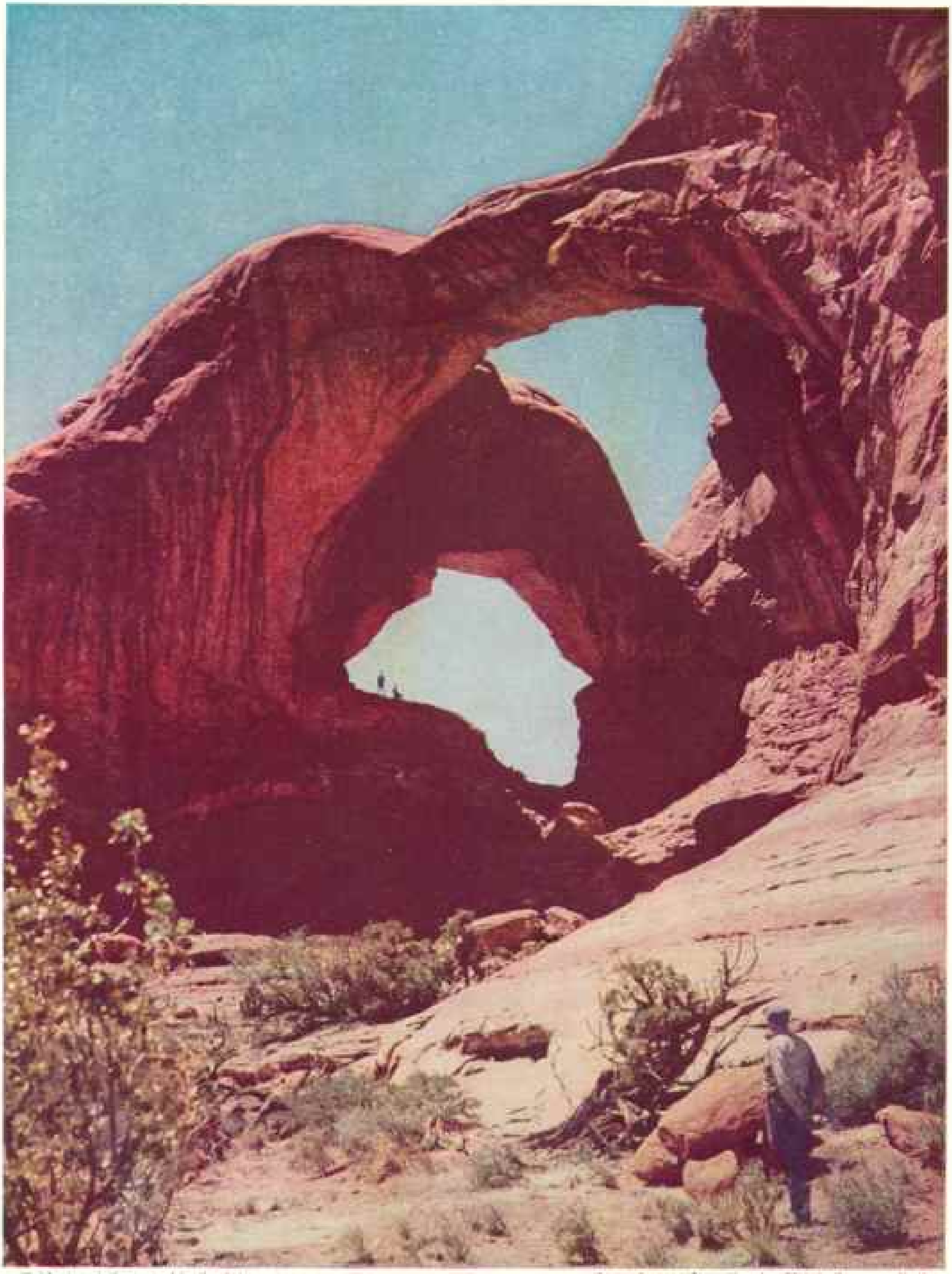
One day in May, 1848, hosts of crickets descended on the young crops in Salt Lake Valley. Suddenly a cloud of gulls appeared from over Great Salt Lake and devoured the insects in time to save the grain. This memorial to bird life stands near the Mormon Temple in the State capital.



Autochrome Lumière by Hugh Stevens Bell

LIKE A PREHISTORIC MONSTER IS THE DOUBLE-O ARCH IN THE ARCHES NATIONAL MONUMENT

Erosion by streams has played weird tricks in eastern Utah. In an area of 4,520 acres set aside by President Hoover are to be seen many such wonders as well as odd rock towers and chimneys (see Plate VIII). This one is particularly freakish, for it has two openings, the smaller to the right of the man in the foreground. In the same region but farther south are the Natural Bridges and the Rainbow Bridge National Monuments.



© National Geographic Society Autochrome Lumière by Hugh Stevens Bell

THE STREAM THAT CARVED TWINDOW BRIDGE SHOWED TEMPERAMENT

After cutting an opening in one cliff, it changed direction and wore its way through another, forming one of the largest double arches. This remarkable example of erosion is in the Arches National Monument near Moab. The more stupendous Rock Mound, Caroline, and Augusta Bridges are in the Natural Bridges National Monument. Similar marvels are in the Wayne Wonderland near Torrey and Fruita.

put away. That picnic was just an old-fashioned family party, with 3,000 persons in attendance!

Governor Blood and his gracious lady invited Randall and me to join them on a trip to Boulder Dam,* and at 3:30 next morning we set out from Cedar City. The reason for the early start became apparent soon after sunrise, and at 10 o'clock a thermometer at the base of the dam registered 109 degrees in the shade. The trip back to Bryce Canyon was a trial by fire, a practical demonstration of what drought means to Utah. If rain did not fall soon, the Governor told me, it would be necessary to kill several hundred thousand sheep, for there would be neither water nor forage to keep them. Light rains later relieved the situation to some extent.

Irrigation was seriously threatened because of failure of streams, and soil erosion by high winds had taken terrific toll. In a letter the wife of the manager of the Rocky Ford Reservoir, which serves a large area near Minersville, poignantly describes the situation:

"This reservoir has suffered in the last five weeks in flood damage, intense silting, and a dislodged control gate, more water having been lost than is left. Fish, unable to pass back through the blocked tunnel, created a scourge, and 50 tons of them had to be pitchforked into wagons and hauled away.

"There have been cloudbursts where no good resulted, but not a drop of rainfall has come to this project to encourage recovery from the dust-choked, wind-pursued desolation."

After a pleasant week-end at Bryce, we drove up through central Utah to Salt Lake City. The trip was a revelation of both the natural and the social aspects of the farm valleys. Somewhat ruefully men talked about the drought, but none we saw seemed fearful of the future. The irrigated fields were still green, though production would be far less than usual.

Towns were more numerous and larger as we progressed northward along the Sevier River, and the country seemed prosperous, a pastoral scene refreshing after the red glare of the prismatic plateaus. Some sixty-six per cent of the 520,000 people of Utah live in the district of which Salt Lake City is the center.

We were heartily welcomed at Panguitch, Richfield, and Manti, seat of a handsome Latter Day Saints Temple, by men who reassured the Governor by their hopeful outlook on the drought situation. Reports were equally good at Nephi, Payson, and Spanish Fork.

The Governor was in a cheerful mood when we reached Provo, third city of Utah, a thriving town of nearly 15,000 population near the shore of Utah Lake. Here it was that Father Escalante, seeking a trail to connect early Catholic missions, visited peaceful Indians in 1776. Provo has the sectarian Brigham Young University and the large State Hospital. Fertile soil and a sufficient supply of irrigation water make of the town "the Garden City" (Color Plate V).

To the Mormon settlers Utah Lake was the "Sea of Galilee" of their new "Holy Land," the river connecting it with Great Salt Lake was, and is, the "Jordan," and Great Salt Lake was the "Dead Sea."

SALT LAKE CITY SPRANG FROM DESERT

Through American Fork, Lehi, and Murray we followed the broad highway and came in late afternoon to Salt Lake City (population 140,267 at the 1930 census or 180,407 if the entire metropolitan area is included) which has been conjured by hard work from what was sagebrush desert only 89 years ago. I like to remember it as I saw it that evening from a vantage point near the mouth of Emigration Canyon, the place from which on July 24, 1847, the 148 pioneers caught their first glimpse of the valley.

What they saw then was a purplish-gray waste with only a few cottonwood trees growing beside City Creek, yet their leader, Brigham Young, said, "This is the place." A monument bearing this quotation stands at the mouth of Emigration Canyon. That very day advance scouts of the party had plowed some ground near the mouth of City Creek Canyon and begun what is generally accepted as the first irrigation project established by Anglo-Saxons on the North American Continent.

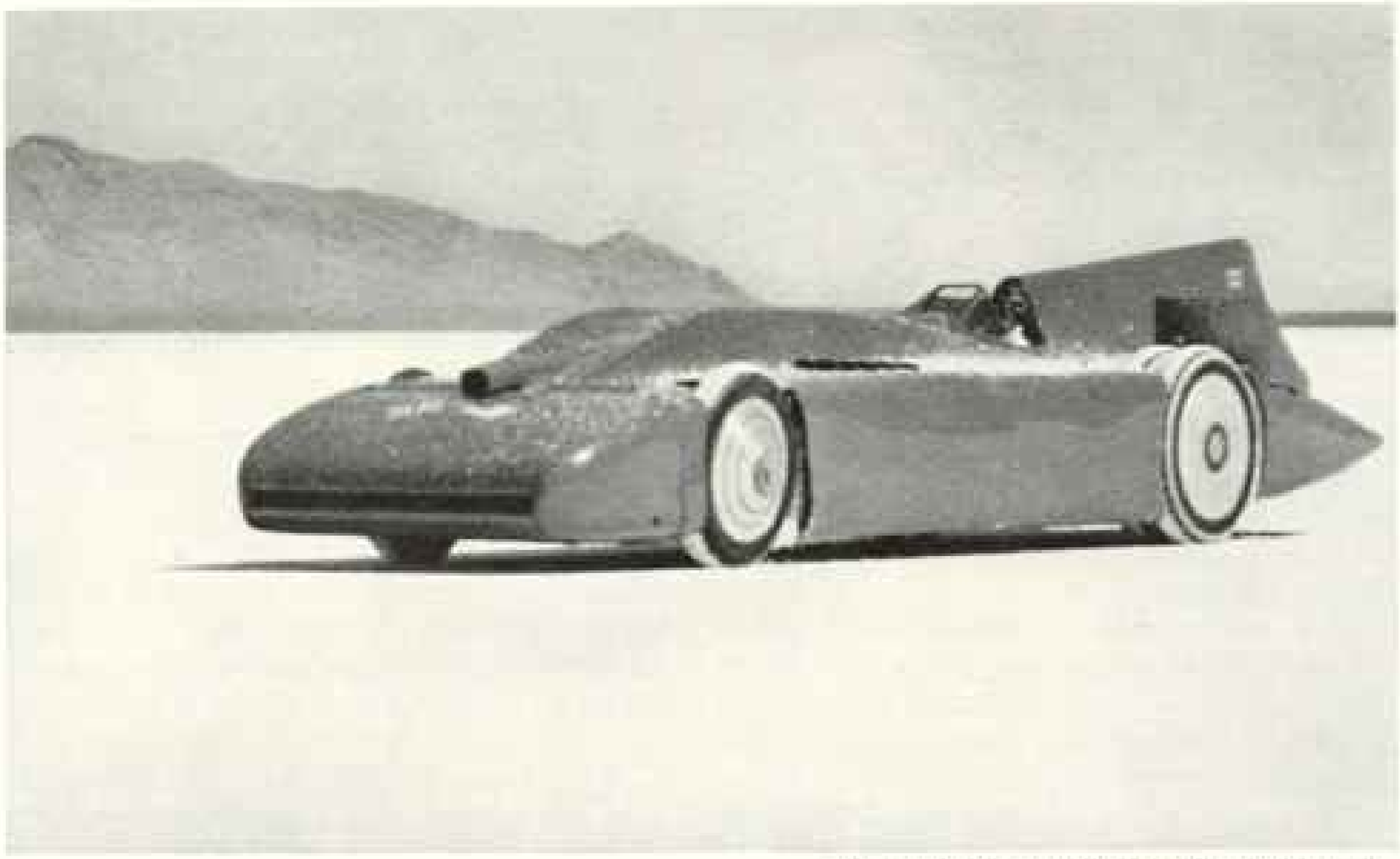
What I saw 89 years later was a magnificent city of trees and homes, the impressive skyline of its business district clear cut against a glorious sunset that smiled over Great Salt Lake. It would be difficult to find a more striking location for a city. Half circled by the snow-capped peaks of the

* See "Southern California at Work," by Frederick Simpich, in the NATIONAL GEOGRAPHIC MAGAZINE for November, 1934.

Photograph by Richard H. Stewart

THROUGH EAGLE GATE BRIGHAM YOUNG USED TO ENTER HIS PRIVATE ESTATE

But the portal was just high enough then to give clearance to a "prairie schooner." His office, the Beehive House, and his residence, the Lion House, still stand in the grounds at the left. The big bird, perched atop a beehive, now seems to guard tree-flanked State Street, which leads uphill to the State Capitol. This structure, built of native granite, was completed in 1915.



Photograph Courtesy Salt Lake Tribune-Telegram

HERE HE COMES! THERE HE GOES!—AND SALT FLAKES FLY LIKE SNOW

Here Sir Malcolm Campbell hurtles over the measured mile in a trial run along the Bonneville Salt Flats. Last September he drove his Bluebird over the bed of the vanished Lake Bonneville at 301 miles an hour, to set a new world racing record. These tracts of white are formed of the settlings of an inland sea which once covered most of Utah, Idaho, and Nevada (page 577). The ancient body of water is described in a scholarly monograph by Grove Karl Gilbert, a generation ago vice president and Hubbard Medalist of the National Geographic Society.

Wasatch Range, and guarded on the open side by an inland sea, it has been called "a perfect jewel in a lordly setting." Sheer amazement at what men have wrought from the desert overwhelmed me as we went down to our hotel beside Temple Square.

Next morning I asked the clerk the way to the office of my friend Gus Backman, and he told me it was only three blocks down the street. The weather was so cool that I felt a little disappointed because the walk would be short, but I soon discovered that three blocks in Salt Lake City constitute no mean distance.

The city was laid out in 10-acre squares, each divided into eight lots. The principal streets measured 132 feet from curb to curb, probably a waste of space in the early days, but an inestimable boon to motorists today.

As I went along, my curiosity was intrigued by a stream of clear water running in the gutter beside the walk, and I asked a fellow pedestrian about it.

"That is City Creek," he said, "the stream that made Salt Lake City possible. We cherish it as a memento of pioneer struggles. The First National Bank now occupies a site near that of the first irrigation ditch."

MORMON TEMPLE AND TABERNACLE

Later that morning Gus and I went to Temple Square, a walled park of ten acres near the center of the city. There stand the stately Mormon Temple and the huge Tabernacle (page 583) amid beds of flowers on a gracious, tree-shaded lawn. The Temple is not open to visitors, but guides daily conduct groups of sight-seers through the Tabernacle and other church buildings. Protected by a pergola in a corner of the enclosure is the first house built in Utah (Color Plate XII).

Some writers have called this center of the Latter Day Saints "mysterious" and "foreign seeming." I did not find it so. In Salt Lake City most of the church denominations with which I am familiar are represented, and all live together in amity. The thought that occurred to me as I looked at the massive buildings was one of wonder that the early settlers, working with such equipment as they had, could have constructed them.

The vast Tabernacle, 250 feet long, 150 feet wide, and 80 feet high, seats 8,000 people, and its acoustic properties are extraordinary. The roof is an oval dome supported by 44 sandstone buttresses that surround the building.

We climbed up between the ceiling of the auditorium and the roof and found ourselves in a space some 15 feet high, among the bridge arches that form the dome. The architect who designed the Tabernacle was a bridge builder, who from his experience devised this unusual structure. Iron and steel being virtually unobtainable when the building was started in 1863, the timbers and struts of the roof were put together with wooden pegs and rawhide thongs, most of which are still intact, though in recent years bolts have been introduced to supplement them.

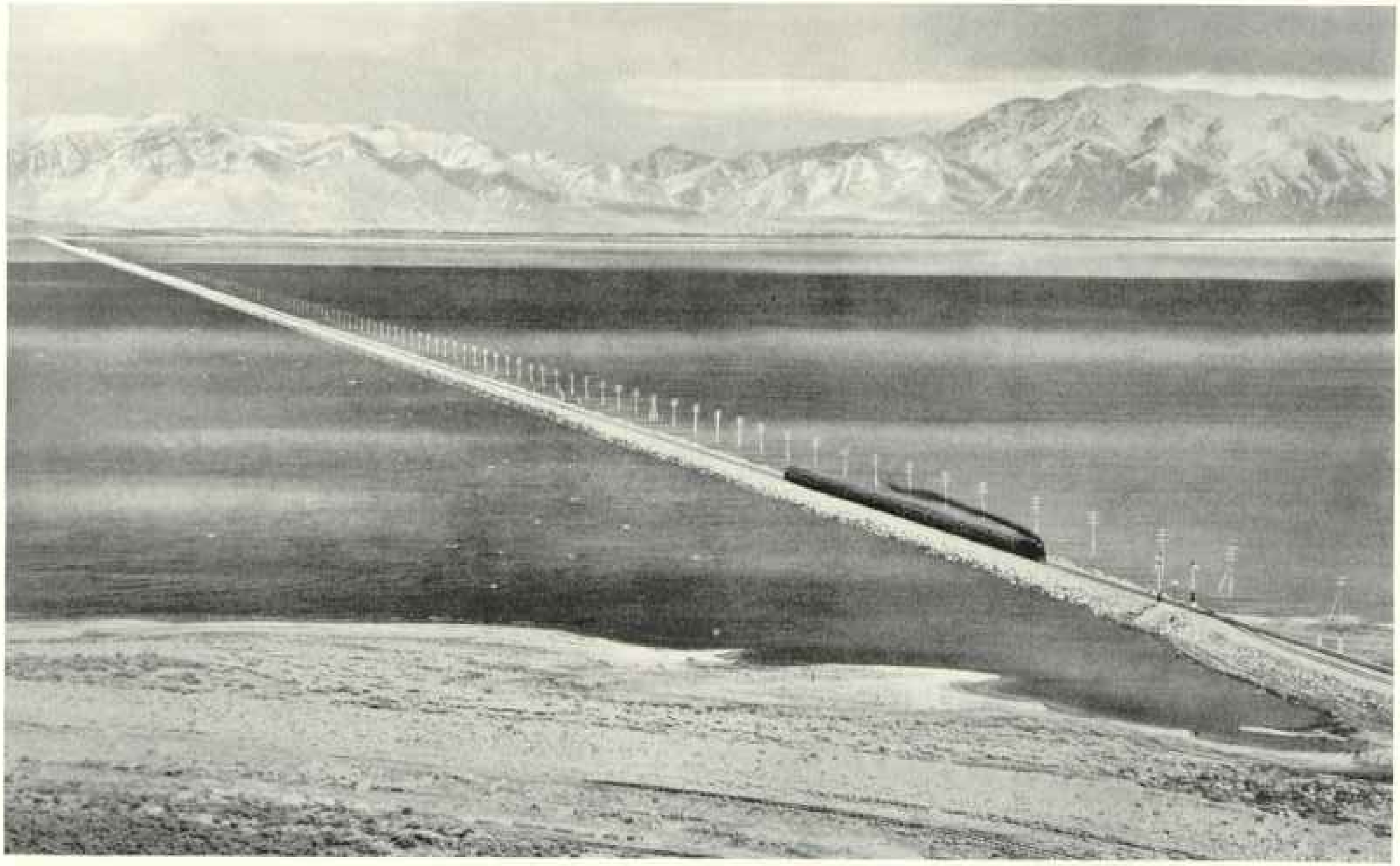
WHERE A CHORUS OF 5,000 SINGS

Even more remarkable than the architecture of the roof is the magnificent organ of between 7,000 and 8,000 pipes ranging in length from five eighths of an inch to 32 feet. The original instrument was made almost entirely by hand by Utah artisans, and much of the wood for the pipes was from "the cedars of Lebanon" in southern Utah. To-day the organ is electrified and boasts many additions, including an antiphonal set of pipes in the basement of the Tabernacle, but some of the work of the pioneer craftsmen remains as they left it.

Daily at noon the Tabernacle organist plays a concert, to which the public is admitted without charge. Radio listeners everywhere are familiar with the broadcasts of the famous Salt Lake Tabernacle choir. Particularly interesting to me is the annual song festival of the young people's organization, when 5,000 singers chosen from local groups in all parts of the United States and many foreign countries unite under the direction of some outstanding chorus leader to present the oratorios they have learned in their home churches.

Salt Lake citizens have always been lovers of music and drama. Soon after the city was founded they built a commodious theater in which appeared some of the best known actors and musicians of their day. This building was torn down a few years ago, but 17 modern theaters now supply entertainment for the populace.

The Mormon Temple required 40 years in the building (1853-93). It is constructed of native Utah granite hauled by ox teams from Little Cottonwood Canyon many miles away. With walls 16 feet thick at the base and 8 feet thick at the top, it is

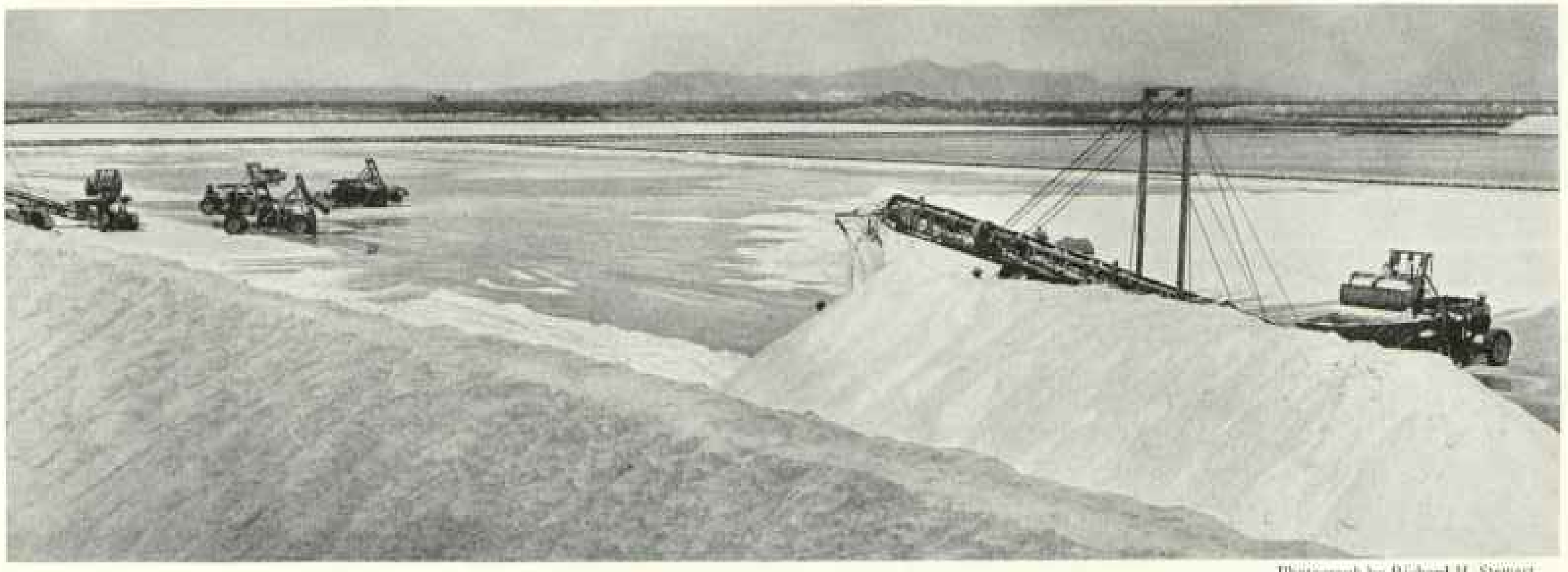


THIS THUNDERING LOCOMOTIVE HAS CROSSED THE LAKE BY RAIL

Almost straight as an arrow and level as a sheet of glass runs the Southern Pacific Railway across the shallow Great Salt Lake. Fifteen miles west of Ogden, trains speed over seven miles of water to salt-crusted Promontory Point. Crossing five miles over the Point, they reach the sea again and glide along a 20-mile causeway to Lakeside. The Lucin Cut-off appears to be a solid path all the way, but actually 12 miles of track are built on a trestle. The road was opened in 1904 to shorten by 43.8 miles the mountainous route that formerly ran around the north end of the lake.

Photograph by P. W. Tompkins

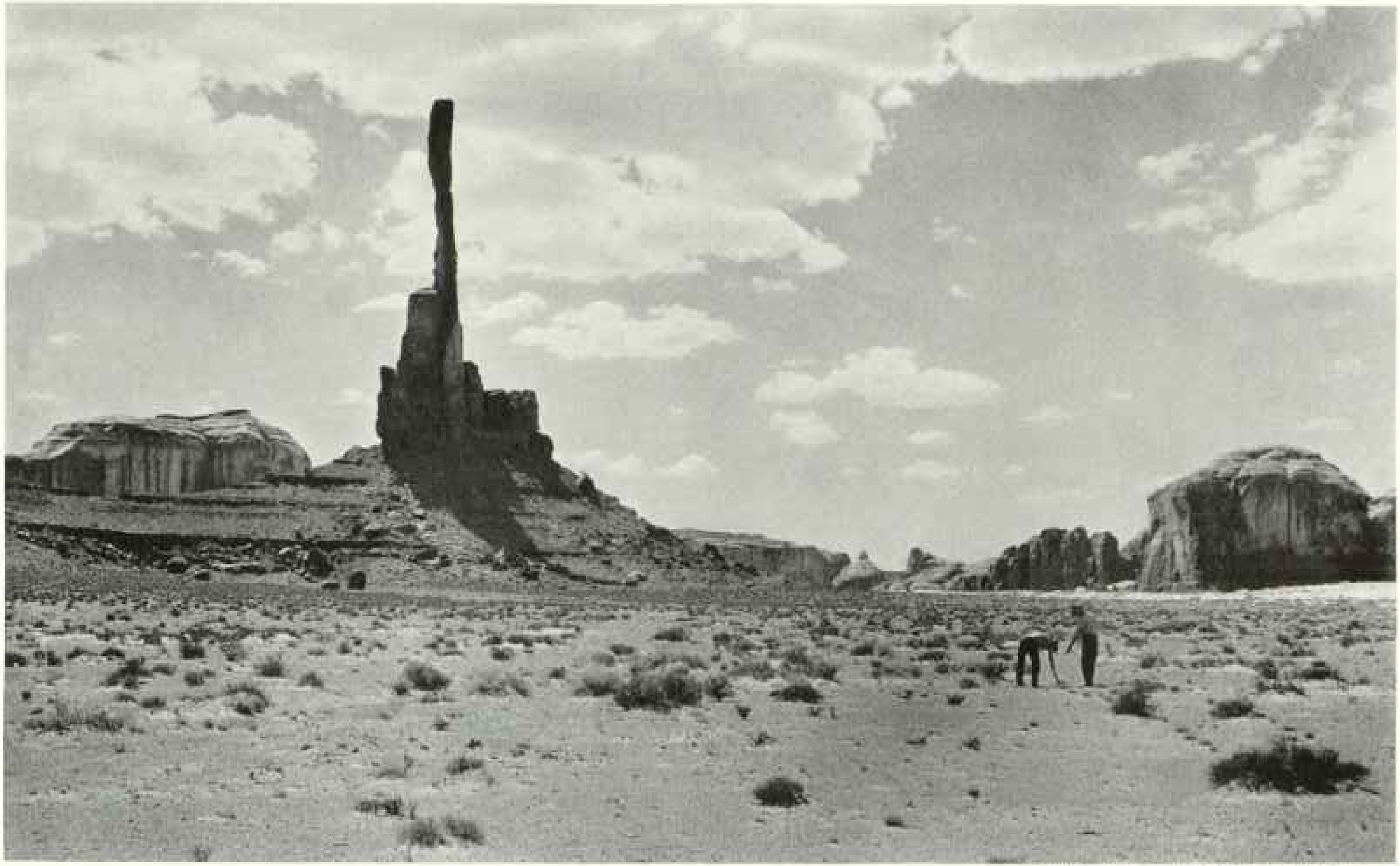
MORE CROOKED THAN THE SERPENT IT RESEMBLES, SAN JUAN RIVER CARVES ITS WAY MANY MILES AROUND THE GOOSE NECKS



Photograph by Richard H. Stewart

MEN WITH MODERN MACHINES TAKE THE "SALT OF THE EARTH" OUT OF THE INLAND SEA

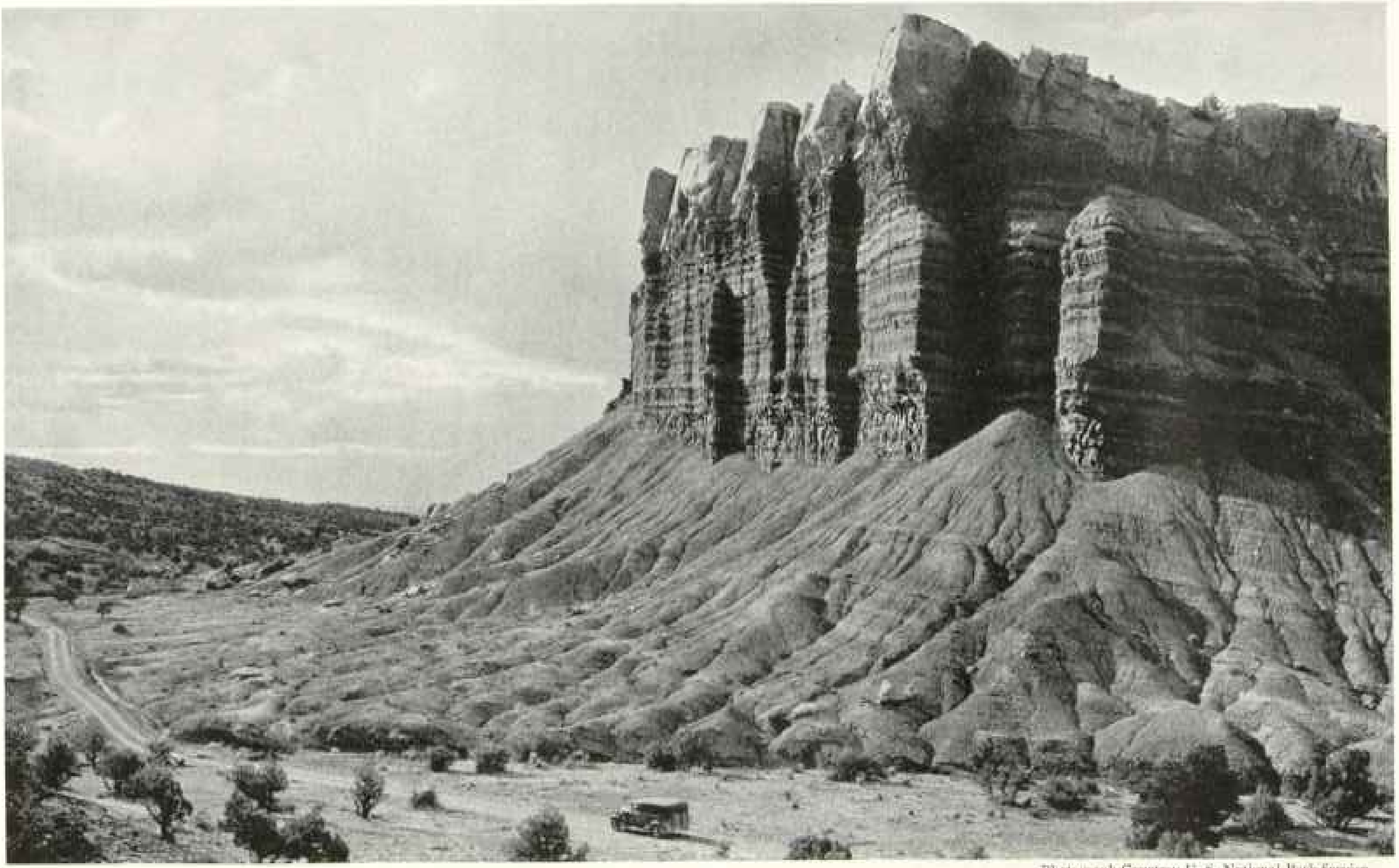
In ponds separated from the Great Salt Lake by dikes (background), the salt water is left to evaporate. Mobile scoops (left) carry loads of the deposit to a conveyor (right), which piles it in miniature mountains until it can be refined in the Inland Crystal Salt Company's plant near by.



Photograph Courtesy U. S. National Park Service

NATURE HAS FASHIONED A "TOTEM POLE" IN MONUMENT VALLEY

From a bed of red rock rises this sliver of rosy-tan De Chelly sandstone. Navajo Indians, who, unlike their cousins of the Pacific Northwest, erected no symbolic spires of the sort, called the area in which it stands *Tsè Bekin* (House of Stone). It lies near the Utah-Arizona line, where the terrain is of the Permian age (page 592). In an 80-mile journey one sees a cross section of geologic history.



Photograph Courtesy U. S. National Park Service

WIND AND WEATHER HAVE CARVED THE "GREAT ORGAN" IN THE WAYNE WONDERLAND

The top is protected by a cap of hard sandstone that is resistant to erosion. The underlying beds are softer. The cliff is dull red, the capping rock tan or buff. Besides hundreds of weirdly sculptured figures there are five natural bridges, and scores of relics of a forgotten civilization near Fruita and Torrey (page 622).

massive as a medieval castle. The angel figure surmounting its tallest spire is of hammered bronze covered with gold leaf.

Salt Lake City preserves memories of many stirring events of the winning of the West. Where the Salt Lake Tribune building now stands was once a station of the Pony Express, which carried mail between San Francisco and Mississippi River cities in the time of the California gold rush. Bronze and granite markers have been placed at points on the route here, and at Echo Canyon, Murray, Jordan Narrows, and elsewhere.

Looking at the modern transportation lines that now serve the State, one recalls with a thrill the intrepid riders of fleet-footed ponies carrying letters through hostile Indian country half across the continent in nine days. Postage then was five dollars for a piece of first-class mail!

On the ground now occupied by the Administration Building of the Church of Jesus Christ of Latter Day Saints, or "Mormon" Church, the early settlers minted gold coins soon after the discovery of the metal in California. The settlers also printed paper money known as "tithing scrip," using paper manufactured in a mill established in 1861 at the mouth of Big Cottonwood Canyon. Ruins of the mill, on the outskirts of the city, have been converted into a clubhouse.

Perhaps the most impressive edifice in the State is the Capitol, which occupies a commanding eminence overlooking the business district. Its walls are of Utah granite, and its dome is Utah copper. Utah onyx and matched Georgia marble form the interior finishing, and Utah gold and silver adorn the furniture in the Governor's Room. In the halls are displayed tastefully arranged specimens of the State's mineral and agricultural products, together with such pioneer relics as the first spinning wheel used by a settler, and a venerable piano hauled 1,000 miles across plains, mountains, and deserts when freight charges were $500 a ton.

SALT LAKE A MANUFACTURING CENTER

Salt Lake City has 263 factories producing diversified goods. Of these industries one of the most important is devoted to the manufacture of gasoline, motor oil, and motor lubricants. At present most of the crude oil is imported, but when the enormous Utah deposits of oil shale, oil sand, and petroleum have been fully opened, the industry may well become an enterprise wholly within the State.

Parks and golf courses are the pride of the citizens, and the climate is so mild because of the city's sheltered location and its 4,354-foot altitude that outdoor recreation is possible virtually the year round.

At the University of Utah, a modern State educational institution with splendid buildings on a charming campus (Color Plate VI), I was interested in a display of dinosaur skeletons from the "Dinosaur Quarry" at Jensen (see Color Plate XII). The institution, founded as the University of Deseret in 1850, less than three years after the settlement of Salt Lake City, is the oldest State university west of the Missouri River.

From the busy airport transport planes fly on regular schedules to cities on the Pacific coast and to the East. It is thought-provocative to soar over the flat salt desert west of the city where Sir Malcolm Campbell recently established the world's record of 301.1292 miles an hour in a racing car (page 602) and recall the creeping ox teams and handcarts that brought the pioneers to Utah.

Long drought had induced a heat wave in Salt Lake, and the temperature on the streets one afternoon exceeded 100 degrees. Noting my discomfort, some one suggested a drive up Emigration Canyon for dinner at Pinecrest. We left the city scorching under a blazing sun and in little more than a half hour were sitting on a lodge veranda where the thermometer registered only 72 degrees.

These mountain-walled canyons are the delight of Salt Lake citizens and visitors alike. To enter them is to go from modern civilization into wilderness. Among the many that may be reached quickly from Salt Lake City are Emigration, Mill Creek, Big Cottonwood, and Little Cottonwood. The Salt Lake dweller need never be troubled by hot weather, for summer cottages and camping places are easily accessible in all these lovely gorges.

There are so many interesting canyons in Utah that it seemed to me every person I met had a favorite of his own, and no two the same. One of the most spectacular, the pride of President Heber J. Grant of the Latter Day Saints Church, is American Fork Canyon, with its alpine drive around Timpanogos Loop. An easy

 Agfacolor Plate by Randall L. Jones

"THE SPLENDOR FALLS ON CASTLE WALLS—
Tennyson never saw Bryce Canyon, but his "Bugle Song" describes it aptly. During heavy rains "wild cataracts leap in glory" from every pinnacle.

 Finlay Photograph by Richard H. Stewart

AND SNOWY SUMMITS OLD IN STORY"

Though the cliffs in the distance have no winter blanket, they gleam white above the pink towers and statues in the bowl. The silk-shirted cowboy guide, an old-timer who lives in the frontier town of Tropic near by, entertains his party with legends of Bryce and "Wild West" days.

Finlay Photograph by Richard H. Stewart

FROM THE RIM OF CEDAR BREAKS, ONE LOOKS DOWN UPON KINGDOMS IN THE WILDERNESS

Finlay Photograph by Richard H. Stewart

INDIANS COME IN FULL REGALIA TO THE UINTA BASIN INDUSTRIAL CONVENTION AT FORT DUCHESNE

For a week in late summer farmers gather here. There are lectures on dry farming and crop production. Tribesmen are interested in new agricultural methods, for ever since the Mormon settlers taught them field and garden cultivation, they have made their living as tillers of the soil. For the parades that open and close the festival, however, they deck themselves in tribal finery and furnish a performance reminiscent of the old West.

PREHISTORIC BEASTS LEFT THEIR GIGANTIC SKELETONS IN THE "DINOSAUR QUARRY"

Near Jensen is Dinosaur National Monument, rich in fossil remains. The monster bodies are believed to have floated down on some ancient river and caught on a sand bar. They remained buried under millions of years of mud deposits until an upheaval shoved them up on mountain crests.

 Finlay Photographs by Richard H. Stewart

THE OLDEST HOUSE IN UTAH IS TREASURED IN THE CAPITAL'S TEMPLE SQUARE

Built by a pioneer in 1847, it became two years later the office of Captain Howard Stansbury, who made the first survey of the Great Salt Lake. The wheels are from a settler's wagon.

ON THE CAPITOL GROUNDS STANDS THIS MONUMENT TO THE "MORMON BATTALION"

In 1846 about 500 Latter Day Saints enlisted in the United States Army and made an epic march from the Middle West to San Francisco, one of the longest and most arduous infantry treks on record. Later, many of them came to Utah, and a group under Captain James Brown founded Ogden.

 Finlay Photographs by Richard H. Stewart

WAITRESSES AND BELLBOYS "SING THE BUSSES AWAY" AT ZION

For summer work at lodges, the Utah Parks Company employs college students with musical or histrionic ability. They are always on hand to speed the parting guests.

© National Geographic Society

CEDAR CITY'S VARIEGATED CHURCH IS UNIQUE

Lacking capital for this Latter Day Saints chapel, the congregation built it of stones gathered from everywhere in Utah and northern Arizona. Motorists from afar helped by bringing in many odd bits of colored rock.

Finlay Photographs by Richard H. Stewart

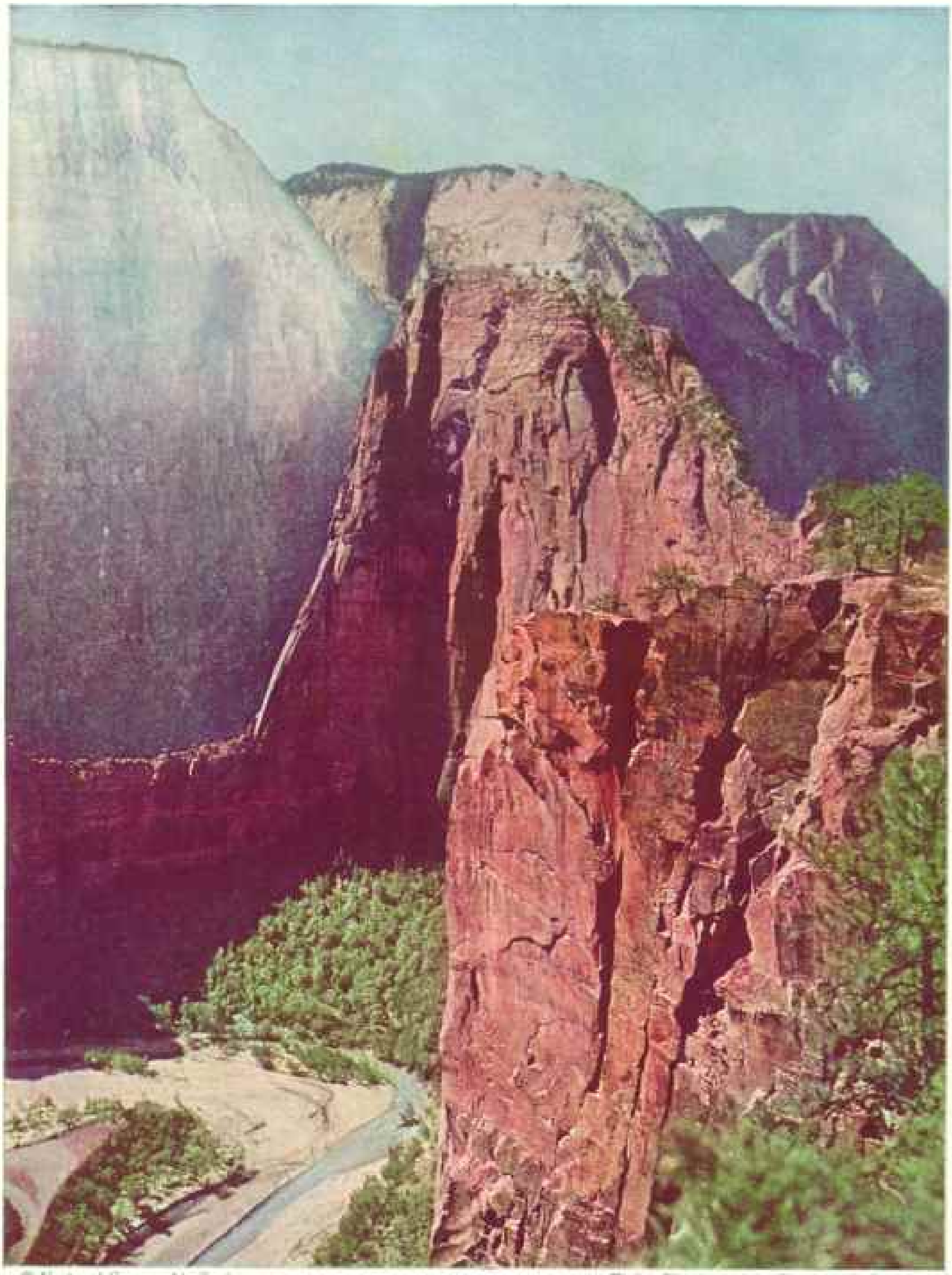
WHITE-BOLED ASPENS GRACE THE UPLANDS

Rising from red sandstone plains, the roads to Cedar Breaks and other high places often plunge suddenly into these lovely forests. The leaves are never still, though foliage of other species near by may hang placid.

Finlay Photograph by Richard H. Stewart

BY SIX SWITCH-BACKS THE HIGHWAY CLIMBS PAST THE GREAT ARCH OF ZION TO THE TUNNEL

The road rises 791 feet in three miles, every turn affording a glorious view of the canyon, and leads through a mile-long passage drilled into the rock bastion to the right. A footpath climbs from the road to the top of the distant natural bridge, which is like a huge fireplace without a chimney.



 Finlay Photograph by Richard H. Stewart

THE VIEW OF ZION CANYON FROM THE WEST RIM IS BREATH TAKING

A few steps from the trail shown on Plate II, the photographer pointed his camera over the edge of the cliff to record this scene. The red tower in the center is Angels Landing. On the extreme left the Great White Throne stands partly in shadow, showing reflected colors from its sunlit neighbors. Deertrap Mountain is beyond it, and the Mountain of the Sun looms in the distance. What look like bushes on the canyon floor are actually large cottonwood trees.

climb above the road is Timpanogos Cave National Monument, not a large cavern but one with exquisite stalactites and stalagmites.

The highway mounts to an altitude of 8,279 feet on the shoulder of Timpanogos, rising more than 4,000 feet in a drive of two hours, and affording at one point a glimpse of one of the farthest-south glaciers in North America. Mount Timpanogos, the giant of the Wasatch Range, is thrust up 11,957 feet above sea level, and the view from its summit is far reaching.

One of the unusual sights in Utah is Maple Canyon near Moroni. It is a series of multiple gorges, the walls of which are composed of a natural cement clutching large bowlders protruding so far that apparently they are ready to crash down on the observer looking at them from the bottom. In this canyon the famous Indian leader, Black Hawk, hid for months with his warrior band.

One morning we went to see the open-cut copper mine of the Utah Copper Company in the Oquirrh Mountains at Bingham Canyon, 20 miles southwest of Salt Lake City. The huge mine, largest of its kind on the continent, is a man-made wonder wellnigh as awe-inspiring as Zion Canyon (page 619).

MOVING A MOUNTAIN OF COPPER

At the time of my visit a whole mountain, 454,000,000 tons of ore and strippings, had been removed, leaving an amphitheaterlike pit 3,200 feet long, 1,600 feet wide, and 1,500 feet deep. There remained to be mined three times as much as had been taken out.

Encircling the walls of the vast pit are 20 terraces of an average height of 70 feet equipped with 85 miles of railroad track over which electric engines haul ore cars of 80- and 100-ton capacity.

We ascended the levels in a supply train and watched the 23 electric shovels with their four-and-a-half-cubic-yard dippers load the cars with rock blasted from the walls. Each "dipperful" weighs from six to seven tons, and a car is filled in five minutes. The record for loading in a single day is 142,000 tons.

Brought down from the levels, the cars of ore are formed into trains of 50 cars each and hauled to the mills at Magna and Arthur. We drove down the single, seven-mile-long, canyon street of Bingham to the company town of Copperton and thence to the Magna mill.

An ore train had just pulled in to the top of the mill, and we climbed breath-taking flights of stairs to reach a platform from which we could watch the unloading.

MAN-MADE THUNDER ROARS

It was one of the most amazing sights of my experience. A switch engine hauled two cars to a rotary dumper over a crusher that looked for all the world like an enormous coffee grinder. As soon as the cars were locked in place, they were tipped upside down, and 200 tons of ore went roaring into the hopper. The man-made thunder was deafening as the "coffee grinder" began to turn and break up three- and four-foot bowlders. Gray dust made a fog as we hurried down a flight of steps to see the second process.

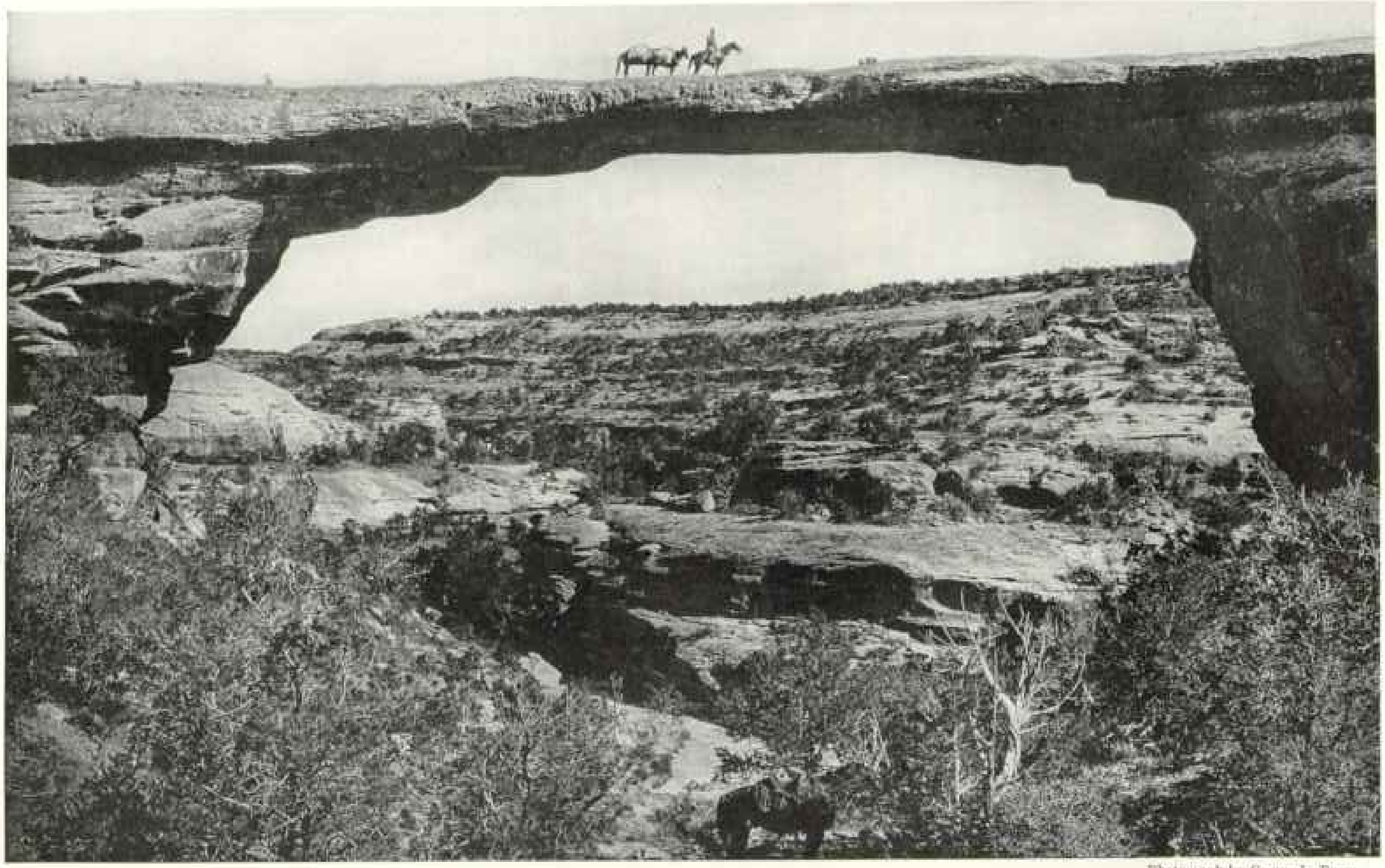
Conveyor belts five feet wide and 500 feet long carried the grist from the first crusher to the second hungry maw which was waiting to chew the ore a little finer. Step by step it cascaded down the mill terraces, from one huge, noisy crushing machine to another. In the later stages the crushing was done in water.

When the grinding was finished, the great bowlders had been pulverized so fine that 85 per cent could go through a screen of 40,000 openings to the square inch. The water content was reduced, and suitable proportions of oil and other reagents were added to cause frothing, after which the mixture, or "pulp," was delivered to the flotation department.

The fine grinding is necessary to release the mineral from the worthless rock, or gangue, in which it is encased. The flotation process extracts the mineral from the pulp, leaving the barren rock to be discarded as "tailing."

In the flotation machines the pulp is violently agitated, and thus a froth is caused to form on the surface. The mineral particles have an affinity for the oily froth, and as the bubbles rise to the top they pick up the mineral, which rides on the bubble. The gangue has no such affinity and settles to the bottom. It seems paradoxical, but it is a fact that the heavier mineral particles float to the top and are skimmed off, while the lighter rock particles sink and are drawn off at the bottom (page 621).

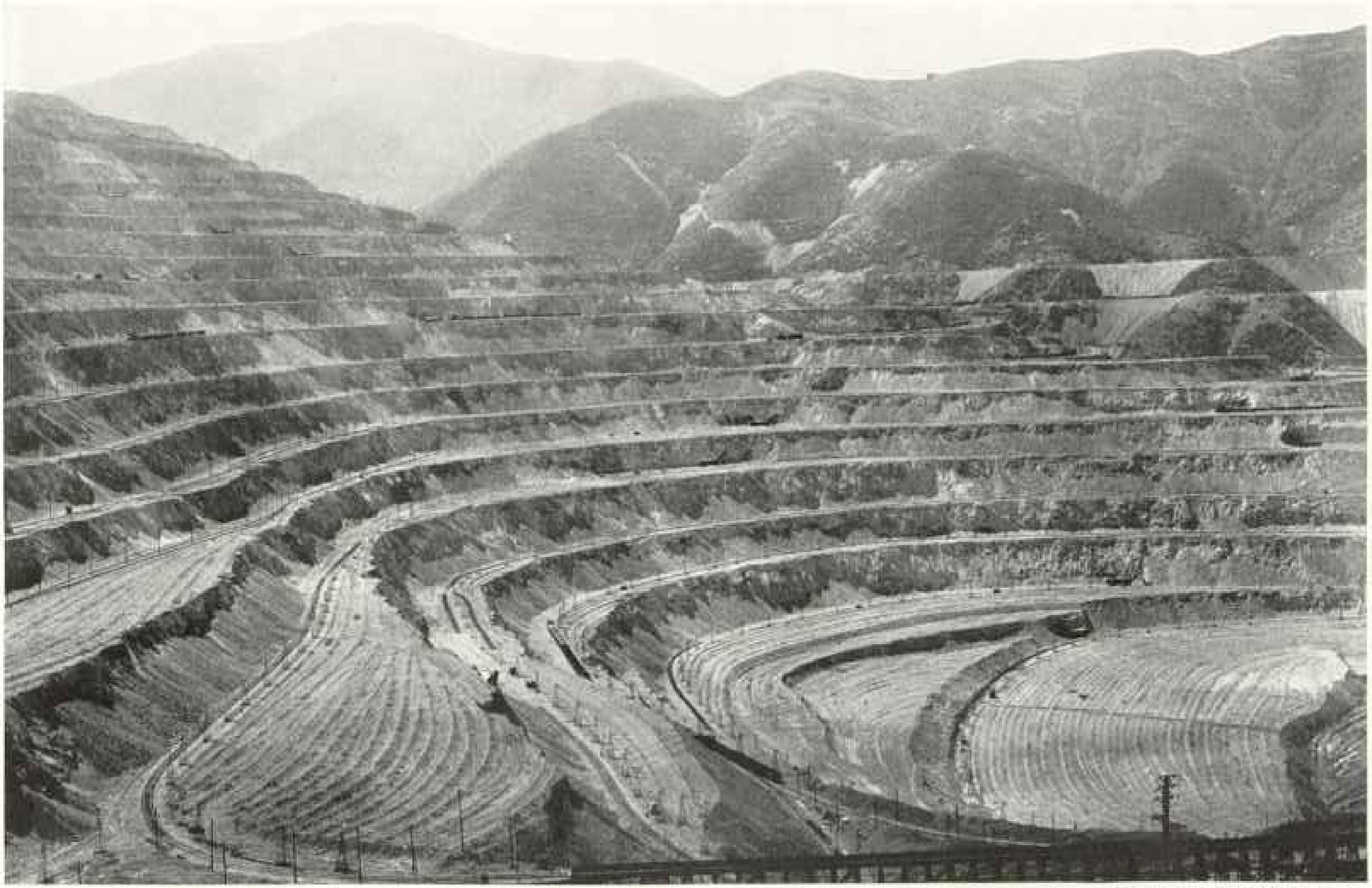
When the bubbles burst, there is a residue of concentrated mineral, which goes through



Photograph by George L. Beam

IF THEIR MOUNTS DON'T SHY, A TROOP OF HORSEMEN MAY RIDE ABREAST ACROSS 194-FOOT-LONG EDWIN ARCH

Other mighty spans in Natural Bridges National Monument (page 622) are the Augusta (261 feet) and the Caroline (186 feet). They are not far from the quaint old Mormon village of Bluff, which was settled by means of one of the most perilous migrations in western history. The pioneers literally hewed a rock chute down into the canyon of the Colorado River and lowered their wagons and freight with ropes.



Photograph by Richard H. Stewart

WITH ELECTRIC SHOVELS PUNY MAN HAS REMOVED A MOUNTAIN AT BINGHAM CANYON

Five- to seven-ton scoops bite low-grade copper ore from the walls of the terraces of the Utah Copper Company mine (page 617). The excavation is now 1,500 feet deep.

Photograph by Richard H. Stewart

SUMMER SUN MAKES OGDEN'S ARTESIAN WELLS GLOW LIKE WHITE TORCHES

Myriad underground streams fed by snow and rain converge far below the surface here at Artesian Park, in Ogden Canyon, where a subterranean rock wall backs up the water. To tap the supply, 43 wells have been drilled. Compressed air, driven underground by electric pumps, forces daily to the surface as much as 16 million gallons of water, which is then piped to the city, about 10 miles down the canyon. A new power and irrigation dam will cause the inundation of this area.

huge revolving filters, to make a product suitable for shipment to the Garfield smelter, which changes it into copper matte.

In following the ore we descended the mountainside perhaps 500 feet. Gravity is made to do much of the work that otherwise would require power machinery. The ore I saw treated is of low grade, averaging one per cent copper, one-tenth of an ounce of silver, and one-hundredth of an ounce of gold to the ton. Were it not for the efficient methods used in mining and concentrating it, it could not be worked at the excellent profit now realized.

UTAH A TREASURE CHEST OF MINERALS

Mining in Utah is an industry of enormous proportions. In 1929 the Commonwealth as a producer ranked first in the Nation in silver, second in copper, third in lead, fourth in gold, and fifth in zinc. Besides these common metals there are a bewildering array of others—a total of 210 useful minerals in the State!

The United States Geological Survey estimates at 196 billion tons the still unmined deposits of coal which underlie a fifth of the area of Utah—enough fuel to supply the whole country for 200 years at the present rate of consumption. From the Survey also come reports that Uinta Basin contains 92 billion tons of oil shale, which will yield 15 gallons to the ton, and that Washington and Iron Counties hold 40 million tons of iron ore. The region around Salt Lake City is one of the greatest nonferrous smelting centers of the world.

In oil-drilling operations natural flows of carbon dioxide and helium gas have been developed, and natural gas has been found in several counties. Salt is produced by solar evaporation from Great Salt Lake, taken from mines in many locations, and raked up from the vast salt deserts.

There are valuable deposits of semi-precious stones, such as jet, agate, chalcedony, jasper, garnet, opal, obsidian, olivinite, rock crystal, and topaz.

What may result with the development of all the natural resources of Utah staggers the imagination.

Soon after my Bingham adventure I went

Photograph by Richard H. Stewart

OIL BUBBLES RAFT COPPER THROUGH THE "LAUNDER" TROUGH

In the Magna mill of the Utah Copper Company modern methods produce concentrates from low-grade ore (page 617). It is a paradox that the lighter waste material sinks to the bottom while the heavier metal, because of its affinity for the flotation agents, rides on the surface.

to Park City for a trip through the deep Silver King mine, where men were taking rich silver ore from the tunnels. It was interesting to wander around hundreds of feet underground, but, strangely, the thing that delighted me most at Park City was the mountainside flower garden the mine manager had planted around the dining hall and sleeping quarters.

Without a sail on Great Salt Lake a trip to Utah is incomplete. My most interesting voyage was one with a party headed by Dr. T. C. Adams of the University of Utah. There are 16 islands in the Lake, the most important of them Antelope, Stansbury, Fremont, Carrington, Cub, Gunnison, and Dolphin. A graduate student of ornithology from the University of California joined our group for the purpose of banding pelicans and other waterfowl that nest on Bird Island and elsewhere in the lake. The following winter he would have reports of these birds from sanctuaries in Florida, Mexico, and elsewhere, and would be able to chart their migration.

Until recently Great Salt Lake, a remnant of ancient Lake Bonneville, which once filled most of the present site of Utah and much of Idaho, was about 75 miles long and 50 wide, with an average depth of 50 feet and a salt content of 22 per cent. Several years of drought, however, have lowered the water and increased the salt to 28 per cent. Saltair, the huge bathing and dancing resort, buildings of which were set on piles in the edge of the lake 15 miles from Salt Lake City, was nearly a mile from the water at the time of our visit, and the lake was so shallow that our boat ran aground at frequent intervals on the way to Antelope Island.

We took off our shoes and stockings and waded out to Dr. Adams' small yacht, the precipitated salt near shore pricking our feet as we walked. Lately Dr. Adams has discovered that salt has been precipitated over almost the entire lake bottom.

Our sails carried us about five miles to Antelope Island, home of one of the few remaining herds of wild buffaloes in the United States, but from there to the nesting islands of the birds we sought we used auxiliary motors.

As we neared Bird Island, we saw a long, straight line of white pelicans strung out in single file behind a leader headed shore-

ward. We continued, however, and our scientific friend banded some cormorants and gulls instead of the absconding pelicans.

A STORM AT SEA IN UTAH

About 4 o'clock in the afternoon we started back, making fair time with our small motors till a terrific storm sprang up. Salt spray blew in our faces; salty waves washed over the sides of the boat and down our necks; we ran aground on sand bars that sheared pins from our propeller and occasioned long delays. For an hour or more we clung to the lee of Antelope Island, barely holding our own against the wind. The gale fell off toward midnight, and we reached Saltair at 12:30. I had never expected to ride a storm at sea in semi-arid Utah.

Our faces were caked with hardened salt, and when we pulled off our clothing it would almost stand alone. I found I could not sink in this salt-saturated water, but death by strangulation is a menace if one is caught on the lake in such a storm.

Friends went with me on several trips through the irrigated valleys where all manner of berries, soft fruits, and vegetables are grown in profusion and canned for the market. Outstandingly delicious is the famous Utah celery. Fields of sugar beets, the foundation of one of the oldest and most important industries in Utah, were in excellent condition (page 585). We visited Echo Reservoir, the source of much of the water that turns the desert green.

One day we went over to Fish Lake to attend a meeting of southern Utah civic clubs. The lake is one of the best-stocked fishing waters in the country, and the fish dinner that preceded the evening program was a treat.

From Fish Lake we drove down to Torrey and Fruita in the Wayne Wonderland, where are five wonderful natural bridges and a wealth of cliff dwellings. This entire area may soon be set aside as a national monument, for it is as remarkable as the better-known national parks (page 607). The eight Kolob Canyons, 12 miles north of Zion, air-line distance, offer another bid for the Nature lover's attention.

No visitor should neglect the trip from Salt Lake City to the Arches National Monument near Moab (Color Plates VII and VIII) and thence down to Blanding and the natural bridges of the San Juan country. The Natural Bridges National Monument, about thirty miles west of Blanding, contains a multitude of these wonders of erosion, the three largest of them being the Owachomo, or Edwin Bridge, 108 feet high, 194 feet in span, 35 feet wide on top and only 10 feet thick at the center; the Kachina or Caroline Bridge, 205 feet high, 186 feet in span, 49 feet wide, and 107 feet thick at its smallest point; and the Sipapu or Augusta Bridge, the Hopi "Portal of Life," a 261-foot span 222 feet above the stream that carved it (page 618).

Entirely separate from this group of bridges is the Rainbow Bridge National Monument, about forty miles northwest of Kayenta. Rainbow Bridge is 309 feet above the canyon bottom, and it measures 278 feet from pier to pier. So high is it that the National Capitol could be placed under it without touching the span!

Lying partly in Utah and partly in Colorado is the Hovenweep National Monument, where are preserved four groups of towers, pueblos, and cliff dwellings made by prehistoric people.

We found Ogden citizens preparing for their Pioneer Day celebration. Every man capable of growing a beard must do so at this time or pay a fine. The mayor informed me that the fines collected in fun defrayed a considerable part of the cost of decorations for streets and buildings.

Ogden, the second city of the State, is an important railroad and manufacturing center of 40,272 population. It has extensive stockyards and large flour mills and sugar factories, as well as numerous other enterprises. On Lucin Cut-off near by one "goes to sea by rail" (page 604).

There is some good-natured rivalry between Salt Lake City and Ogden. When Salt Lake imposed parking restrictions, Ogden promptly put advertisements in Salt Lake papers, "Come to Ogden to shop; we let you park where you please."

Winter sports attract thousands to the mountains of the Wasatch. The place is a playground every month of the year.

At Logan President Peterson of the Utah State Agricultural College conducted me over the mountainside campus overlooking the valley. He explained how the college is cooperating with other agencies to solve the soil-erosion problem. After our trip around the campus, we drove up Logan Canyon, a sylvan gorge so deep that from the bottom the forest at the top looks like bushes. One juniper tree pointed out to me is estimated to be 3,000 years old.

Photograph by Richard H. Stewart

THE ROADSIDE WELL NEAR BRIGHAM DOES DOUBLE DUTY

After cooling the watermelons, the water irrigates peach orchards near by. Such artesian fountains are becoming more and more common in Utah, where parched land must be quenched of thirst regularly if good crops are to be grown.

In the Bear River Marshes west of Brigham 65,000 acres have been set aside as a national bird sanctuary. Here congregate literally millions of waterfowl.

In the high Uinta Mountains are a thousand or more clear woodland lakes brimming with trout. The Uintas, one of the few mountain ranges of east-west axis in the world, are a Nature lover's paradise, with their forests, acres of wild flowers, and dashing streams. Many of the peaks exceed 13,000 feet in altitude.

Every time I visit Utah, the Commonwealth carved by winds, waters, and hard work, I leave it with reluctance. Its scenery is ever unique, ever different; and its people are genuinely hospitable.

In a radio address inviting his countrymen to see Utah, Secretary of War George H. Dern, eight years Governor of the State, expressed the spirit of his home folk: "As a non-Mormon citizen of Utah, I am happy to say that the Mormon people are kindly, honest, warm-hearted, industrious, thrifty, and progressive. It could not be otherwise, for the early settlers were of the best old New England stock.

"Some of our places are so outstanding that the National Government has set them aside as National Parks and National Monuments. These are the show places in which every American holds a share of ownership. Come out and inspect your property, and you will be proud of it. Your pride of ownership will make you a better, more patriotic American, in the best sense of that much abused word, 'patriotic.'

"When we get you out there to look over your own property, we will show you some other things that you will not forget.

"We are waiting to welcome you. With our mountains and valleys; our lakes and streams; our farms, orchards, and ranges; our mines, mills, smelters, and manufactories; our schools and churches; our good roads and perfect climate, is it any wonder that our State song is entitled, 'Utah, we love thee'?"

Photograph by F. S. Lincoln

HEIRS OF A SEAFARING RACE ARE THE FISHERFOLK OF DIEPPE

Their ancestors were Scandinavian sea rovers who a thousand years ago beached their dragon-prowed galleys on the northern shores of France and gave their name to a province—Normandy, land of the Northmen. Aboard this boat the fishermen prepare their gear for a voyage, inspecting the lines which lie coiled on deck. The last catch was carried to market in the big baskets and sold by the woman, who now sits quietly by, seemingly content to be near her men during the short time they are moored at home.

NORMANDY—CHOICE OF THE VIKINGS

By Helen Churchill Candee

Author of "Life's Pattern on the Riviera" and "Summering in an English Cottage," in the National Geographic Magazine

WILLIAM the Conqueror, cider, omelets, Mont St. Michel—these are features of Normandy that come to mind with the name of that old province of France. You accent, thus unconsciously, history, art, and refreshment.*

Cherbourg, the port where Normandy seems to thrust its nose impudently upward—what does it mean to the ocean traveler? So much weariness of the flesh in connection with embarking and debarking that one is glad to be off. But things are to be seen there, and Cherbourg is a gentle introduction to the heady sights farther on.

It is here that we become aware of the value of the fishing industries as a social center. The chatter, both shrill and thunderous, that goes with the business is by no means the least of the interest.

It is not perfunctory, this fish selling by the men of the boats and their wives. Emotion turns the card in many a sale, for if Jean, the seller, takes offense at the low offer of a retailer, he growls a refusal to trade; and if Ginette displays her wares with enticing good nature, she laughingly reaps a big handful of coins for the deep pocket concealed in her ample wool skirt.

And of course there is the exchange of local gossip. Where a few white-capped women gather, the talk runs highest, for the woman who retains the bonnet of her ancestors is usually one who prefers word-of-mouth to newsprint or radio. It is a pity the caps are passing. The faces, ruddy and perhaps too irregular, look better when topped with picturesqueness than when frankly unadorned.

In Cherbourg, too, one comes upon the sight of women washing at a public fountain. That is a matter that always interests. How can they work in cold water? What a boon it would be to these hard-working women if a little hot water were supplied! If you have ever watched them at work you have seen grim courage.

In the very first miles out of Cherbourg the charm of Normandy begins to assert itself. Suppose it be May, what is the enchantment? The apple trees. They are everywhere, like maids dressed in sprigged muslins.

The country is full of little hills, so that each farm has its slopes and its brooks, among which stand the blooming trees. And all this loveliness produces the cider which is the wine of the Norman country and one of its big products.

APPLE-BLOSSOM TIME IN NORMANDY

The farmhouses themselves are approached by these saucy trees which flaunt sprays of pink against the old gray stones. You get an impression that all farmhouses are near cousins of old castles. Their size is often prodigious to American eyes, accustomed as we are to the wooden farmhouse. The wide sweep of well-cut gray stone walls has a dignity of other days.

A round tower, which seems to be set on some part of the building, rises from the ground, a separate entity, yet an indispensable part of the whole. It may be intensely agrarian in its intent, in its interior uses, but it vividly suggests the old story of the castle tower in which a fair damsel was confined in cautious protection, a protection naughtily defeated by the maiden's letting down her hair as a ladder to a waiting lover.

Even the livestock of the Norman country is conspicuously different from the accustomed. The gait of the immense Percherons sets a pace for the work of the farmer, who is ever shouting to them a strange sound, "Hue!" delivered with reproach or with scorn. Magnificent animals they are, but never to be hurried, whether at the plow or along the roads.

As a farmer can go no faster than his horse, his life is regulated by the Percheron. Will he some day exchange this placid power for a hurrying Ford or Citroën?

A light horse built for speed, perhaps five miles an hour, is used for the high-wheeled hooded carts which take folks to market on a market day (pages 627 and 628). Sometimes real beauty hides in these excluding hoods. At Honfleur one sees it often.

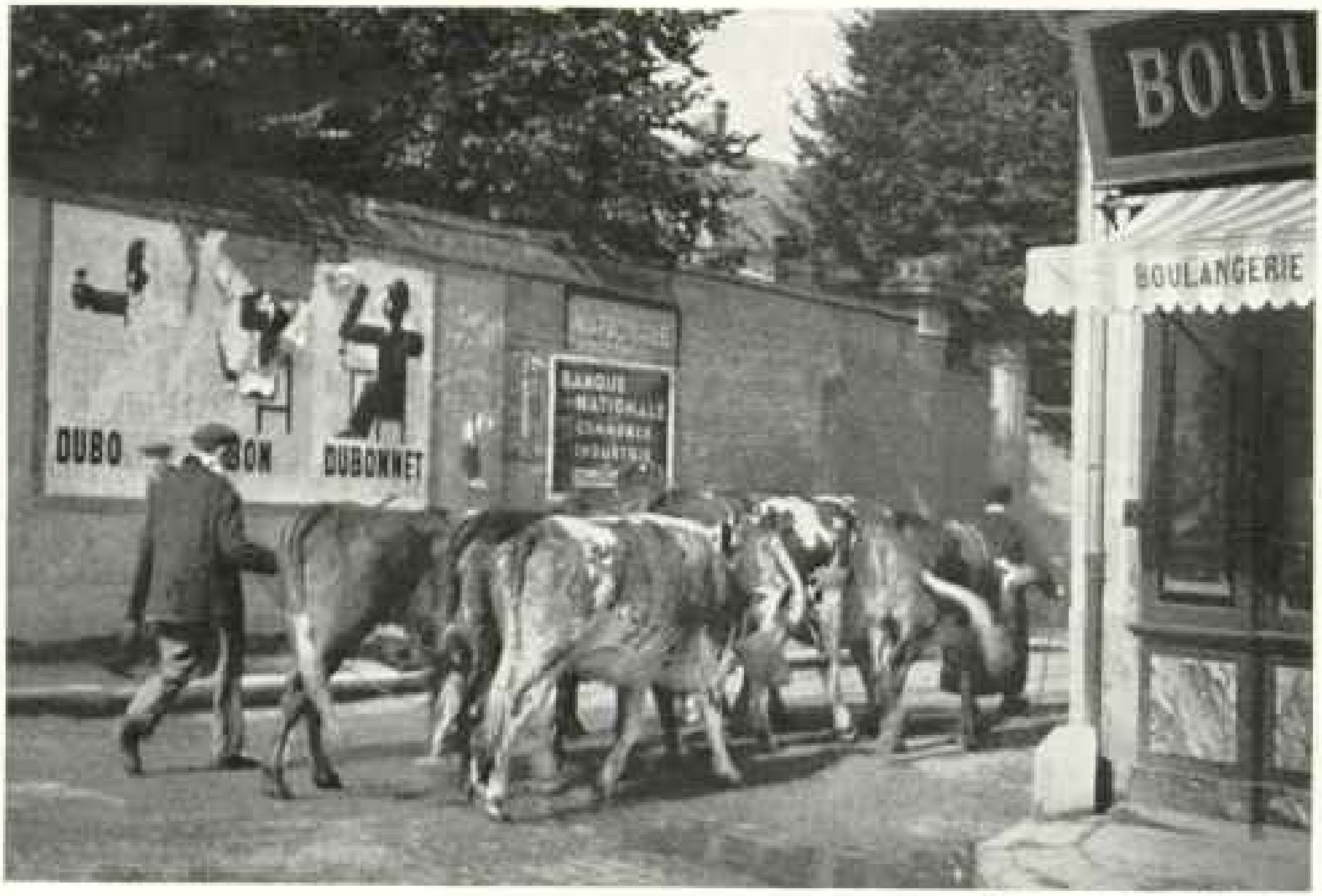
The Norman fields are red and white with buckwheat. It is an important crop,

* See "The Land of William the Conqueror," by Inez Buffington Ryan, with illustrations from natural-color photographs by Gervais Courtellemont, in the National Geographic Magazine, January, 1932.

Photograph by Melville Bell Grosvenor

AN OLD COUPLE COUNT THEIR SOUS BEFORE GOING TO MARKET

This is in Cherbourg, but the scene might be duplicated in many another Norman town, where stalwart farmers and women in snowy bonnets bring baskets to carry home their purchases.



Photograph by F. S. Lincoln

WHEN THE COWS COME HOME, THEY MARCH RIGHT THROUGH MAIN STREET IN COURSEULLES-SUR-MER

A woman leads the herd past a bakeshop, while a man trudges along behind. Husbands and wives share farm work in Normandy, sometimes called "one big dairy farm." It supplies Parisians with milk and cream and sends butter and cheese across the Channel to England.

Photograph by Melville Bell Grosvenor

"VEAL ON THE HOOF" IS TAKEN FOR A BUGGY RIDE, EARLY IN THE MORNING

The little white-faced calf takes a back seat, but it seems to be enjoying the sights as the two-wheeled cart rattles along at a good clip from Barfleur to Cherbourg's market.

but raised for local sustenance. To Americans, the word "buckwheat" means just one thing—griddlecakes, light and brown, eaten with a bit of savory sausage or drenched with melting butter and sweetened with that divine essence of the woods, maple sirup.

But in Normandy the buckwheat cake is unknown. Some missionary from the North Woods should teach its mixture, or make a pile of "stacked griddles" such as old Adirondack guides can cook. The way buckwheat is used in Normandy is to make of it a sort of bread, soggy, putty-colored.

A GLIMPSE OF MONT ST. MICHEL

The call of Mont St. Michel is a call to the heart. You may go hither and yon through France, seeing castles and monuments, flowered lanes and bewitching rivers, but always is felt the tug toward Mont St. Michel, often called, less formally, "the Mount" or "the Rock."

Unresisting, you at last find yourself straight down the coast from Cherbourg at the little town of Avranches (map, page 629), from which the happy pilgrim gets his first glimpse of the Mount.

Avranches is set on a sudden hill, and to reach its gems of interest the road sweeps upward on the steeps. In so doing it passes a library. That seems prosaic until into one's mind flashes the remembrance that it is here that great treasures of the Mount have found safe harbor after disturbing conflicts. Here are parchments written in the twelve hundreds.

Here, too, is the work of the monk, Abélard, whose love for Héloïse is even better remembered than his treatise, "Sic et Non"—such is the delight one takes in romance.

Up the hill is the Plate-forme, a name which sounds dull enough until, as one stops to survey it, its history comes back from some pigeonhole of the mind. What an astounding chapter of history it commemorates, this simple stone platform ringed about with chains! It is all that is left of the great cathedral which was taken down in 1799 as it began to collapse.

This spot, the Plate-forme, was just before the cathedral door, and it was here in 1172 that the King of England, Henry II, knelt before the prelates and emissaries of the Pope to atone for the murder of Thomas à Becket in Canterbury Cathedral. The

Photograph by Melville Bell Grosvenor

FATHER, WHITE-CAPPED MOTHER, AND TWO LITTLE SONS OUT FOR A STROLL

They are sight-seeing in the busy port of Cherbourg, where, as in more remote parts of Normandy, one sees the old and the new curiously blended. On one side are parked high-wheeled hooded carts, while down the street comes a big open motor bus.

© Donald McLeish

BOBBINS WHIRL AND CLICK AS YOUNG GIRLS OF BAYEUX MAKE LACE

Using pillows as bases, they rapidly work the pattern with the pins, to which the threads are attached. Delicate fabrics they themselves have made adorn the collars of the two girls in front.

Drawn by Newman Bumstead

FROM NORMANDY'S SHORES, CONQUERORS AND EXPLORERS SAILED TO MOLD WORLD HISTORY

Normans have always been sailors. In their veins runs the blood of Vikings, who ravaged the coast of France and later settled there. Setting out from Dives-sur-Mer, the Normans crossed the Channel to Pevensey for the momentous conquest of England; while, at about the same time, brother adventurers in the Mediterranean conquered Saracen Sicily and parts of Italy. Traders, colonists, and fishermen from Normandy helped open up the New World. No longer a unit of government, the historic province occupies roughly the central portion of France's northern coast.

King, having been excommunicated, was not allowed to prostrate himself before the gorgeous company from the Vatican within the building, but had to remain outside until their absolution was given him; and on his royal knees, which ached miserably.

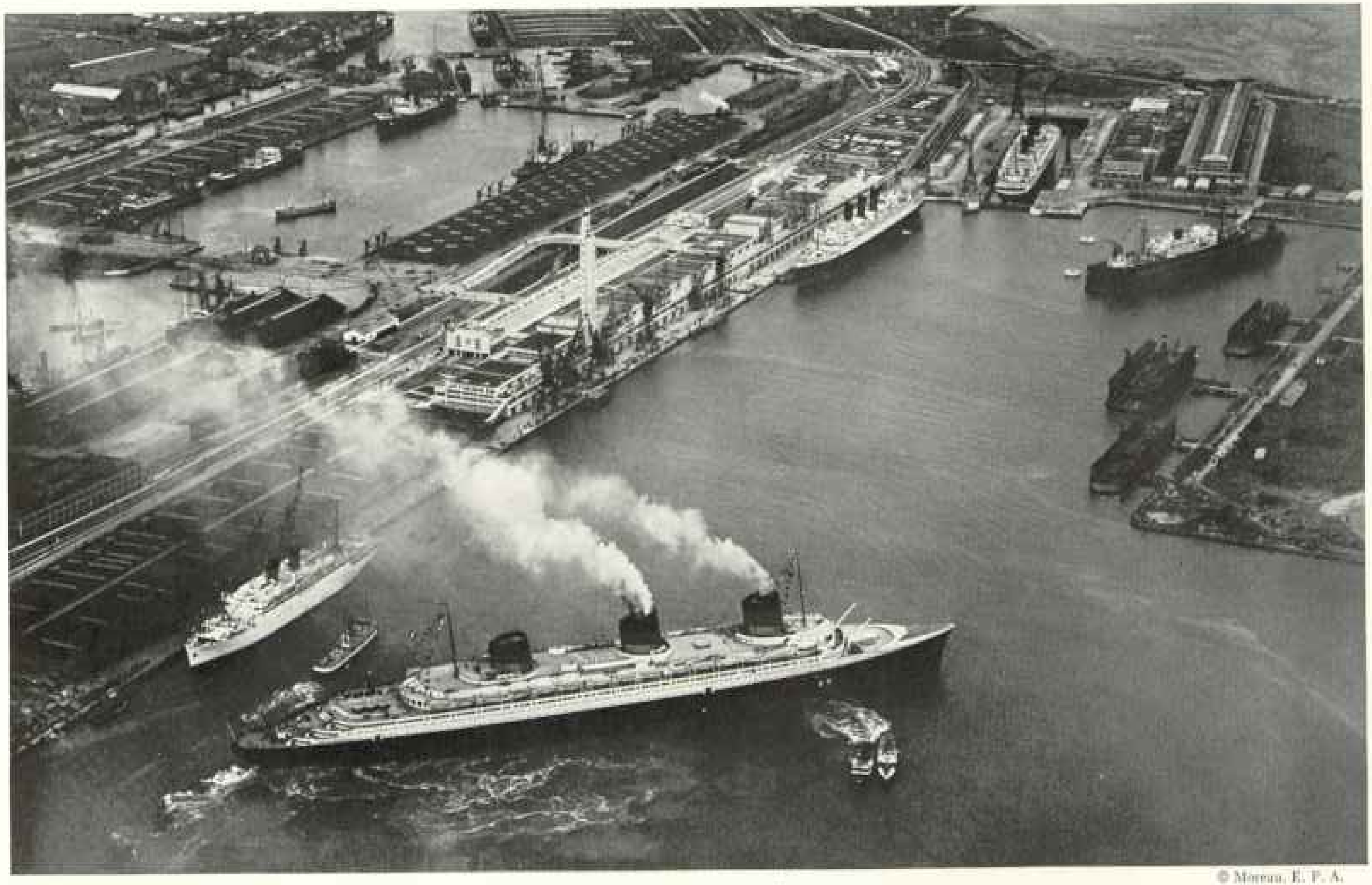
The day when first I saw the wondrous Mount, the sea lay softly between the Rock and the land, and about the lower part of the islet pressed a fog cloud. Above this the Abbey rose like a group of fairy towers in the sky, and the sword arm of St. Michael's high figure was stretched toward Heaven's blue and flashing in the sun (pages 633 to 648).

But the time to see Mont St. Michel is at any time when you find yourself near. If a chance to see it is given, even if it be

Photograph by Melville Bell Grosvenor

GAILY BEDECKED FISHING SMACKS IN THE HARBOR OF HONFLEUR, WHENCE CHAMPLAIN SAILED TO FOUND QUEBEC

Flags and drying sails lazily rustle in the wind as the crews unload cargoes of mussels or clams onto the old stone quay. This little Norman port was once a flourishing center for exploration and commerce. Its merchants traded with Java and Sumatra, its fishermen plied the waters of Newfoundland, and Honfleur colonists were the first to settle on the St. Lawrence, in 1608. Long the delight of artists, it has been supplanted in maritime importance by Le Havre, on the opposite bank of the Seine.



© Morgan, E. F. A.

DWARFING ALL NEAR-BY SHIPS, THE 80,000-TON "NORMANDIE" NOSES INTO HER HOME PORT—LE HAVRE

Appropriately she enters Normandy's chief seaport—second only to Marseille in all France—where trim new docks line the ample harbor at the mouth of the Seine. Normans are proud of their giant namesake. On her maiden voyage, the liner crossed the Atlantic, from Bishop Rock to Ambrose Light, in four days, three hours, and thirteen minutes. She covered 748 nautical miles in a single 24-hour run. All big ships are turned by tugs in the narrow basin before tying up at the docks.

midnight or winter, the sight should not be missed. But if a choice of times can be made, then the time of high tides is that time. And if there is a moon, and one can spend the night on the Rock, then sightseeing has reached its ultimate.

From Avranches the view resolves itself into a map of the Bay of Mont St. Michel and that great space of sand from which the tide recedes. For 22 miles, from Avranches to Cancale on the Brittany side, extend these tidal sands; and in the middle of all this flatness, as if floating in the sky like a mirage, rises the granite rock of Mont St. Michel. Two hundred and fifty feet it towers, and man-made structures have increased its height to 498 feet.

The curious and seeking observer can also note from afar the three distinct tiers on the Rock. First above the waters are the ramparts, splendid in their medieval strength; next, the band of clustered houses, "clinging like limpets to a rock"; and then the buttressed Merveille and the crown of towers and turrets resting on that marvel of masonry.

And just as the Rock has three tiers of architectural interest, the three tiers represent three purposes—fortress, prison, and abbey.

FROM DRUID DAYS TO AIRPLANE ERA

Pontorson, lying on the little river Couesnon, is the place of departure for the Mount. There one would take to the sea, were it not for the causeway of approach, built across sand and water.

In olden times—it can be done now if the traveler likes risk of wetting—the only way to reach the Rock was to walk or ride across the exposed wet sand. Even kings and bishops came that way, risking tides and quicksands. Fancy Louis XI snatching up his long gray robes and picking his way among the salt puddles!

After centuries of wet feet and floundering horses, energy was expended to bank high a causeway and on this to run a little train from Pontorson. And now we have the motor car by hundreds and even the airplane, which alights like a butterfly on the sands by the ramparts.

There was an earlier group, an almost prehistoric one, that passed with wet feet over the sands to reach the shrine—for religion has always loved this Rock. Druid priestesses established here a sanctuary and conducted mystic rites. They decorated their heads with fragrant wreaths of vervain and carried quivers full of golden arrows which had a property valuable to those who shudder and faint in thunder storms.

SAILORS SHOT STORMS WITH ARROWS

One of these arrows, it was believed, would disperse the fiercest storm if shot into the clouds by a lad who had never encountered Cupid. Sailors were given to calling at the Rock for an arrow. If the archer-mariner was successful with a storm, he could return and apply to the Druid priestess for a high reward, one of the most lovely of her maidens.

Hermits of a holy sort came after the Druids. The place was then called Mons Tumba, or Mont Tombe, because it had been one of the sea tombs of the ancient Celts.

Altogether modern after Celts and Druids seems the advent of St. Aubert. In the 8th century he lived on the hill of Avranches. He was bishop there, working and daydreaming with the mighty Rock before his sight, when a heavenly command came to him from St. Michael to establish a Christian church on the apex of the granite pile. Visions of that sort were common in those days (A. D. 708) and were fervently obeyed.

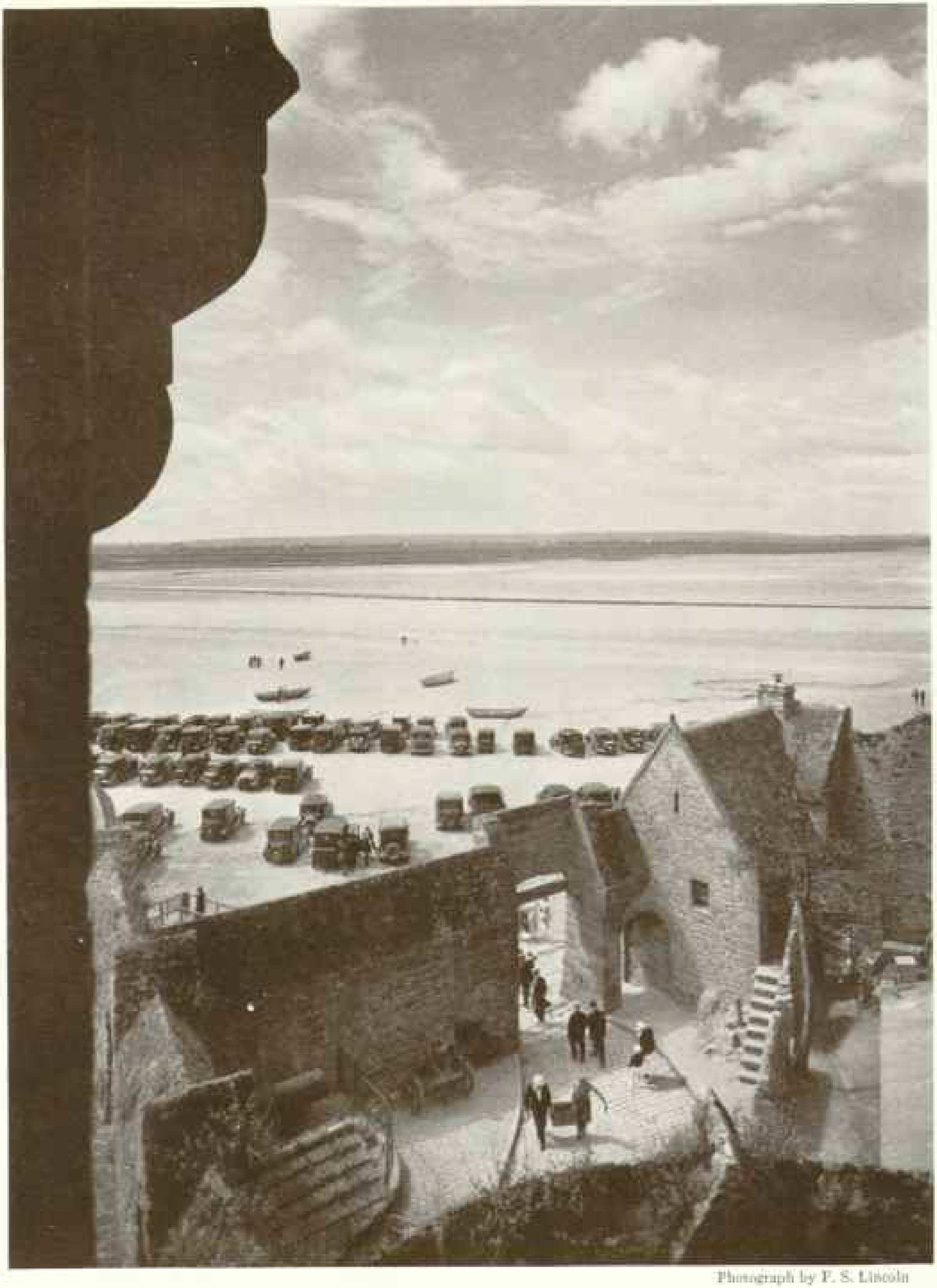
Bishop Aubert found a few holy hermits nesting like sea birds on the heights of the Rock, and that meant helpers. So he established an oratory and the place soon attracted pilgrims from far and wide. Later a monastery was founded. Mont Tombe dropped its sepulchral name and became Mont St. Michel, in honor of the saint who had appeared to Aubert in the vision thrice repeated.

Evidently the Normans, who came two centuries after Aubert, bore no particular jealousy toward the monks and their abbey, for the buildings were not destroyed. The Norman chief, Rollo, and William the Conqueror, his descendant, had larger and more aspiring business in mind.

AN ARTIST IN OMELETS

Omelets! Is it possible that the first thing demanded on the Rock is not the marvel of buildings, but an omelet? What a tyrant is an empty stomach!

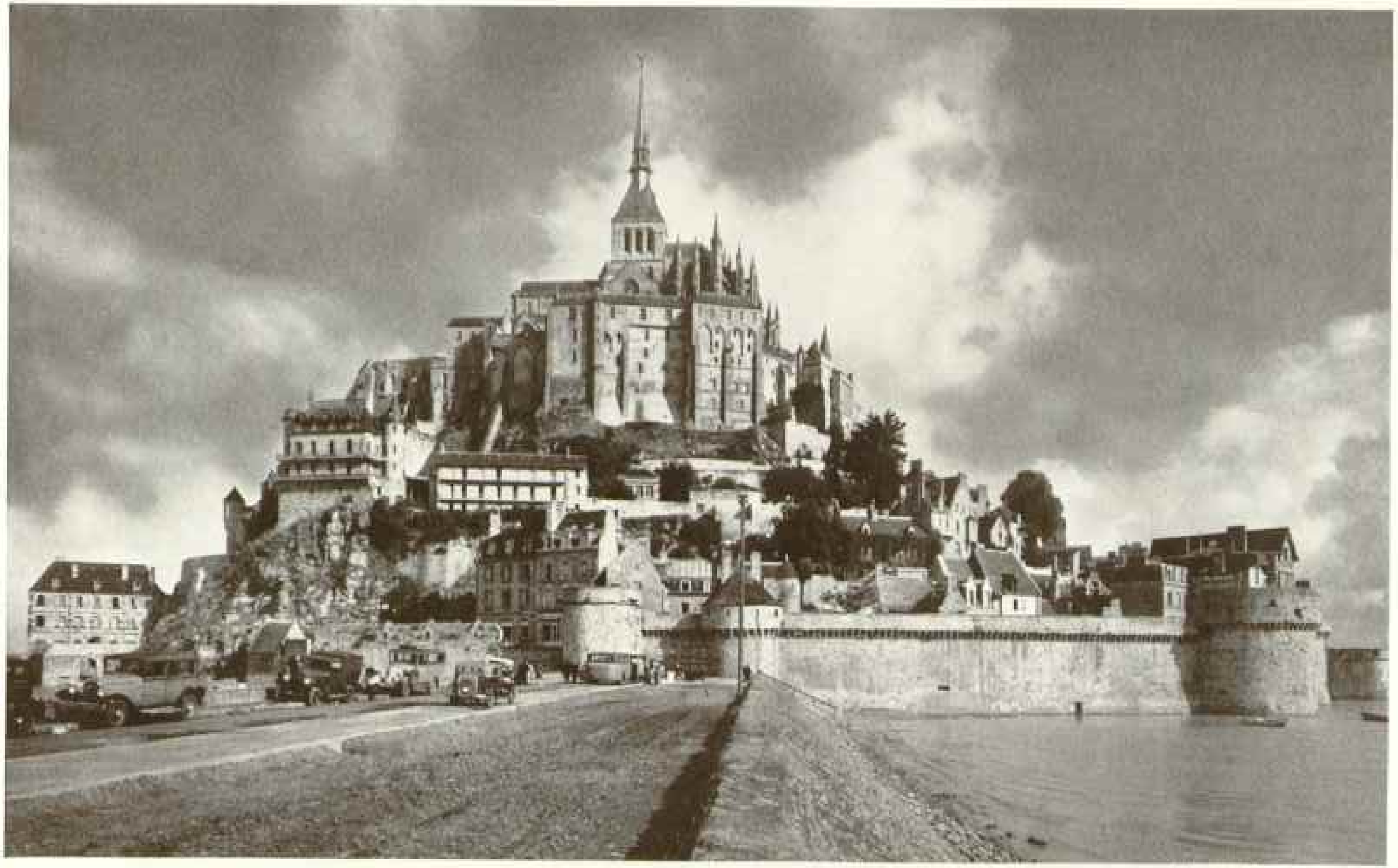
The omelets of Mont St. Michel are the legacy of Mère Poulard, a famous hostess of the Rock. She stands supreme as the maker of omelets, in the minds of those



Photograph by F. S. Lincoln

THROUGH ONE MODEST GATE PASS ALL WHO ENTER MONT ST. MICHEL

Pilgrims with red crosses pinned to their shoulders, long-robed priests, political prisoners, sight-seers, and permanent dwellers—all have come this way through the islet's ramparts. English soldiers, who in 1434 vainly attempted to take the Abbey, left behind two bombards used for shooting balls of stone. One of these early cannons, with its projectile, stands behind the iron railing at the left.



Photograph by F. S. Lincoln

A GILDED ST. MICHAEL ATOP ITS SPIRE, THE ABBEY ALMOST DOUBLES THE GRANITE ISLET'S ORIGINAL HEIGHT

About a mile off the Normandy coast rises the sugar-loaf rock of Mont St. Michel, where Benedictine monks founded a monastery 970 years ago. Here, at high tide, water encircles the Mount and the small boats ride at anchor instead of resting on the sand, high and dry. Automobiles and busses keep to the causeway, on which a tramway runs to the mainland. Before the road was built, in 1879, travelers walked or rode horses across the wet sand (page 642).

Photograph by F. S. Lincoln

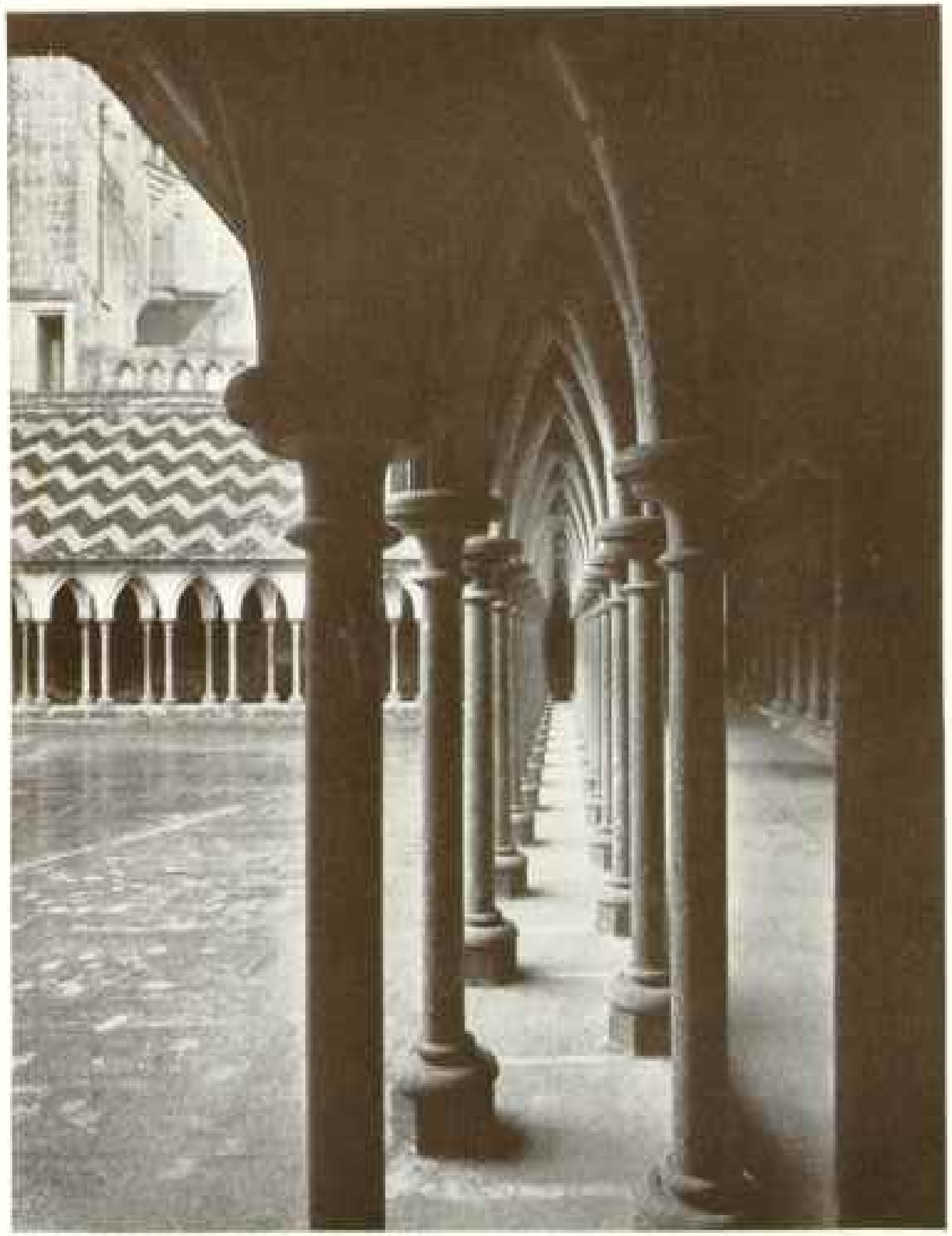
A DOWNWARD GLANCE REVEALS TOYLIKE CARS AND BOATS PARKED AND MOORED ON THE DRY OCEAN BED

Towering above the sandy floor, uncovered by the receding waters, looms a turreted château like some fairy-tale castle. Still higher, fertile vegetable gardens nestle on a terrace of the rocky cone. When the tide sweeps in, motorists hustle down these hairpin turns to move their cars in time, and visitors take the boats for rows.

Photograph by F. S. Lincoln

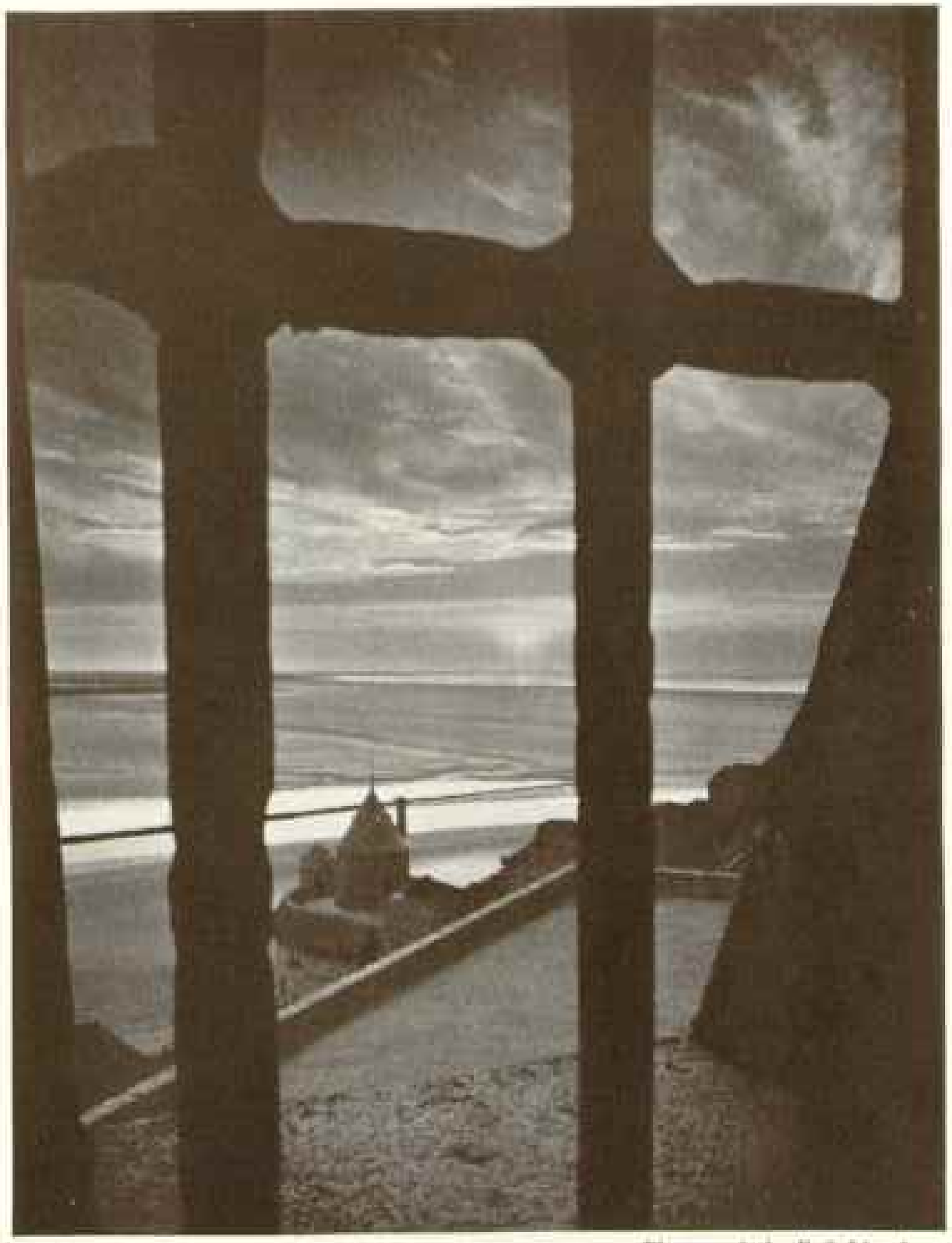
FASTER THAN A HORSE CAN GALLOP, THE TIDE RUNS BEFORE A STORM

When Channel winds lash the Abbey-fortress, visitors gather on the towers to witness the onrush of the wild sea. The tide, sometimes rising 45 to 50 feet above low-water mark, and treacherous quicksands have claimed many victims among fishermen. At low tide the water's edge recedes as much as seven and a half miles.



THE CLOISTERS ARE THE JEWELS OF MONT ST. MICHEL

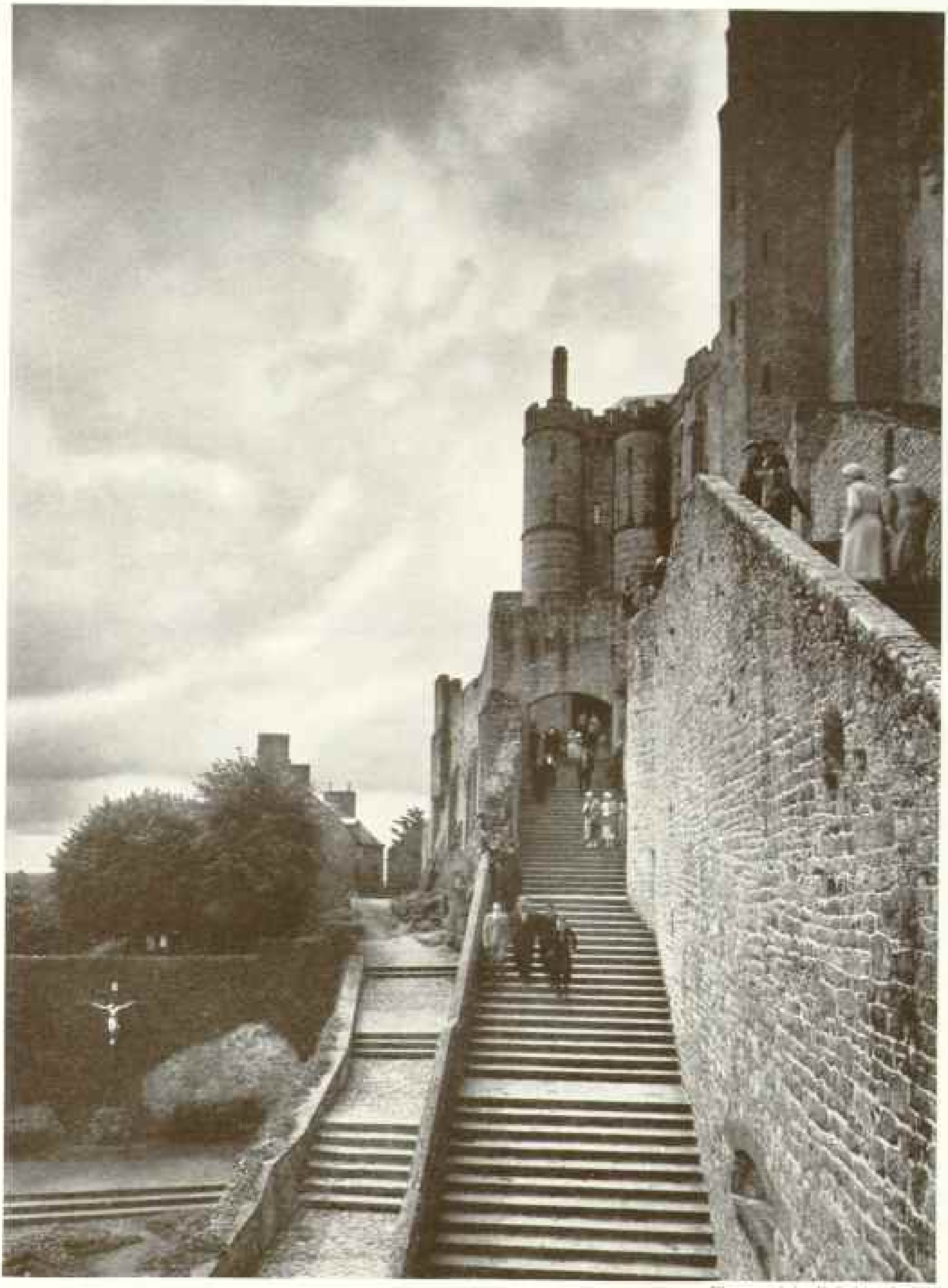
Their graceful arches and polished granite pillars are a delightful surprise in the somber monastery. Skillful builders of more than 700 years ago staggered the slender columns so that each could be seen from the court.



Photographs by F. S. Lincoln

A HEAVY GRILL DIVIDES THE VIEW INTO NARROW PICTURES

They are fortunate who can catch such vistas at sunset or by moonlight. Below, on the fortress wall, the Gabriel Tower's peaked roof looks toward the coast of Brittany and a gleaming fringe of ocean.



Photograph by F. S. Lincoln

"IS THERE NO END TO THE STAIRS?" THINKS EVERY VISITOR TO THE MOUNT

Since the Abbey is founded on a sharp pyramid of rock and all the streets slope steeply or are stairways, one seems forever climbing or descending. Here is the grand stairway leading to the gateway of the Abbey, built on three levels. The floor of the church, resting on rock and masonry walls, is even with the top floor of the buildings below. In 1066 this monastery was rich enough to send six ships to William of Normandy to help in his conquest of England.

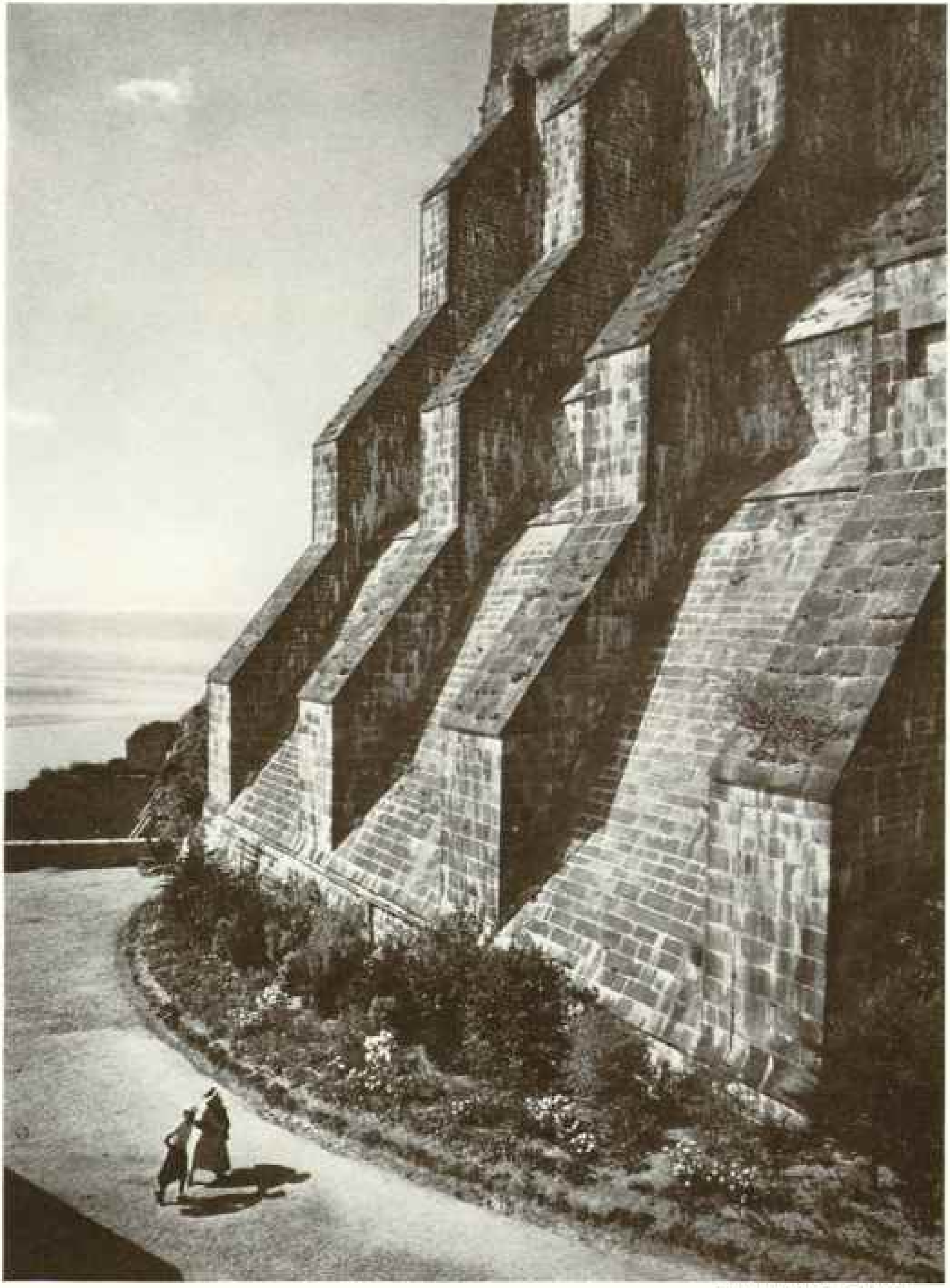
GIRT BY SEA AND RAMPARTS, MONT ST. MICHEL HAS HELD OUT AGAINST MANY A SIEGE

It was the only Norman stronghold that successfully resisted the invasion of Henry V of England in the 15th century. Between the Mount and the low-lying coast of Normandy on the horizon rises another rocky islet, Tombelaine (pages 648 and 651).

Photographs by F. S. Lincoln

AN OLD CARVING DEPICTS THE FOUR EVANGELISTS, EACH WITH HIS TRADITIONAL SYMBOL

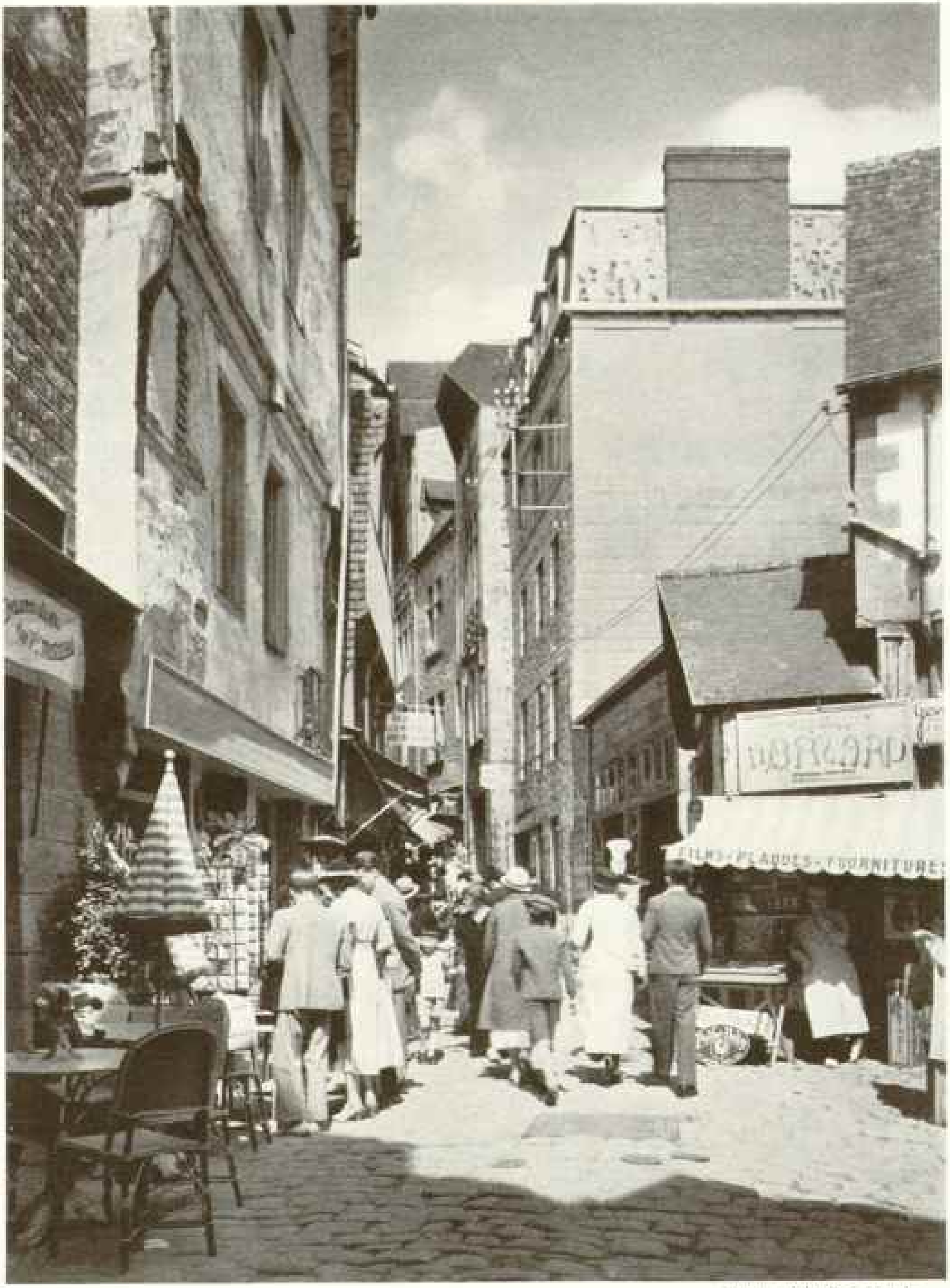
A winged lion crouches at the feet of Mark, left. John has his eagle, Luke a winged calf, and Matthew an angel. This panel decorates the Abbey church.



Photograph by F. S. Lincoln

LIKE GIGANTIC CORSET STAYS, BUTTRESSES SUPPORT THE MOUNT'S UPPER STRUCTURE

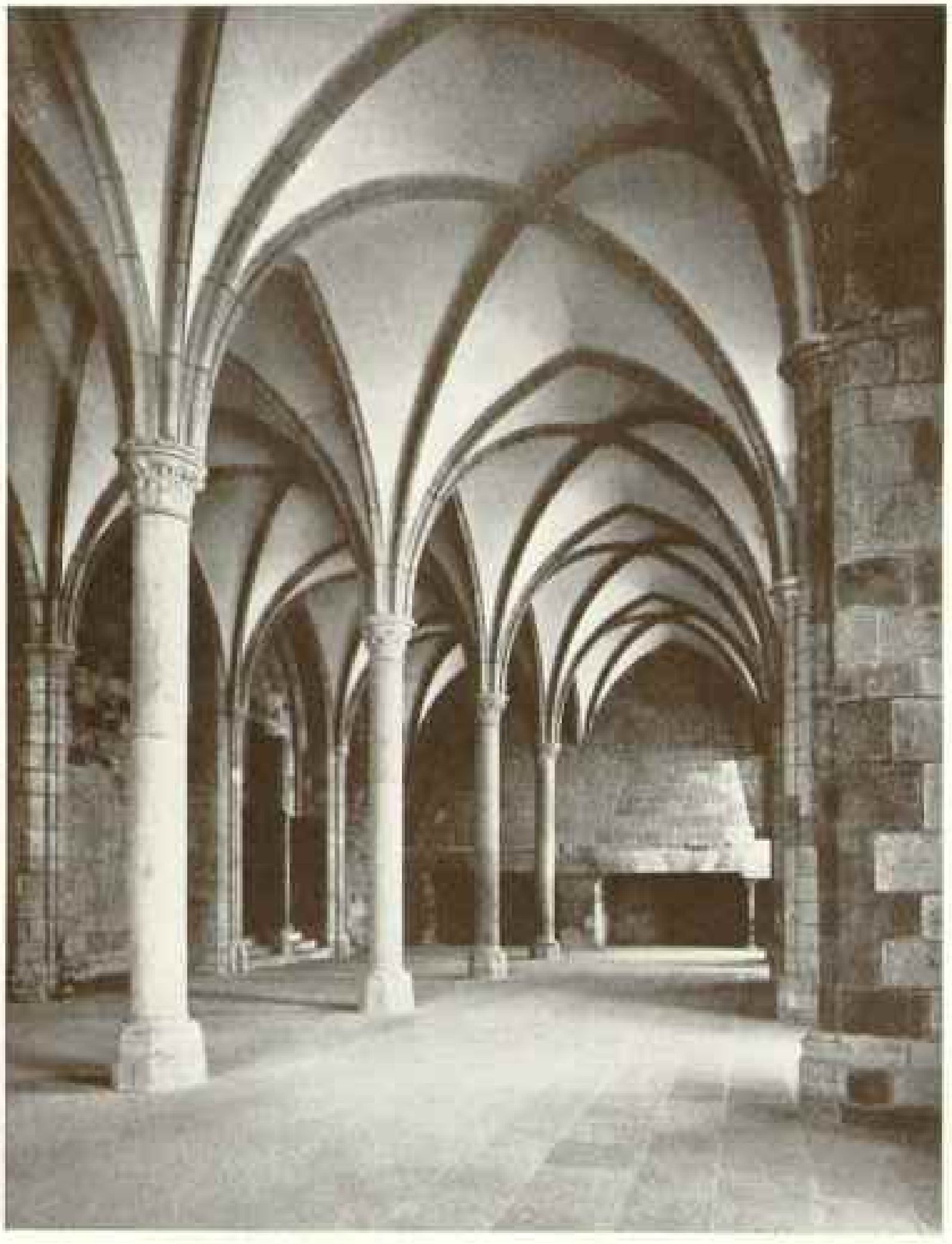
They hold in the massive walls, counteracting the thrust or outward pressure exerted by arches in the building's interior. When the early monks erected their church on the granite rock, they refrained from cutting away the pointed summit, for that would have sacrificed about 30 feet of the height. Instead, they took the peak as a level and built foundations on all sides around it.



Photograph by F. S. Lincoln

GENERATIONS OF DEVOUT PILGRIMS HAVE SOUGHT CURIOS IN THE GRANDE RUE

Their footsteps have worn smooth the flagstones with which Mont St. Michel's "Main Street" is paved. Here are souvenir stands, inns, restaurants, and inviting open-air cafés where one may sip refreshments before continuing along the steep, narrow lane to the Abbey. Near the center of the picture is a hotel sign in French which reads: "Here are received persons who bring their own provisions."



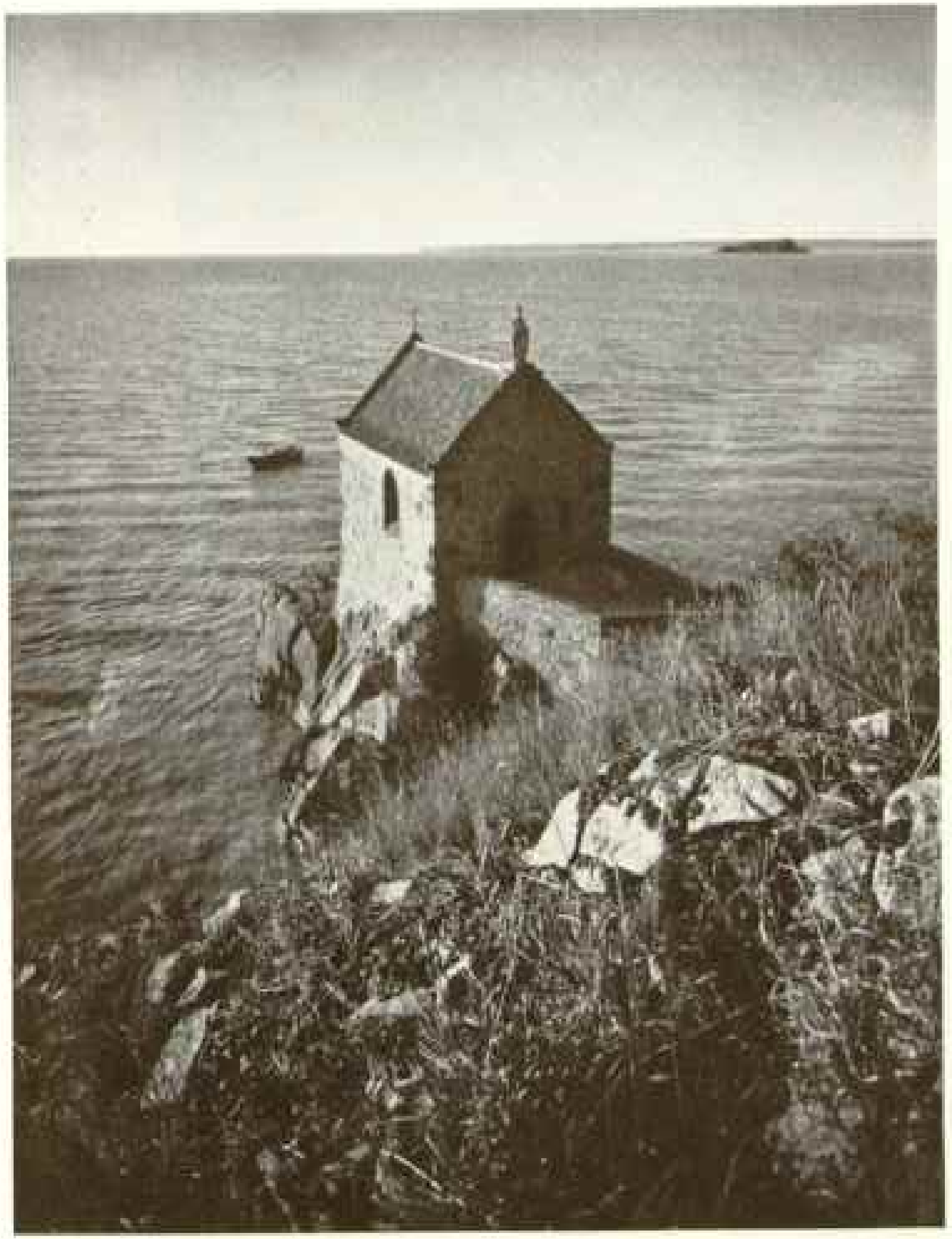
HERE HOSPITABLE ABBOTS COULD FEAST 200 GUESTS

The lofty refectory was planned for lavish medieval entertainments, at which even kings were sometimes present. Such perfect arching as that seen in the vaulted ceiling seems as if just made, so little has time injured it.

Photographs by F. S. Lincoln

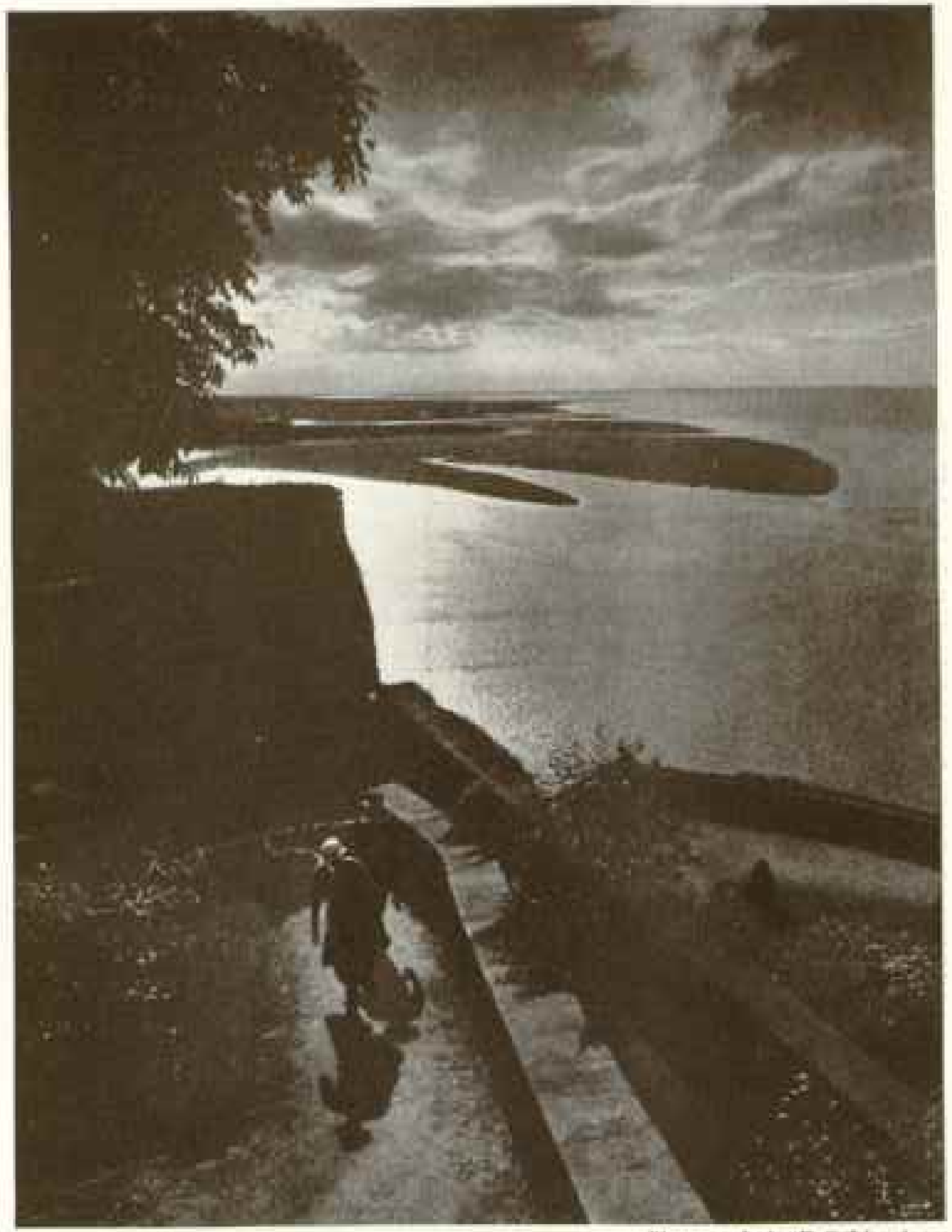
A PORTCULLIS ONCE BARRED THE WAY TO INVADERS HERE

The Porte du Roi still displays its weathered shield; while a signboard, to the delight of the hungry, points the way "To the Renowned Omelet of Mère Poulard," who is pictured with her enormous frying pan (page 632).



THE CHAPEL OF ST. AUBERT FACES THE RISING SEA

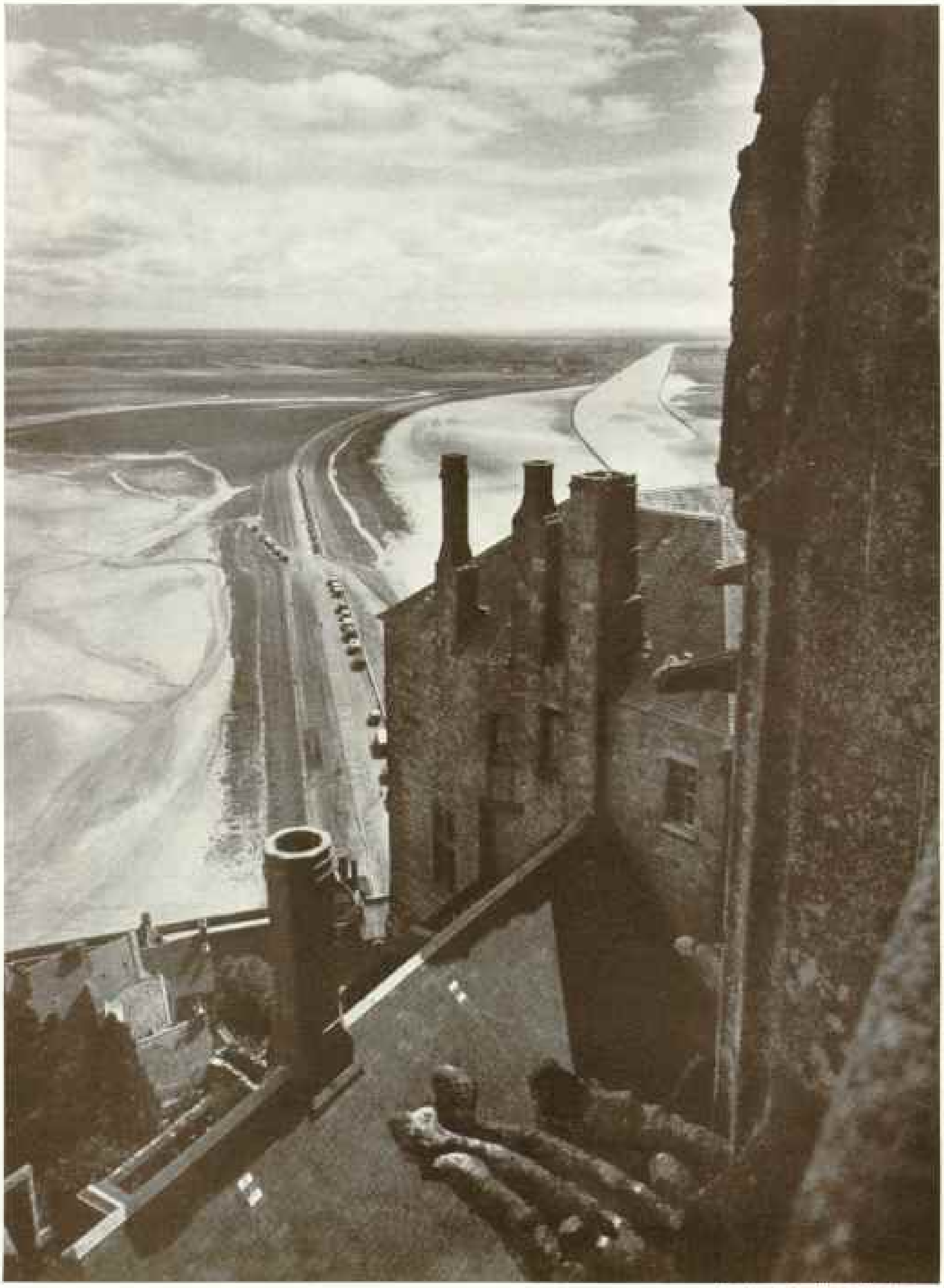
A legend tells how the rock on which it stands fell to the sea from the heights to further the work of St. Aubert (page 649). At low tide one can circle the Mount on foot, but the author used a boat such as the one appearing from behind the chapel at high water (page 653).



Photographs by F. S. Lincoln

SAND AND SEA TOGETHER MAKE STRANGE PICTURES

From a terrace on the north side of the Rock, where a forest still stands, is seen the vast western expanse of the bay, into which bars of sand, uncovered by the tide, jut out like giant fingers. Near Mont St. Michel is the border line between Brittany and Normandy.



Photograph by F. S. Lincoln

GROTESQUE GARGOYLES GAZE DOWN ON A CHANGED PANORAMA

When the carved stone waterspouts, projecting from the side of the Abbey, were built, there was no causeway leading from the mainland. From here can be seen the dikes which protect the crowded road by holding the Couesnon River in a channel as it runs out to join the bay. Seen from on high, the river looks like a broad highway nearly paralleling the causeway.

Photograph by Burton Holmes from Galloway

RESTAURANT KEEPERS MAKE USE OF SCANT SPACES ON DIZZY HEIGHTS

Their establishments are mere "holes in the wall," where diners at cozy tables have a view of the bay before them and, in summer, can feel the cool sea breezes. Someone is always eating at Mont St. Michel, and many seek the heady Norman cider as well as the celebrated omelets. Farther along the balconylike terrace is one of the inevitable postcard racks, conical Mounts plainly visible on the cards.

MONKS HOARDED WATER IN THIS WINDOWED RESERVOIR

Ever rare and precious on the Mount, water was formerly hoisted from a well to the Abbey by a huge windlass. Rain water is still collected to supplement the well supply. On the spire stands the winged Archangel Michael, saint of high places.

Photographs by F. S. Lincoln

"PETRIFIED LACE," THEY CALL THE GOTHIC PINNACLES

At these giddy heights, visitors often feel an urge to hang onto the parapet, especially when a strong wind blows. More than twelve centuries ago St. Aubert built an oratory on the Mount, obeying what he considered a command from St. Michael (page 652).

A NORMAN PORTER CARRIES 200 POUNDS WITH A SMILE

Bearing the photographer's equipment, he shows the way to the Hotel Poulard. On the day of the annual pilgrimage to Mont St. Michel, the town's limited accommodations are often swamped by crowds of good-natured devotees.

Photographs by F. S. Lincoln

A PICTURE IS AN AMUSING EXPERIENCE TO HER

Wearing heavy wooden shoes, short black socks, and an ample apron billowed by the wind, this good-natured Norman woman pauses to pass the time of day at Pontorson, near Mont St. Michel.

© Compagnie Aérienne Française

LIKE A PHANTOM CASTLE IN THE CLOUDS, MONT ST. MICHEL RISES FROM THE SEA

From an airplane the wide causeway looks like a mere footpath as it leads in a graceful curve from the Normandy coast to the fortified gate of the Mount. Scarcely distinguishable from the surface of the bay is the canalized Couesnon River, flowing between dikes to the left of the road. Near here thousands of acres of sand have been reclaimed from the sea for use as sheep pastures. In the distance is the neighboring islet, Tombelaine (page 639).

who long ago felt the warmth of her gracious greeting, the heat of her great open fire, and the tantalizing fragrance of her brown and yellow harmony.

As soon as the visitor to the Rock stopped within the city gate, he felt the pull of Mère Poulard's hospitality and remembered the phrases of her fame. A whiff of a browning omelet changed the entrance court into the antechamber of a delicious luncheon.

"Good day, my friends. Be seated; an omelet is just ready for you."

No matter how many times that low, even voice repeated the greeting, it went to the hearts of the hungry as a welcome for them alone.

As for Madame's recipe—there seemed to be none. I watched her and her handmaids with a detective's eye, but all I could see was a bowl of eggs being prodigiously beaten. Alas, how many eggs I have sacrificed at home trying to copy Madame Poulard!

Coming now again to the Rock, I miss her magic. Nevertheless, I fall upon the omelets of her successors and copyists with the old-time appetite. One always arrives hungry at the Rock, whether one is a pilgrim by bus, train, or motor car. And besides the omelets there are succulent chickens turning on the spit.

Visitors crowd the Grande Rue, the only real street on Mont St. Michel, and they are found in all places, high or low, on the ramparts. But one must be alone to dream over the entrancing history of the place.

For me the matter was settled by taking a room in one of the little retreats that cling to the Rock, with all windows toward the view. The early morning I devoted to exploring.

AGE AND INFANCY AS GUIDES

On a doorstep of one of the barnaclelike homes which cling beside the Grande Rue sat an old man with a baby in his arms.

"Good day, Madame," he said. "Perhaps I can show you something you have not seen. It is hidden and small, but it is a gem of a chapel."

His voice and smile were winning, and then there was the baby in his arms, as peaceful as the Child in ancient pictures.

He rose—Cartier was his name—and lamblike I followed, down steps, up steps, and finally to a platform on the far side of the rocks near the trees which still remain to suggest the forest that once surrounded the Mount.

"Behold! there it is." He stood with smile serene and looked to me for approval. "It is the chapel of St. Aubert, he who built the first church on Mont St. Michel. You know the story of his vision, in Avranches, of St. Michael, the saint of high places. But when St. Aubert started to build, a huge rock reared itself in his way. Madame, that is the very rock on which you see this little chapel standing" (page 643).

LEGEND OF A CHILD'S KICK

But the skeptic asked how it got to the foot of the Mount, down by the sea.

"Ah, that was done by a child as tiny as this little one I am holding on my arm. St. Aubert fetched it from the forest and with one kick of its soft bare foot the rock toppled and fell to where you see it. Then a chapel was built on it to the saint. A little foot like that caused the rock to fall.

"Yes, and thy foot, too, will grow strong some day." This last he said to the baby cradled in his arm.

"You see, Madame, I bring her often here in the hope St. Aubert will give her strength. It will come some day," he smiled. "She is sweet, like my daughter, her mother, who works at the hotel beating omelets."

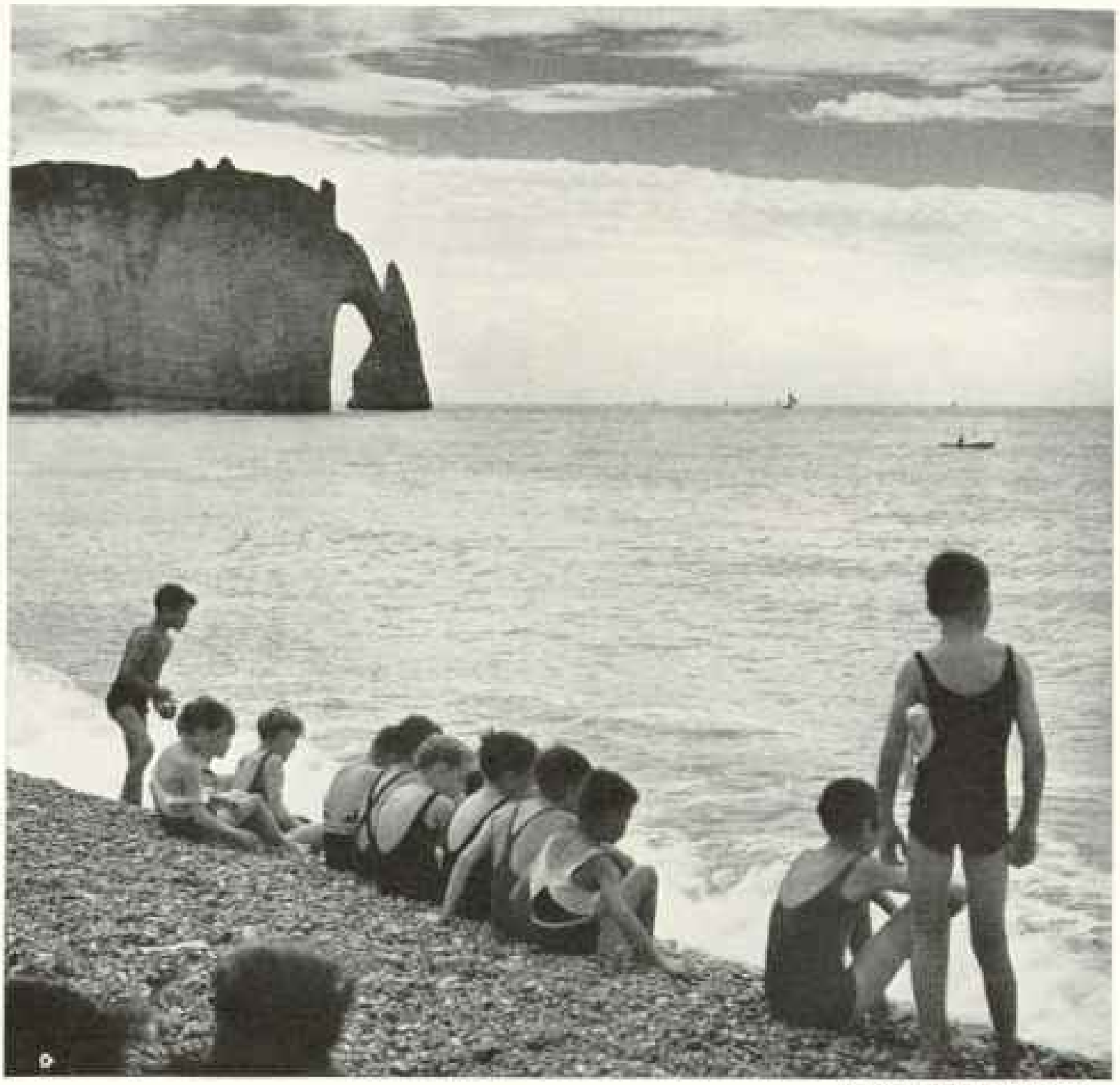
"How many eggs a day? How many chickens?" I asked.

He laughed delightedly and pointed to loaded wagons coming across the sands from Pontorson.

"All those are eggs and chickens, and they come every day like that. We return now, by the sands, before the tide comes."

The crowds have gone. I have the Mount to myself: inspiring thought which drives both feet and spirit to seize all avidly. Robert Jolivet, in the early fourteen hundreds, completed the ramparts, decorative, with machicolated tops. They can wait; they are near at hand. St. Michael calls to the heights. He is the saint of high places and one leaps to join him.

The steps have been counted from the port to the top—662. Appalling if taken all at once, but eyes and mind find so much on the way that stops are a natural part of the ascent. Even before the steps begin there are bazaars on the "Main Street," unpretentious places, but even the gravest men of science are known to have paused to buy prodigious rosaries and tiny copper pans, miniatures of Madame Poulard's.



Photograph by F. S. Lincoln

A ROCK ARCH, LIKE A FLYING BUTTRESS, DOMINATES THE BEACH OF ETRETAT

Waves have hollowed it out of the cliffs which tower above the steep, pebbly strand. Some of the boys, trying to get up courage for a dip, are English, for during the season many visitors cross the Channel to this fishing port, now a fashionable resort.

The ramparts, too, are a place to retard those who mount. Past the shops and cafés, occupied only by the permanent population, not too far up, is the little church, a village church it would be if the clambering houses could be called a village. It was built originally in the 11th century.

WHERE EARLY PEOPLES WORSHIPED

The Rock itself now is visible. The Mount is a rock of granite, but so encrusted is it with architectural results that one forgets the phenomenon and is mindful only of buildings. On facing La Merveille, that amazing combination of cliff and buttress, one beholds the grandeur of the bare Rock. Thoughts turn quickly to ages past, when the Druids, Celts, and Franks all vested it with fables of their religions.

We go there now to visit the buildings of Christianity, magnificent and historic, but as we pause on the long stairs of 90 steps, the Grand Degré, thoughts turn to those early peoples who found their gods on the untouched cone of granite.

The grim monastery above conceals so much—cells, prisons, chapels—that the interior must be viewed with the deliberate intent to come away knowing more of history than before. Running up a few steps, one reaches the platform from which a despairing man once jumped away his life. Gautier's Leap (Saut Gautier) it is called.

The eyes fly upward to the Abbey church,

Photograph by F. S. Lincoln

ADORNED WITH BOUQUETS, MEAT COMES TO THE FORE IN THIS CURB MARKET

Perhaps as a concession to cleanliness in Avranches, and to hide unsightly parts, the large beeves have white muslin aprons tied around their middles. Many French butchers sell horse meat, which is well liked. Such shops are indicated by life-size gold horse heads over the doors.

the Stairway of Lace (Escalier de Dentelle), then, leaving these beauties, they alight on the figure of St. Michael. He stands victorious over evil, the Devil at his feet. With uplifted head and arm thrust skyward he seems to promise Heaven still further moral victories, and to lead others on to inspiration—us poor panting sight-seers? Yes, why not? From Avranches on the mainland, St. Michael seemed to top the last spire as a brilliant architectural finish to the Mount itself, but here close at hand he becomes a high-hearted leader flashing courage in the sun.

The Abbey was erected in the time when Norman Gothic prevailed. The Cloisters are a veritable forest of slight columns with capitals and arches of daintiest carving. Almost oriental is the effect, and a thought, fleeting and faint, is thrown toward the exquisite work of the Moors in Europe so many centuries ago that it seems a possible inspiration for these (page 637).

ANOTHER ROCK WITH A HISTORY

The old man with the baby on his arm began to watch for me, and each time I saw the humor in his young eyes I knew he had some novelty to show me.

"You are becoming my guide," I said.

"A guide? Heavens, I never was that. But has Madame seen Tombelaine?"

He led me, talking the while in friendly Norman fashion, to where I could see the

Photograph by F. S. Lincoln

FETCHING WATER, ONE SEES WHAT'S DOING ON THE STREET

It may not be as convenient as having water piped to the house, but at least there is no meter on this public hydrant. The little girl's foaming pitcher is familiar to travelers who have stopped at small European inns where running water is not available.

big rock which seemed to lie floating on a sea of quicksilver, halfway between Mont St. Michel and the village of Genêts, on the Norman shore. It looked like a miniature Gibraltar or a couchant lion (page 639). Had it a history, that bare lump?

My guide who was not a guide looked down like a mother on the passive baby, and then with real pleasure talked of the lesser rock. When Mont St. Michel was called Mons Tumba, the smaller islet was called Tombelaine; both were sea tombs of ancient peoples. He liked the idea, he said; one was nearer God on calm, wide waters than anywhere else. He had felt that when he was a fisherman.

Then Tombelaine became a Christian holding, and a tiny abbey was built there with a cell for a lonely monk, an offshoot of the great Abbey on the Mount.

Did Madame remember the story of Fouquet, the ambition-mad Finance Minister of Louis XIV, who incurred his King's displeasure by growing too extravagant and powerful? He built a château on Tombelaine, and he should have been forgiven the spendthrift magnificence of his château at Vaux, for no man is worthy of prison who would seek to be alone with God on the rock of Tombelaine.

The King had even that vestige destroyed, and Tombelaine is now only a rock which young sight-seers gain by defying the quicksands.

It was a bright hour of the morning when old Cartier decoyed me up the only street of the Mount to show me a house.

"Look, there is the house of Tiphaine Raguenel. There she lived with Bertrand du Guesclin, a fine man, though only a Breton and not a Norman."

That to me typified romance, the life of that splendid 14th century warrior calmed for a while by his marriage with his ideal, the rare lady, Tiphaine Raguenel.

Cartier would not let this end the stroll.

We looked ahead and up the sharp ascent of the street. The narrow space between buildings was dotted with little blond angels lightly descending in sheerest white robes from some celestial region to bless us with their contact.

"They make their first communion," said Cartier, as two stopped to caress the baby.

The parish church, toward which the children flew like liberated butterflies, seemed to be the objective. Again Cartier's interest was in the individual, not in the building. Here is buried David Benoit. Knowing well the peril the Mount can be to the sailor in a fog, he established a great bell of warning, a fog bell that saved many a bewildered sailor—"Ah, that was an act worthy of a Norman, Madame."

Photograph by F. S. Lincoln

A HOUSE OF MANY GABLES HAS FOR NEIGHBOR AN "AMERICAN BAR"

Signs in English as well as French proclaim this four-story timbered dwelling of Etretat to be a restaurant, bar, and rotisserie, or cookshop where customers can buy roast meats to take home. On the sidewalk beneath the overhanging second story are little tables where one may sit and watch the world go by.

Cartier was dissatisfied because I had not made the circuit of the Mount, assuring me a half hour's walk on the sands would accomplish it. But the fear of quicksands was deep in my heart and I dislike wet feet.

RELICS OF A BATTLE FIVE HUNDRED YEARS AGO

"If Madame likes, I will borrow a boat and row her when the tide is right. Marie Louise can care for the little one."

We went out the gate (page 633), passing the big bombards left by the defeated English when they attacked the Mount in 1434. At sight of them Cartier sought my eyes and laughed heartily as if he personally had been the victor and as if the English army were still blushing with shame at its failure.

Out on the water the ramparts show their magnificence and strength. The Gabriel Tower (page 637), which above seems but a platform for sight-seers, becomes a defiance to any enemy. The water slipping around its base includes the channel of the Couesnon as it runs down from Pontorson.

Photograph by F. S. Lincoln

YOU MAY WASH BEFORE YOU DINE AT THIS WAYSIDE INN

Soap, towel, and basin, with the water tank above, were installed under the wisteria as an accommodation for motorists who stop for meals in St. Saëns. While the serving maid dries the cutlery, the big black dog seems to guard the outdoor washroom.

Photograph by Melville Bell Grosvenor

HER COSTUME MAY BE OLD-FASHIONED, BUT SHE KNOWS ALL THE SALES WILES

The lady is quite eloquent in her efforts to dispose of her fine fat sheep. Hand on hip, she seems to say: "Well, take them or leave them!" Sturdy, shrewd, and typically Norman are this woman and the man at the right, arms folded. Few travelers realize, when they hurry through the customhouse at Cherbourg and to the boat or train, how much of interest they are missing in this marketplace lined with houses.

Around toward the north, the forest sweeps up the hill as a surprise: nothing here but nature, it seemed—no masonry, no buildings, the forest screening all with beautiful dissembling. But my companion politely disagreed with this observation.

"No, Madame," he said, "several things are to be seen from here. There is the rock that the child's foot kicked down for St. Aubert and the chapel built upon it. And beyond is St. Aubert's fountain. Now the Mount has a magnificent cistern which supplies our need of water, but when the saintly bishop started to build the chapel for St. Michael, he had no water for his company of builders (page 632). He struck a rock with his staff and water gushed forth. That is the fountain yonder.

"You have seen the great wooden wheel up above which drew up the baskets of food for monks in the monastery. Look well now among the trees and you can see the track made by the passing of the baskets. It saved a lot of porting up the hill."

We floated out farther upon the waters and from there saw La Merveille in all its strength and grandeur. Religion inspired it and elevation of the spirit it inspires.

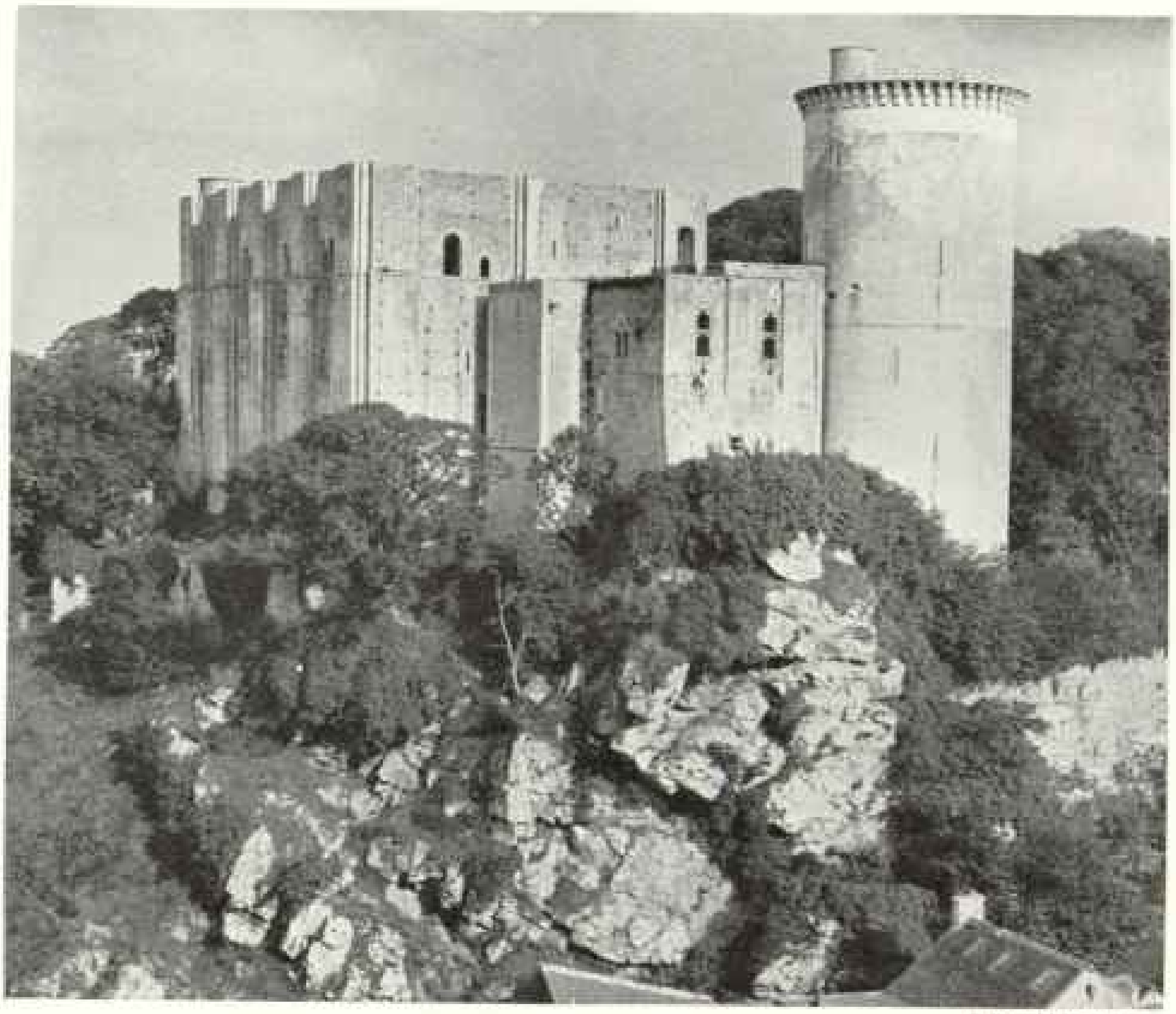
The boat drifted past the forested side of the Mount. We were again in sight of the little town plastered against the Rock, and skirting the magnificent ramparts.

"Madame is content with her promenade?" asked Cartier, expecting enthusiasm. I gave it freely.

That afternoon, when the tide was out, I felt that I knew intimately not only Mont St. Michel but the miles of flats, the salt fields recovered from the sand for grazing sheep, and the little river, Couesnon, which refuses to disappear—the whole setting of the marvelous Mount.

The crowds were gone, the big omnibuses had swaggered over the causeway, the tram-train had given its last scream for the day. A few automobiles remained, but most of the drivers consider a stop at the Mount as a deterrent to a day's run and had taken all at high speed.

In the evening, the little town becomes itself again. Neighbors, intimate the year round, are keenly interested in one an-



© Donald McLeish

IN THIS CASTLE WAS BORN THE CONQUEROR

It was from one of these windows, so the story goes, that Robert the Devil, Duke of Normandy, first spied pretty Arlette, the tanner's daughter. She was washing linen in the brook below the rocky promontory. They fell in love and at this castle of Falaise their son, the celebrated William, was born about 1027.

other. A little visiting, a little gossiping, and then, one by one, the tired elders go to bed. A quiet hour comes when Jean and Jeannette meet half-stealthily for a whispered word of the lovemaking that makes the world go round. Then the girls who have whipped hundreds of yellow eggs all day steal home and to bed.

The Mount stands silent, magnificent, as it has stood through millenniums of nights. The sea runs in and claims it, throwing a vast mantle around its feet.

COUNTRY OF WILLIAM THE NORMAN

How Normandy came to be Norman is as historically interesting as how it came to be French. Daring Vikings sailed there from wild north seas and made it theirs. It had not been Norman much more than a hundred years when William the Conqueror matured to take his place as Duke and then to loose his ambitious project on England.

The Conqueror pervades Normandy. It is not possible to put him aside in traveling about; neither does one want to. He leads on to such charming places. There is Falaise, the epitome of all that is romantic in old castles, a great gray pile, of round tower and square keep, with full equipment for romance. It is here that Duke Robert lived, the father of William.

Robert was but a youth of eighteen when, so one story goes, he espied a matter of interest through the castle window of slender columns and pointed arch. It was a sunny morning, full of the color and scent of apple blooms. Under the flowering trees was a

WOOD CARTS ARE HITCHED IN TANDEM TO FORM A TRAIN

The author tells how the drivers incessantly shout to their horses the "strange sound, 'Hue!' delivered with reproach or with scorn" (page 625). Stacks of grain border this narrow but smoothly paved road leading to Caudebec-en-Caux.

Photographs by F. S. Lincoln

FOR LONG AGES, NORMAN WOMEN HAVE KNELT BESIDE NATURE'S LAUNDRY TUB

Stooped by toil, this farm wife of Mortain nevertheless has a twinkle in her eye as she washes clothes in the pool and scrubs them against the rough board. Thus may Arlette have been doing the wash when Duke Robert saw her from the castle of Falaise.

Photograph by H. Armstrong Roberts

ALL WHO HAVE DRIVEN ALONG THE COASTAL ROAD OF NORMANDY REMEMBER THIS VIEW OF TROUVILLE'S POPULAR BEACH

Beyond the dark cross on the hillside stretch long ranks of portable bathhouses and striped tents of brilliant colors. Deauville, more fashionable and much more famous abroad, lies in the distance, just across the Touques River. Casinos, horse races, yachting, and all kinds of sports bring visitors from everywhere to these Norman watering places during the "season," in August.

Photograph by Branson De Cou from Galloway

THREE LITTLE TOWHEADS AND THEIR MOTHER READY FOR A JOY RIDE

It's fun to go bouncing along in such a big open cart. The fair-haired mother and her children inherit their Scandinavian characteristics from Norse ancestors who settled in France during the ninth and tenth centuries. From behind the cart peeks a coy matron wearing sabots, or wooden shoes. The barn, left, is part of the stone dwelling. Norman farmhouses are so big that they seem to be "near cousins of old castles."

Photograph by Brasson De Cou from Galloway

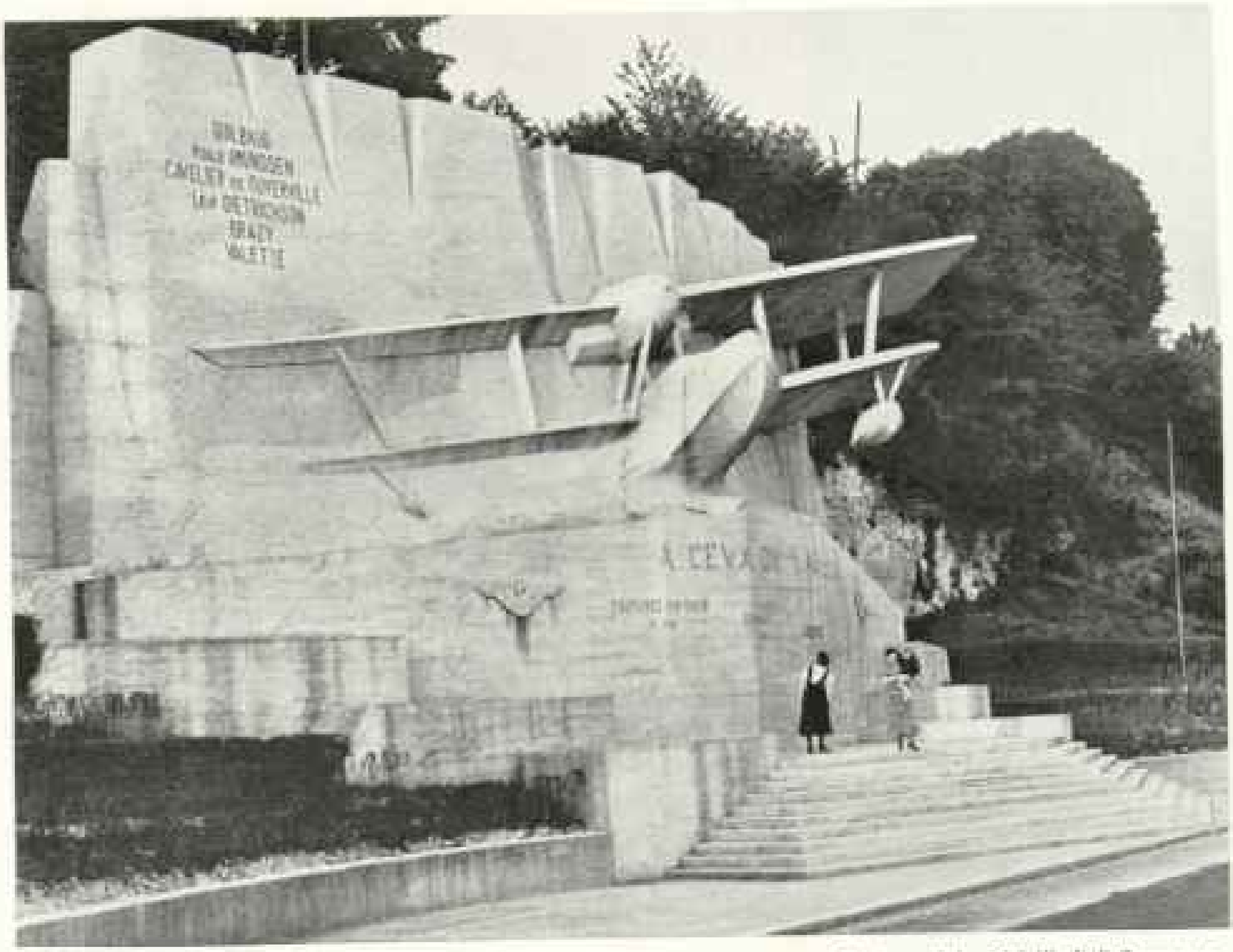
WILLIAM THE CONQUEROR INN IS IN THE TOWN WHICH SAW THE NORMANS SAIL

Dives-sur-Mer was an important port in 1066, but now the advancing shore line has left it more than a mile from the sea. The inn was erected some 500 years after the Conqueror's time.

Photograph by F. S. Lincoln

MAN, GIRL, AND DOG SIT BACK AND LET THE DONKEY DO THE WORK

For plowing and other farm work, Normans use big Percherons.



Photograph by Melville Bell Grosvenor

FLYING OUT OF A CLOUD BANK OF CONCRETE, THIS SEAPLANE HONORS AMUNDSEN AND HIS COMRADES

From the Seine River at Caudebec-en-Caux, where the huge memorial stands, Commandant Guilbaud and a crew of three took off in 1928 to rescue Nobile and the men of the dirigible *Italia*, stranded on the Arctic ice. At Bergen they picked up Amundsen and Lieutenant Dietrichson. Proceeding northward from Tromsö, the discoverer of the South Pole and his five companions met disaster and were never heard from again; but Nobile and many of his crew were saved by others.

public place where women gathered to wash their linen. Among the women was a young girl of such distinguished beauty that the youth loved her on sight and sent for her to come to the castle. Arlette was her pretty name.

Thus the parents of William the Conqueror came together. It was years before they were married, and then it was not to each other. Arlette had two other sons, half-brothers to William, who were concerned in his fortunes, but Robert had no other known child. Even today the village women of Falaise wash their clothes in that same ancient fountain and talk of Arlette and her phenomenal son, but not when any English are around, lest their feelings be hurt at mention of their Conqueror.

The window through which Robert looked first on Arlette still stands in the old castle and one is shown the room occupied by Arlette, but skeptics quarrel with these details.

Still hungry for lore of the Conqueror, one drifts to Dives-sur-Mer, where William assembled his fleet of some 700 ships, large and small, and his "innumerable host" of slingers, archers, and other warriors. An appalling task it was to transport them.

The town centers around its 16-century be-tiled, be-flowered, be-gabled inn named for the Conqueror. Here in his day probably stood no more than a rude shelter where captains gathered for the great adventure of conquest.

TOWN NO LONGER ON SEACOAST

Madame de Sévigné, letter-writer, stayed at the inn for some time in the sixteen hundreds, but it fell into decay through the centuries. It was restored and put into commission again by a wise innkeeper

Photograph by Maynard Owen Williams

THE SINGLE HAND OF ROUEN'S BIG CLOCK HAS POINTED THE TIME FOR MORE THAN 400 YEARS

Thanks to repairs, the clock still keeps as good time now as when men in armor tramped through the narrow street. Above its sculptured dial rises a tower with three slender ornaments, the central one bearing Rouen's coat of arms. At the curb, a hotel bus brings travelers to their lodgings. In this ancient Norman capital Joan of Arc was burned at the stake (page 665).

who fitted it with furniture ancient and appropriate, and now it is a show place for travelers. The Dives-sur-Mer of William the Conqueror was on the sea, which is now withdrawn a mile away.

No one had told me about Caen before I first stumbled on it in journeying from Dinard to Le Havre to take a transatlantic liner (page 631). It is well to come upon it that way, with no preconceived idea. You then experience the wonder and delight of such a discoverer as Columbus, for example.

And here William the Conqueror reigns supreme, not as a conqueror, but as a man in private life.

Photograph by Emil P. Albrecht

SPIRES OF THE CONQUEROR'S CHURCH PIERCE THE SKY ABOVE CAEN

He married his cousin, Matilda, and they had a lovely daughter, Cecilia, with whom acquaintance is made in Caen.

The busy street of Caen, where shops and hotels collect the Norman population, takes the eye and mind. A fair-haired child, a woman who looks at you from clear blue eyes, the clean sapphire spark in a young lad's glance—these flashes remind you that Caen is, after all, not ordinary; it is Norman.

CHURCH BUILT BY THE CONQUEROR

Then all at once against the sky, above the city buildings, amazing spires rear themselves, and demand your presence at their feet at once. Through a maze of streets you come upon the great Norman Abbey of St. Etienne, also called Abbaye aux Hommes.

This is the building which William the Norman gave to the Church. And it is here that your heart beats fast because you are in the presence of a church so different from the ornamented Gothic of France and England that it is like a stranger. It speaks of strength, of severity, of life in Normandy when Norsemen struggled into a higher civilization than they had known in their own cold climate. It speaks of spiritual conquest as well. I was glad to be alone that I might feel the spirit of the Abbey.

On the opposite side of the town, Matilda built La Trinité, known also as the Abbaye aux Dames.

Photograph by F. S. Lincoln

GRIMLY HEROIC IS LE HAVRE'S MEMORIAL TO ITS WAR DEAD

The stone figures seem to embody the watchword "They shall not pass!" Le Havre was an important base for American troops during and after the World War, and many ex-doughboys doubtless recall the curious lampposts, decorated with flower pots brimming over with blossoms. In a hotel here the Belgian Government was housed after the fall of Antwerp. Behind the memorial bristle the masts and funnels of ships (page 631).

These are the two abbeys that distinguish Caen from all other towns in Normandy. Each includes several buildings, some newer than the Conqueror's time.

Cecilia, the oldest daughter of William and Matilda, was made abbess of La Trinité, and the abbess of a large monastery in those days held a position so important as to be an honor to the daughter of a king.

William and Matilda were both buried in their respective abbeys, but later centuries disturbed them. Their tombs were broken open during wars and disturbances.

BY BOAT THROUGH WIDE LAWNS

Caen is not all in the past. It has a lively commerce with Le Havre through an entrancing canal to Ouistreham (p. 629).

The boat is a small affair that runs with an engine and takes passengers bound for the seaside joys of Cabourg and even the twin resorts of Trouville and Deauville. You wonder timidly if it is really safe for the crossing in the sea to distant Le Havre. Ouistreham, the coast stop, is the port used by the English in the 14th and 15th centuries when they shipped home the loot collected after successful raids on Caen.

A magnificent pig delayed the little boat's start. He was actually dignified, almost elegant, in his fresh pinkness. He was booked as a passenger, but when his white-lashed eyes looked upon the vessel and its uncertain gangplank he became sure that he preferred the land.

Ten minutes of driving by skilled farmers failed to accomplish his embarking. His

ponderous dignity suffered when he was lifted into the air by ropes and derrick and the crowd laughed in the delight man always feels for a pig's predicaments. The porker swung high. A rope broke. He fell heavily into the water and swam madly away.

Sometimes in one's dreams a boat travels serenely over green lands. That is how the boat of the canal seems to go, for on both sides are fair lawns, wide as a park and as well kept, flanked with tall, tall poplars. People sit on benches along the way and children gambol with dogs; you might be in the Park of Versailles, but you are really a traveler on a definite journey. More travelers from overseas should know of the Caen canal.

HISTORY RECORDED IN EMBROIDERY

The Bayeux Tapestry, as a certain historic embroidery is called, beckons one to leave Caen for a day before taking the canal. It is one of those relics of the past of which everyone knows the name and which everyone not in mad haste of travel would like to see, for in this Normandy of William it is an important "human document."

Two hundred and thirty feet long, this remarkable piece of needlework depicts numerous scenes in the Norman Conquest. Particularly interesting to travelers who have visited Mont St. Michel is one which shows heavily armed Normans being pulled from the quicksands where the Couesnon runs into the sandy flats surrounding the Mount.

The tapestry-embroidery lies in a double glass case in the old Bishop's Palace, now the town Library, at Bayeux (page 628). But alas, they tell us we must doubt that Queen Matilda wrought it all herself with her needle as a tribute to William's power of conquest.

The quiet little town seems half asleep around its Cathedral, and short strolls lead to its straggling borders. A man outside a shop of negligible interest suddenly stepped forward and threw before me on the sidewalk a tapestry of splendid color, undulating in the sun.

"Very low price, Madame." He did not argue, nor persuade, merely repeated "Very low price," rippling the colorful square. And verily it was a low price. I took it, for what more fitting end to a day with the Bayeux Tapestry than to become possessed of a tapestry of one's own?

"Ah, these Americans," I heard the shabby shopman say in a voice of joy to his visiting neighbor. He was a true gentleman, attributing the sale to my fine qualities instead of to his own skill as a salesman.

That tapestry now hangs in one of New York's big hotels, but of all the people who lounge before it and enjoy its Renaissance beauty, I am the only one who sees in it the little town of Bayeux and that famous embroidered record of William's conquest.

SHRINES WHERE TWO SAINTS DIED

Lisieux, too, belongs to Normandy, though it is far to the east.

A chauffeur drove me there, a jaunty, cocksure man of Michigan who had married a French girl and stayed in France after the war. He pulled the car to the curb in the big square and said, "There you are. This is the home town of St. Theresa, the Little Flower."

To the Carmelite convent in Lisieux came youthful Thérèse Martin in 1888, and here, nine years later, she died in her early twenties. In 1925, only 28 years after her death, the young nun lovingly known as the Little Flower was canonized for her holiness as manifested in the miracles ascribed to her intercession.

Rouen is a shrine, not alone for France but for the whole world. Joan of Arc, and her sacrifice here, make of it a sacred city. Visitors crowd it, and over them all is a spirit of awe, unexpected perhaps when they first enter the ancient city so full of architectural treasures (page 662).

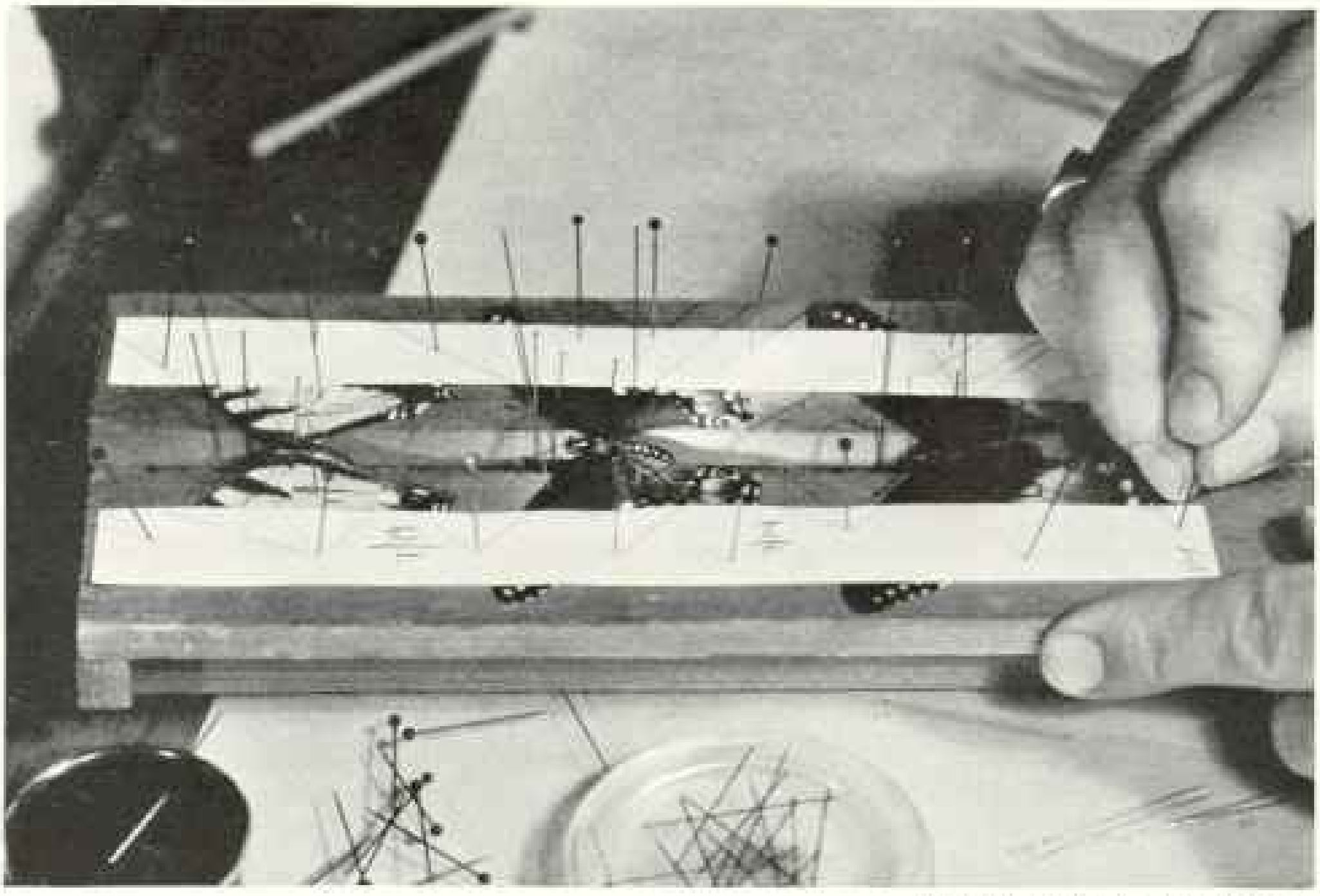
The towers, the churches, would seem to be the reason for stopping there, but whenever one goes wandering about these Gothic temples, the feet inevitably stray to the old marketplace where the young girl gave up her life. Over and over again one returns. It is not now a pretty place—the other sights of Rouen far surpass it—but there one becomes deeply conscious of the spirit of the Maid, of her work, her simple faith, and her love for God.

The real heart of Normandy is here, for this was its early capital. But to me the abiding symbol of this land and all that is enduring in its eventful past is that phenomenal Rock, with its hoary buildings, rising above the tide-washed flats like a granite monument. Once seen it can never be forgotten, and now, in retrospect, the vision of the Rock comes back to me—most vivid of all my Norman memories.

Photograph from Laurence Ilsley Hewes

LIKE A RIFLEMAN, HE DRAWS A BEAD ON THE TARGET

Firmly grasping the end of the net, the author exerts a strong downward pressure on the handle, so that when the end is released, the net will snap down over the butterfly. One must be stout of wind to go hunting on a steep slope like this, on San Francisco Mountain in Arizona.



Photograph by Paul Griswold Howes

PAPER STRIPS, FIRMLY PINNED, HOLD THE WINGS SPREAD OUT TO DRY

The insects' bodies fit in a groove between the boards so that the wings lie flat. On one strip is marked the date of mounting. After a week or ten days, pins and paper are removed and the finished mounts placed in cases. Sometimes specimens become rigid before there is time to mount them and must be moistened to make them pliable for shaping.

BUTTERFLIES—TRY AND GET THEM

By Laurence Ilsley Hewes

ABOUT seven hundred distinct species of butterflies flit over the American Continent north of Mexico. An hour or a lifetime may be spent in absorbing pursuit. But try and capture all of them! No collector has ever achieved that feat. That is one of the fascinations of butterfly collecting—an ever-extending hunt for your last few scarce ones.*

Make no mistake about the real butterfly collector. His is no lily-fingered pastime. He is distinctly not the crazy crank of the cartoonist. My acquaintance among collectors of Lepidoptera numbers a policeman, an ex-prizefighter, a man who climbs telephone poles, a jewelry designer, physicians, bankers, and engineers. To all of them butterfly collecting is recreation, exercise, and an enduring cultural interest.

They must get their specimens outdoors, in sunlight. Their hobby involves a study of climate, geography, and botany. It requires hiking that will test the endurance of the hardy, or patient waiting that will reward the invalid.

It carries men to the northlands, to wind-swept peaks of the Sierra Nevada, and to the Everglades of Florida. I saw one wade an Idaho mountain stream to capture a female of the Leto Dryad, a lovely mountain silver-spot. You learn of specimens found only on the hot Mojave Desert, of others that fly only on the peaks of the Colorado Rockies.

No, if you are really after butterflies, you can smile at the "he-man stuff" of the trout fisherman or the hunter!

FIFTY YEARS A COLLECTOR

On a winter's day in Omaha, a veteran butterfly collector, R. A. Leussler, showed me his own thousands of accurately labeled, perfect specimens. For an hour he pulled out drawer after drawer of his fascinating exhibit. His were faultlessly pinned, unblemished insects, beautifully arranged. He had complete series of many varieties and nearly five hundred distinct species.

"It's the last third that evades the net," said he.

Train time cut short the show. "You have done a splendid job," I said. "How long have you been collecting?"

His ruddy face beamed. "Fifty years. I began as a boy."

How often that is the case! As boys they begin collecting butterflies. As men, some very few go on. There are a few persistent, systematic ones who get to know their field and become really advanced collectors.

My friend closed his steel, pest-proof cabinet, and we walked to the station. He spoke of exchanging specimens with correspondents from Florida to Alaska. He told anecdotes of great collectors. When, at parting, I evidenced humility at my own desultory efforts through scattered years, he smiled.

"Collect just as you please," said he. "It will tire you sometimes, but never let it bore you; then you will always come back to your collecting. I envy you a trip to California; there are two hundred and fifty varieties there."

COLLECTING CAN BEGIN ANYWHERE

You can begin collecting butterflies anywhere you live, right in your own back yard. There are species of great beauty everywhere. The outfit of delicate bagnet and collection box is simple, the costs trifling, and the adventure endless. Nowadays the automobile is a great help.

For certain species you must arrive at the distant locality at exactly the right season.

On Mount Washington, New Hampshire, for example, is an isolated colony of elusive far northern butterflies that may have followed the retreating ice cap. They are dusky, with fine granitelike markings underneath, and are known as *Œneis melissa semidea*. These are indeed a fine catch, for in New England they are found only on Mount Washington and on a few adjacent peaks. You capture them during brief periods of sunshine up there among the rocks.

There are two quite different species of *Eneis* in Maine, one of which has also been caught in Michigan. Others live in the Far North, around Hudson Bay, and in our western ranges. In the National Museum there is the original or type specimen of *Eneis polixenes subkyalina*, brought home from the far north by Captain Sir John

* See "Strange Habits of Familiar Moths and Butterflies," by William Joseph Showalter, with illustrations of 143 species in their natural colors, National Geographic Magazine, July, 1927.

Photograph from John L. Sperry

A WOMAN COLLECTOR SPIES THE PREY

Frozen in her tracks, she grips the end of the net in her left hand to keep the opening wide. A moment later there will be a quick swoop—and if she is skilful, a specimen of *Erebia magdalena* will be safely inside her net. This insect suns itself on rocks on snow-mottled Longs Peak, Colorado, and on some other western mountains (page 672).

Ross in 1825. I have seen specimens of *Erebia rossi*, a small dark butterfly, from the bleak lands washed by the Arctic Ocean.

In March, in Santa Cruz County, California, we went afield with a gentleman past seventy. We were after the Veined White (*Ascia napi venosa*), that earliest fragile white butterfly with the sooty veins. It emerges early in a few special canyons along the Pacific coast. Four of us took more than eighty specimens, male and female, but the number included only three of the rare lemon-yellow form of the female.

Why so many? Because into the well-built collection should go finally a series of perfect specimens to be culled from the catch. Because, also, *venosa* is good for exchanging; it is lacking in many smaller collections because it is so extremely local. The odd fact is that the second brood of these butterflies in May and June has an entirely different color. It is whiter, with the veins almost erased, and is a variety called *Pieris napi castoria*.

And now the secret about the seven hundred species is out. That, it is true, is the number of distinct species in North America. But many of these have geographical races, seasonal forms, varieties, subvarieties, and more or less striking aberrations which altogether run the numbers into many more hundreds. *Pieris napi venosa* and *P. n. castoria* are only seasonal forms of the same butterfly. They belong to the large group or genus called *Pieris*, which also includes the abundant Cabbage Butterfly, of which you have seen thousands.

One finds that butterfly collecting has its anecdotes, its human side, its gossip, and its scandals. In California there is the Lorquin Society, named for a Frenchman who came in '49 with the gold rush. He collected several new species and sent them to France.

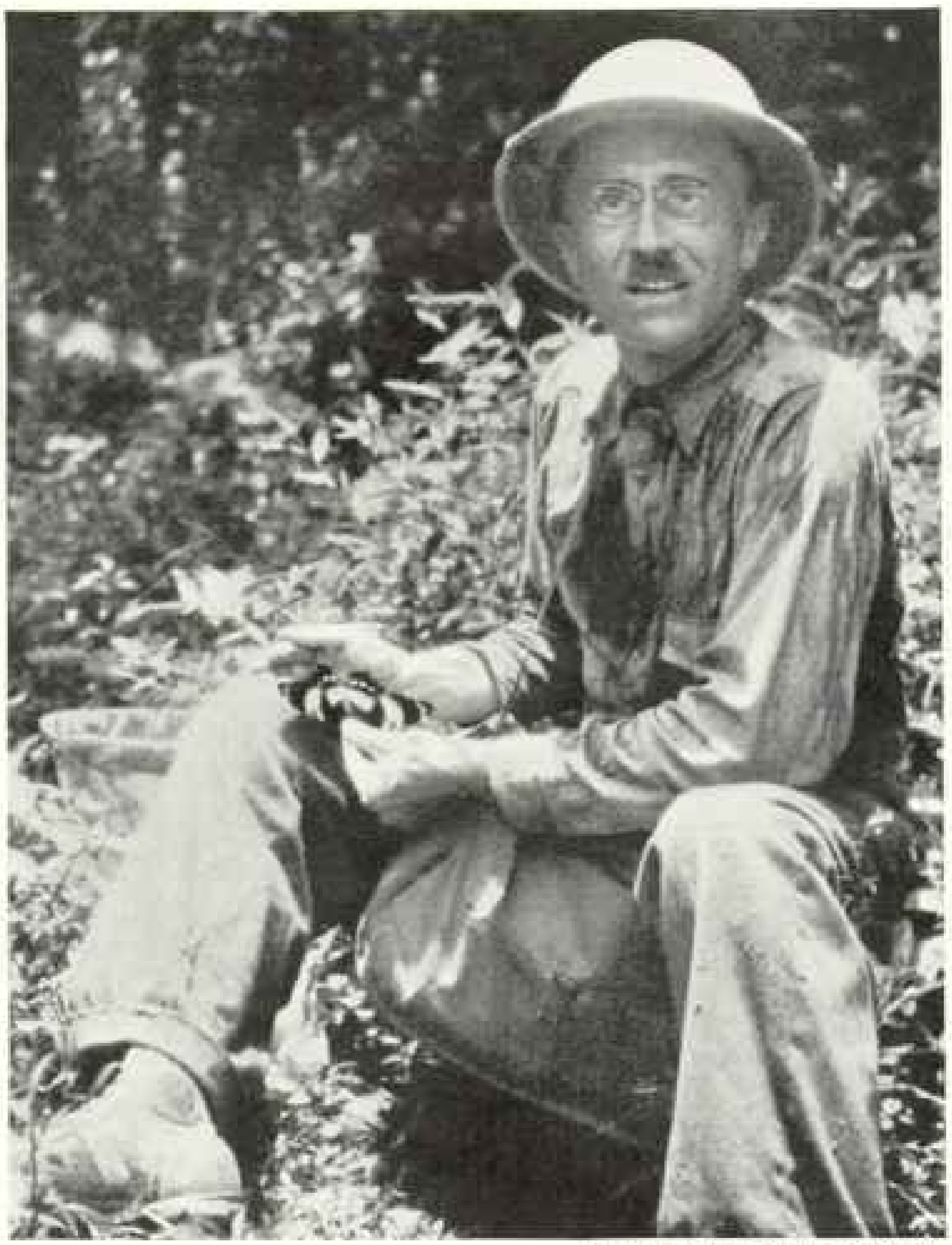
There Dr. J. A. Boisduval, then an outstanding lepidopterist, named and described them in entomological journals. Miner Lorquin's name, however, is attached in his honor to a beautiful black-brown butterfly, with bands of white and with yellow-tipped wings. It is Lorquin's Admiral (*Basilarchia lorquini*), found all up and down the Pacific coast region and in the far northwest.

Collectors in San Francisco tell you that in the great fire following the earthquake of 1906 several valuable collections were destroyed, among them the Wright collection of butterflies of the Pacific coast.

There is also a story, which cannot quite be verified, that the fire destroyed one of the two then existing specimens of the butterfly known as the American Yellow Parnassian. It is said that Wright had lent the other to William Henry Edwards, the great collector of his day. Those two specimens, perhaps descendants of Siberian ancestors, came from Alaska.

At San Francisco there once flew over the sand dunes near the sea, perhaps, a butterfly originally described by Boisduval and now called *Cercyonis sthenele*—one of the satyrs, grayish brown, small, inconspicuous. This butterfly is now apparently extinct. For years collectors have sought it in vain. Some deny that it was found in the sand hills and look elsewhere.

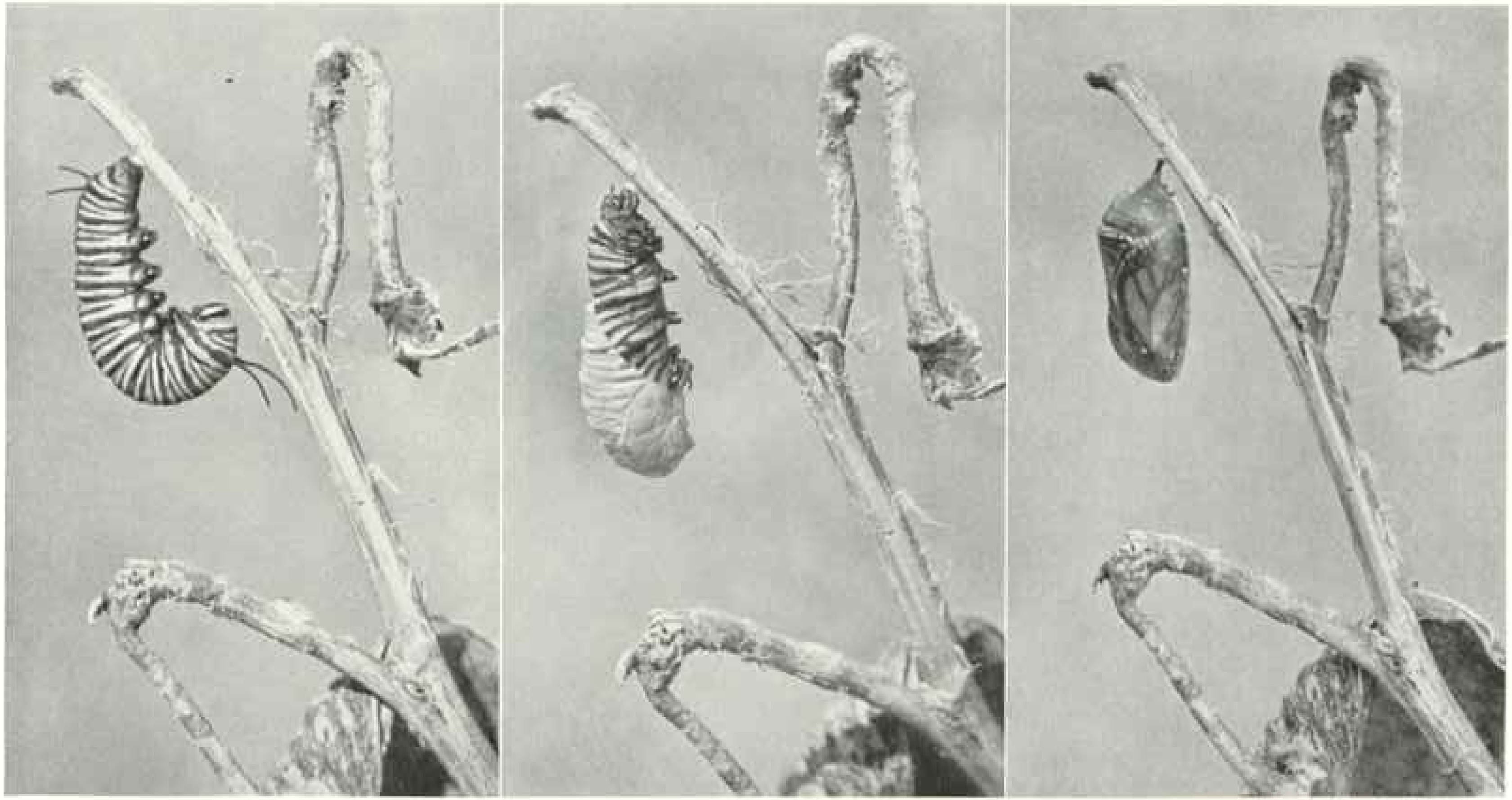
They are encouraged by the reappearance, after thirty-five years, of the once believed extinct *Glaucopsyche xerces*, a small blue butterfly that reappeared a few years ago in the San Francisco Presidio. I have taken numbers of this little butterfly, once rated as almost priceless. Because of new Federal buildings, this San Francisco "locality" now covers less than ten acres!



Photograph from Carnegie Museum

TRIUMPHANT AND A BIT DAZED BY THE GOOD LUCK

The captor is Dr. Andrey Avinoff, Director of the Carnegie Museum, Pittsburgh. His prize is the renowned *Papilio homerus* of Jamaica, largest swallowtail of the Western Hemisphere. This butterfly has a wingspread of nearly seven inches, and is extremely hard to net because, unlike many other species, it soars high up out of the reach of anything but the longest nets. With thumb and forefinger, the collector holds the coveted insect by its thorax so as not to injure the brightly colored wings.



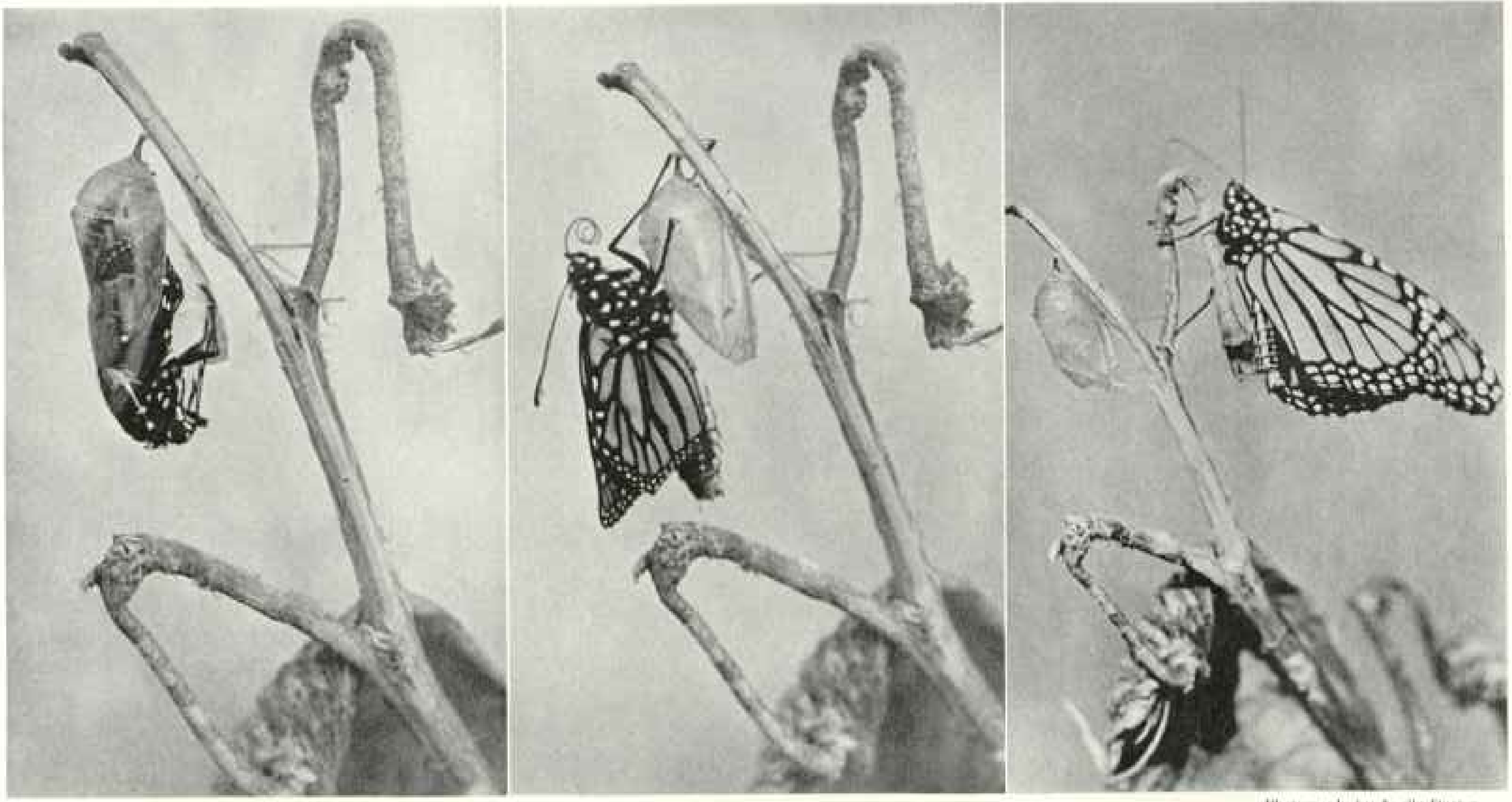
Photographs by Amelia Dexter

A HOUDINI OF THE INSECT WORLD WRIGGLES OUT OF ITS SKIN IN CHANGING FROM CATERPILLAR TO CHRYSALIS

Several times the caterpillar has shed its skin and grown a new one to accommodate its ever-increasing bulk. Now, full grown (left), it prepares to cast off for the last time the handsome striped suit of yellow, white, and black. With the silk-spinning organ under the mouth, it made a little button, or mat, of silk on the twig. To this the caterpillar hooks the hind pair of prolegs, or claspers, and there it hangs helpless and almost motionless for about 24 hours. Gradually the yellow and white stripes become greenish and the "horns" grow limp, as though the larva were dying.

Suddenly the skin splits up the back and wrinkles upward, carrying headskin and prolegs with it (center). After a series of struggles and contortions, somewhat like those of a man escaping from a strait-jacket, the soft yellow-green chrysalis, or pupa, emerges and tosses the useless skin aside.

The chrysalis (right) resembles neither the caterpillar it once was nor the Monarch, or Milkweed Butterfly, it will eventually become. At first it is soft, elongated, and irregular. Gradually the abdomen contracts and the covering becomes jade-green, studded with tiny dots that look like golden nails. Inside, the immature butterfly lies concealed for about ten days. Then the spots and stripes on its tightly folded wings become visible through the thin skin of the chrysalis.



Photographs by Amelia Dexter

IN THIS "STRIP" A BEDRAGGLED MONARCH EMERGES, PUMPS BLOOD INTO ITS LIMP WINGS, THEN ENJOYS A WELL-DESERVED REST

All at once the covering of the chrysalis (left) splits and the edges fold backward like the flaps of a tent. Headfirst, the butterfly slowly pushes its way out. Bracing its feet on the Cellophanelike case, it struggles until the wings and fat abdomen are free. Weak and soft, it crawls to some suitable support and clings there.

Though full size, the new-born butterfly is all out of shape (center), with small crumpled wings and distended abdomen. Changes occur swiftly. Blood is pumped from the body into the wings, which expand as the body shrinks. Not until the wings have reached their full proportions does this flow of body fluid cease. The butterfly coils and uncoils its long tongue in an effort to fasten together the two parts, which, when joined, make a long tube for sucking nectar.

Fifteen minutes after "birth," the Monarch becomes more comfortable (right). Its tongue is neatly coiled and the body has grown short and slender. The expanded wings, hung out to dry, grow firmer and stronger as the air hardens their chitinous coat. The insect is bright and gay, and will grow no larger (page 690).

Some years ago, hoping to insure the survival of the little colony, collectors released living specimens on the present site of the campus of the University of San Francisco, then an isolated hill of virgin vegetation. Now that colony, too, is crowded out. But in the summer of 1934 specimens were taken in vacant lots within the city limits near the ocean.

TRACKING DOWN ELUSIVE SPECIES

To butterfly collectors this word "locality" is indeed a magic word. Although certain species, like the Monarch, or Milkweed Butterfly, are found practically everywhere, others are greatly restricted in range; so collectors keep a minute record of worthwhile "localities."

I was once directed by those faithful collectors, the Sperrys of Riverside, California, to the very pair of bars leading into a field in Rancho Santa Fe where flew in March the so-called *Euphydryas quino*, a rather disputed checker-spot. There only could I complete a series of this precious insect.

If you want *Colias pelidne skinneri*, rather rare in collections, you must go to the north shore of Grebe Lake in Yellowstone National Park in July. The females are normally white, but there also is found an occasional yellow female, *neri*.

Among the bare rocks high up in the Colorado Rockies, and particularly on Longs Peak in Rocky Mountain National Park, flies the rare *Erebia magdalena*, a blackish-brown butterfly that is most elusive. Recently it was located by Ashby Boyle of Salt Lake City at about 10,000 feet altitude near the summit of Bald Mountain in the Uinta Mountains.

Here and on the vast fields of slide rock on neighboring peaks numbers of specimens have been taken, but only with the greatest difficulty and considerable hazard. A 10-foot net handle proved to be a great advantage. The prize disappears in deep crevices between large granite blocks and must be stalked painfully, as running across the huge rocks is impossible.

Some of the enthusiastic butterfly people around Los Angeles journey hundreds of miles into the desert for certain spring specimens. There is a lovely orange-tip in Arizona that often evades pursuit, for spring in the desert is brief and beautiful and the days of insect flight are short. An unlooked-for rainy period may delay the catch a year.

Smaller butterflies that fly only for a few days in remote localities may elude the net for several seasons. On two occasions near Tucson, Arizona, I hunted in vain for the lovely orange-tip *Anthocharis pima*. Finally I discovered that apparently it does not fly until 10 o'clock, even on the warm hills among the saguaro cactus. And yet the female of the precious admiral *Basilarchia obsoleta* that flies in the hot lands of the lower Colorado River, at Blythe, California, may disappear completely before 11 o'clock!

PRIZES TURN UP IN ONE'S OWN YARD

But it isn't the distant or difficult locality alone that brings the exciting adventure. Right in his dooryard my Omaha friend has collected stray Texas species. Near Tygh Valley, in Oregon, while the automobile was stalled, I collected in a gravel pit by the highway some checker-spots—small black, white, and red butterflies—that were described by Leussler as representing a new species, *Melitaea hewesi*.

That is one of the fascinations of butterfly collecting—the unexpected. But you always need a net, a cyanide collecting bottle or box, and the sun. You almost never fail to add specimens to your growing collections. It's a mistake to look for rarities; one collects what is flying. The rarities turn up.

An eastern friend admitted he would never forget his first catch of that short-tailed swallowtail called *Papilio indra*. It was in Yosemite Valley, before breakfast. He was led a chase all over the meadow opposite Camp Curry, jumping brooks and crossing bogs, but to him *Papilio indra* was worth it. It flies briefly in Mount Rainier National Park and near Great Salt Lake. Some day my friend hopes to add that other race of the same butterfly discovered by Mr. Henry Edwards in the San Bernardino Mountains—*pergamus*. Edwards called it.

Wherever a collector collects, there is sport. He can make it as strenuous or as gentle as he likes. For a beginner, like a banker who recently started, it may take a season or two to get good specimens of the common butterflies of his own neighborhood; but in most vicinities it will require many seasons to gather all the varieties and forms.

An observant collector in New England will find in his garden patch "coppers" that the Pacific coast man can get only by exchange. Behind his house, in the warm

 Painting by Hashime Murayama

GAUDY SWALLOWTAILS DON'T ALWAYS WEAR FULL DRESS "WITH TAILS"

Many a boy has started his collection by netting one of these common butterflies. Often swarming in veritable yellow clouds, Tiger Swallowtails are found from Alaska to Newfoundland, and southward, east of the Rockies, to Florida and Texas. The striped Zebra Swallowtail (right), of eastern range, likes to flutter near the ground. Sipping nectar from the topmost lilac blossom is a Tailless Blue Swallowtail, found in Mexico and occasionally across the U. S. border. This specimen, captured near Washington, D. C., is the only one reported from the eastern United States.

sun after a rain, a dozen species will flit over the hedge. On the lilacs, the zinnias, and the phlox of the eastern gardens feed gorgeous butterflies.

TALES OF THE BUTTERFLY HUNT

"You get this way over butterflies," said an architect friend. "They come to mean country and flowers and weathers and altitudes. Soon you are a bit of a botanist; you know the snow-line plants of the mountains, wild buckwheat, and the vegetation of the summit; the march of the seasons in far-spread latitudes. As a field sport, butterfly hunting can be more exciting than angling."

"Yes," said his companion, "I have fished in the Yaak River in Montana, and have caught big trout in Clear Lake, Oregon, and huge pike in the St. Lawrence; but the recollection dims beside the sport of certain rare days with a net at the right time and place.

"Once it was at Corpus Christi, after a rain," he continued. "There were swarms of species almost within the city limits. The Texas mesquite was alive with the giant swallowtail *Papilio cresphontes*.

"In the mountains of southwest Virginia I once took in one sweep of the net ten lovely specimens of the eastern Tiger Swallowtail *Papilio glaucus* (see Color Plate I). There were dozens crowding about something in the road that proved to be stranded toad's eggs, slightly fermented. More memorable yet is an afternoon in Jackson Hole, Wyoming, when mountain meadows were distracting with butterflies. There I took the rare checker-spot called *Euphydryas gillettii*, and Weidemeyer's Admiral, for which I'd waited years.

"But if you are a real hunter," he went on, "try for *Papilio bairdii oregonia*, another swallowtail. You find him along the middle Columbia River. Here is game for the skeptical, this brilliant yellow and black *Papilio*. He is rather scarce. But in a certain canyon, year after year, in the arid summer heat, he may be taken in late June.

"Imagine a gorge with the west wall a sand chute covered with black rock float. The temperature in the shade of a willow in the bottom may be above 100°. The east wall is terraced basalt. Quietly you move along among the blistering rocks with the white-sand skyline six hundred feet above.

"*Oregonia* is a crisp, sharply marked denizen of the arid wind. He is utterly devoid of leisure; his flight is bold and rapid. The canyon thistles invite him. Far down the steep slope, near the thread of the drying streamlet, grow these scattered blooms that are his undoing. Over the sharp sand edge above drops suddenly this brilliant raider.

"Abruptly he sweeps upward, pauses, and drops back. Around and across he flashes his quick reconnaissance, then for a few seconds he hovers, nervously pulsating splendid wings over the cloying sweet.

"You must be alert or he is gone. Choose a high position so you may dart downward. The up-climb in the loose sand will quickly exhaust you in this heat. For a moment the insect is utterly oblivious. If your movement is swift and careful, he is in your net!"

RAISING BUTTERFLIES FROM THE EGG

And yet a more scientific way to secure this *Papilio bairdii oregonia*, and other species, is to raise the butterfly from the caterpillar. There is a German hermit looking for these caterpillars as he tends his goats along the rocky margins of the mid-Columbia. He knows that the female places her eggs on the tall Artemisia, one of the wormwoods belonging to the aster family. The banded caterpillar, or larva, reaches full size in September, as do the larvae of many of the larger butterflies. The next stage is the yellowish ashy chrysalis, which over-winters.

The food plant of the caterpillar is often the key to locality. Only on their particular plant or plants will butterfly larvae usually feed; they will often die rather than eat substitutes. If, for example, you would find the eastern checker-spot *Euphydryas phaëton*, you must go to moist places and locate the balmony, or turtlehead, plants, for seldom do the caterpillars of this butterfly feed on other plants, except in the spring after they have come from hibernation.

Collectors exchange endless information about such things, and their published journals carry on the story in minute detail.

Commander Dammers, late of the British Navy, is patiently working out at Riverside, California, the hitherto unknown life histories of many butterflies by raising caterpillars from the egg.

In Washington one winter, from a careful collector I learned of strange cases of apparent "spot" distribution, of far-western forms in Massachusetts, and I have even heard of a Gulf of Mexico species once found on the Columbia River.

You are surprised also to learn that butterflies live a dangerous existence. From the time the egg is laid until the butterfly emerges from the chrysalis, there are insects constantly alert to destroy butterfly lives. Undue drought or late spring cold annihilates many species which emerge early. Birds take toll of larvae, and shrews and mice eat the adults.

DANCE IN THE SUN, THEN DIE

The lives of most butterflies are short—from a few days onward, as the vigor of the species increases. The longest-lived butterfly is the tortoise-shell of the North, *Aglais j-album*, which may live for a whole year. The life cycle includes the egg, the larva, or caterpillar, and the chrysalis, from which emerges the mature insect, or imago.

Many butterflies pass the winter in the chrysalis. The admirals (*Basilarchia*) winter as tiny caterpillars, each in a small stocking spun within a bit of leaf. They can survive the coldest weather, swinging above the snow with head exposed, and beyond doubt frozen stiff. You can collect these caterpillars in midwinter and raise perfect specimens by supplying food when spring comes. These same over-wintering larvae of the viceroy (*B. archippus*) are often found on low, isolated willows along New England roadsides.

There are people who raise butterflies for sale (page 692). In London there are firms that buy and sell butterflies from all over the world. Yet there is little commercialism. Some years ago a man sold quantities of the small green sulphur butterfly that swarmed near Tioga Pass, above Yosemite Valley. This butterfly, *Colias behrii*, is a rarity that flies only for a few days in any one locality. There is a legend that Indians killed this man!

Naturally, California has many different species and varieties because of her range of climate, of latitude, and altitude. The State has many collectors, too. Before the fire there was a notable group of them around San Francisco Bay. They were led by the late Dr. Hermann Behr, for whom are named several species and varieties, besides the green *Colias* of Tioga Pass.

A group of collectors still meets in San Francisco to discuss their hobby. The older men tell of the time when one could collect on bushy hills that are now Chinatown, of the early days of the San Francisco Academy, of the vanishing of the checker-spot *Euphydryas baroni* because of real estate development, and of places to hunt Behrens' Silver-spot in the north.

That same elusive silver-spot *Argynnis behrensii*, however, recently was discovered by a San Francisco collector who in two weeks took forty specimens. Of these not one was a female, doubtless because of the later emergence of females from the chrysalis.

There is constantly new interest in the study of butterflies. Have you heard that the larvae of some are carnivorous, that they eat aphids, or live in ants' nests eating their young (page 686); that the males of many butterflies, among ours especially the silver-spots, are fragrant; and that many species of butterflies migrate in swarms?

WHEN BUTTERFLIES MIGRATE

No collector can tell you much about butterfly migrations. They just occur. The best example, perhaps, is the yearly migration of the Monarch, or Milkweed Butterfly. He is found all over the United States and in southern Canada (see pages 670-671).

He goes south in the autumn, and in favorable seasons may go in swarms. He went so along the New England coast in the fall of 1899. The insects were in perfect condition and could be gathered with the fingers.

In 1926, the California Tortoise Butterfly swarmed on Mount Shasta. A new collector encountered it in twos and threes as he started to climb toward Alpine Lodge through the wild lilac (*Ceanothus*), on which the caterpillars of the swarming butterflies live.

That sunny day the tawny and black butterflies at first came straggling in threes and fives, then in dozens, till soon the air was vivid with their flight. Later they came down off the mountain in thousands, filling the air with their hard, sweeping flight. Armies of them, resting briefly in the sun, covered the sheer granite walls of a ravine, and then, at the 8,000-foot level near the August snow line, they disappeared.

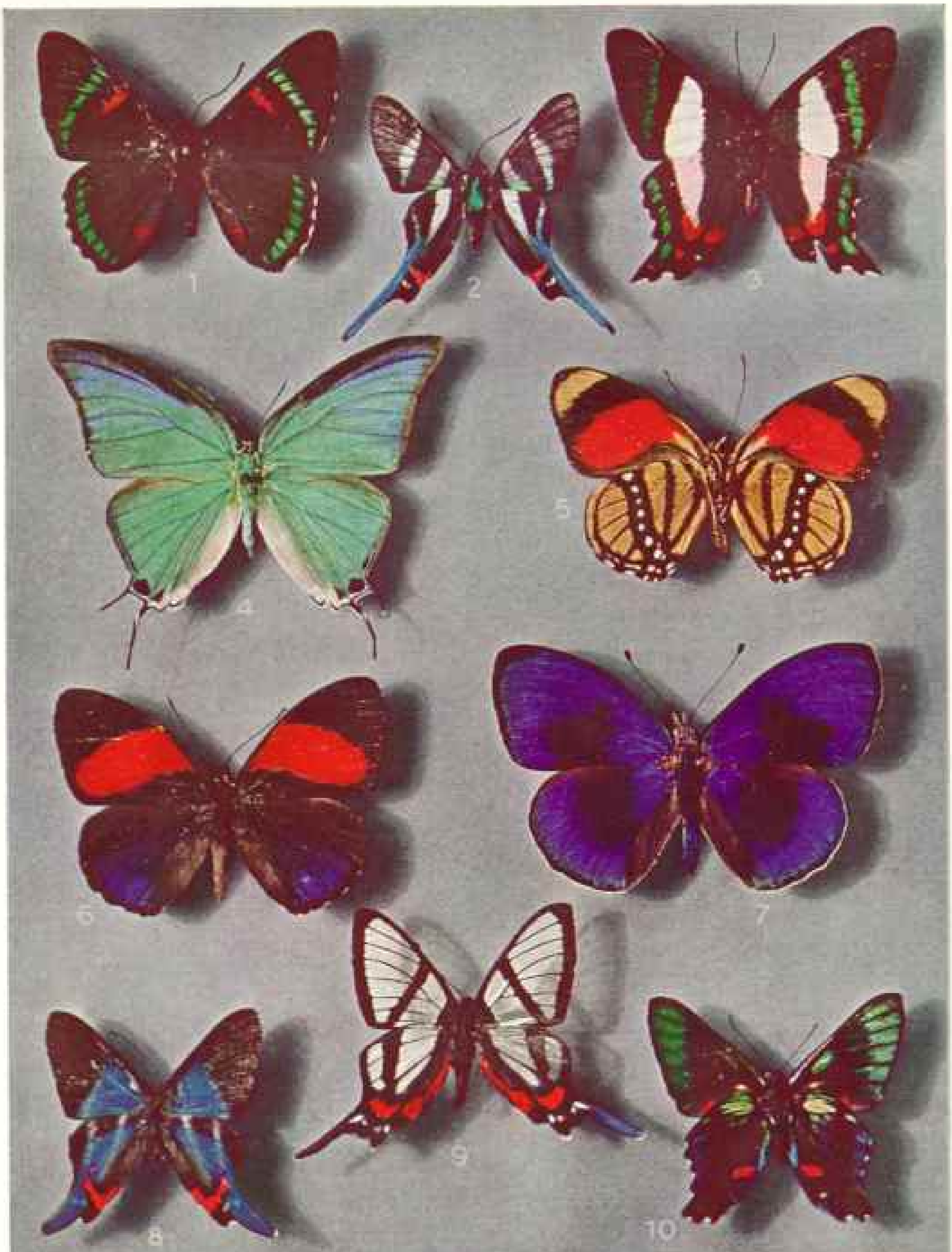
A swarm of the West Coast Lady Butterfly (*Vanessa cardui*) invaded Salt Lake City in 1924, flying north in myriads. Such swarms are a rare sight, but the butterflies are not rare.

The really rare American butterflies are subject to dispute. One old collector rated as his rarest specimen *Enodia portlandia*

 Natural Color Photograph by Willard R. Culver

BIG, LIVELY NYMPHALIDS ARE MEMBERS OF A WORLD-WIDE TRIBE

(1) *Callithea sapphira*, female, under side, Brazil; (2) same, upper side (see male, Plate III, fig. 7); (3) *Tharops menander*, northern South America; (4) Southern White Admiral, Virginia; (5) Leila's Gold-banded Skipper, Maryland (see Plate IV, fig. 4, and Plate VIII, lower); (6) *Agrias amydon boliviensis*, Bolivia; (7) *Catagramma cynosura*, Peru; (8) same, under side.



 Natural Color Photograph by Willard R. Culver

BRILLIANT LATIN AMERICANS FLASH THE COLORS OF THE TROPICS

(1) *Neoxeria duellona*, Ecuador; (2) *Diorina arvina knannus*, Peru; (3) *Ancyluris formosissima*, Colombia; (4) *Thecla marsyas damo*, Mexico; (5) *Catagramma cajetani*, under side, Peru; (6) same, upper side; (7) *Callithea sapphira*, male (see female, Plate II); (8) *Diorina dyonit pseas*, Mexico; (9) *Zeonia zylphina*, Peru; (10) *Ancyluris meliboeus*, under side, Peru (see Plate V)

andromacha, a spotted beauty found from New Jersey southward to Florida along the coast, and also in the Gulf States, but extremely local. A specimen of the supposedly extinct *Cercyonis sthenele* is, of course, very valuable (page 669).

For the scarce species one often must go far. Parts of Arizona offer the collector a paradise. In the Baboquivari Mountains the late collector, Poling, who for years worked close to the Mexican border, found the great white waxy-winged butterflies with the large lemon-yellow spots—*Amynthia clorinde*. He had intimate knowledge of locality, unfortunately now lost.

NOTABLE BUTTERFLY COLLECTIONS

When you motor through Tombstone, you will also see at the high school some of the work of the late Arizona collector, Biederman. There are his precious specimens of the very rare *Neophasia terlootii*, a black and white southern cousin of the more northern Pine White. The female of *N. terlootii*, however, is brick red! Many rare specimens in fine collections came from the nets of these two collectors in Arizona.

And there are notable collections. For many years that of the late Dr. William Barnes was housed in Decatur, Illinois, in a specially built concrete building, with devices for assuring correct temperature and air dryness (page 682). Here in vast array were hundreds of thousands of specimens of butterflies and moths that represented years of collecting by many of the doctor's agents.

This collection was purchased for $50,000 by the United States Government and moved to the National Museum in a special express car. Two skilled men worked two weeks in Decatur ramming home the three hundred thousand insect pins, so that no specimen should jar loose in transit!

In the Field Museum of Natural History, in Chicago, is one of the pioneer collections, that of the late Dr. Herman Strecker, originally purchased thirty years ago from his heirs for $20,000. Dr. Strecker began collecting as a boy in Pennsylvania.

The remarkable collection of the late Dr. Henry Skinner is in the Philadelphia Academy of Natural Sciences. In the Carnegie Museum at Pittsburgh are the collections of the late W. H. Edwards and Dr. W. J. Holland. Elsewhere are others scarcely less notable.

In the U. S. National Museum at Washington is now a reliable master collection from all over the world.

In the Natural History Museum at South Kensington, London, there is a world collection of butterflies, among which the Keeper of Entomology, Capt. N. D. Riley, pointed out nine specimens of the famed *Cercyonis sthenele* from California.

These collections of butterflies are of the utmost value to science for comparison of specimens and determination of species and forms.

Most collectors hope to discover some new butterfly. This event happens, but fortunately not as frequently as formerly, perhaps because so many slight variations already have been named. Specimens that have been "described" and named are called "types." Collections with many original types are correspondingly valuable. The original types of the supposedly extinct *Cercyonis sthenele* are in the National Museum.

GRAND CANYON RICH IN BUTTERFLIES

The Grand Canyon yields many varieties. Near the mouth of Bright Angel Creek, in the canyon's granite depths, flies the common *Papilio philenor*, the Blue, or Pipevine, Swallowtail, one of our iridescent-winged butterflies, blue and black. I have taken them in Virginia and Arkansas and a varietal form in the hot Sacramento Valley, where they feed on the wild Dutchman's pipe. There, in the caterpillar stage, they sometimes cross the highway in armies.

It may be that west of El Tovar, beyond the Kaibab National Forest, is some undiscovered new species for you or me. In late October, far down the canyon, are glorious jasmine blossoms and rare miniature grapes in a sea of vines. Near by is the delicate foliage of the tornilla mesquite and the luscious blood-red cactus fruit flourishing in semi-tropic sunshine.

Few white men have been beyond the last fall of Havasu Creek. What is there? Perhaps that wrinkled old Supai woman knows something about it. Perhaps her grandchildren will show me a new race of that gorgeous brown and white and crimson form of the California Sister, which flits among the rocks and dwarf oaks.

There must be the unusual in this mysterious Supai country, this land of contrasts of barrel cactus and apricot, of fig and pumpkin. There may be new species of butterflies there—try and get them!

WHO'S WHO AMONG THE BUTTERFLIES

By Austin H. Clark

United States National Museum

BUTTERFLIES seem carefree creatures, but they have a special duty to perform. That duty is to produce eggs and scatter them far and wide on the proper food plants so as to insure the largest possible crop of baby butterflies, or caterpillars. All their efforts, all their emotions—and they are many and diverse—have to do with the proper performance of this duty.

We are prone to think of butterflies as dainty ornaments of woods, fields, and gardens, where they flit about sipping nectar from the flowers.

But feeding is a minor occupation with them—in most cases more of a diversion than a necessity—and many do not feed at all, or at least do not feed on flowers. The caterpillar does the feeding, both for itself and for the butterfly into which it turns, leaving the latter free to devote itself to the perpetuation of the race.

BUTTERFLIES ARE JEALOUS

We look upon butterflies as the most harmless, as well as the most conspicuous and attractive, of all those very numerous creatures known as insects.

But, actually, many male butterflies are exceedingly jealous and aggressive. They fly viciously at each other and at insects or even small birds that cross their path.

Usually this belligerent spirit is aroused by intrusion into the domain—a strip of roadside, a section of a wooded road, or the vicinity of a particular branch of a tree or bush—that a certain male regards as his rightful property.

Some kinds have special dueling grounds to which they retire when in a fighting mood. And many "fight" wherever they may chance to meet.

Such a "fight," of course, is really a game of bluff, as butterflies are so delicate that they would quickly incapacitate themselves if they met in rough physical combat.

Among the less belligerent kinds pressure of population frequently is relieved by migratory flights often including many millions of individuals.

The most famous of the migrants is the common Monarch, or Milkweed Butterfly (*Danais plexippus*). In the late summer it is often seen in enormous flocks, including both sexes equally, sometimes "millions filling the air for several hours to a height of 300 to 400 feet," or in "great swarms thick enough to cast a shadow" from 40 to 200 feet up (see pp. 670-671).

These flocks usually fly in a southerly direction, and there is no real evidence that the butterflies ever return. This insect many times has been reported from Europe. It has been seen at sea 60 miles off Cape St. Vincent, Portugal, and many individuals have been caught in England.

Migrations, more or less spectacular, are regularly, frequently, or occasionally undertaken by a considerable number of different kinds of butterflies, including several of the common ones. These migrations, and the other curious habits of these insects, have received relatively little study, and we yet have much to learn about them.

Butterflies represent only a small section of the scaly-winged insects, or Lepidoptera, which include five times as many moths. Nature does not distinguish butterflies from moths; indeed the skippers, usually placed among the butterflies, might just as well be considered moths.

Most butterflies are attractively colored and fly in the bright sunlight, and most moths are dull and fly by night. Consequently, we have a friendly feeling for the former and like to believe that they differ from the latter much more than they really do.

Butterflies fall naturally into six different groups, in each of which the eggs, caterpillars, and pupae have their own special features, just as do the adult butterflies. Representatives of all these groups, and of many of the subgroups into which they are divided, are shown in the accompanying Color Plates (see also text, page 692).

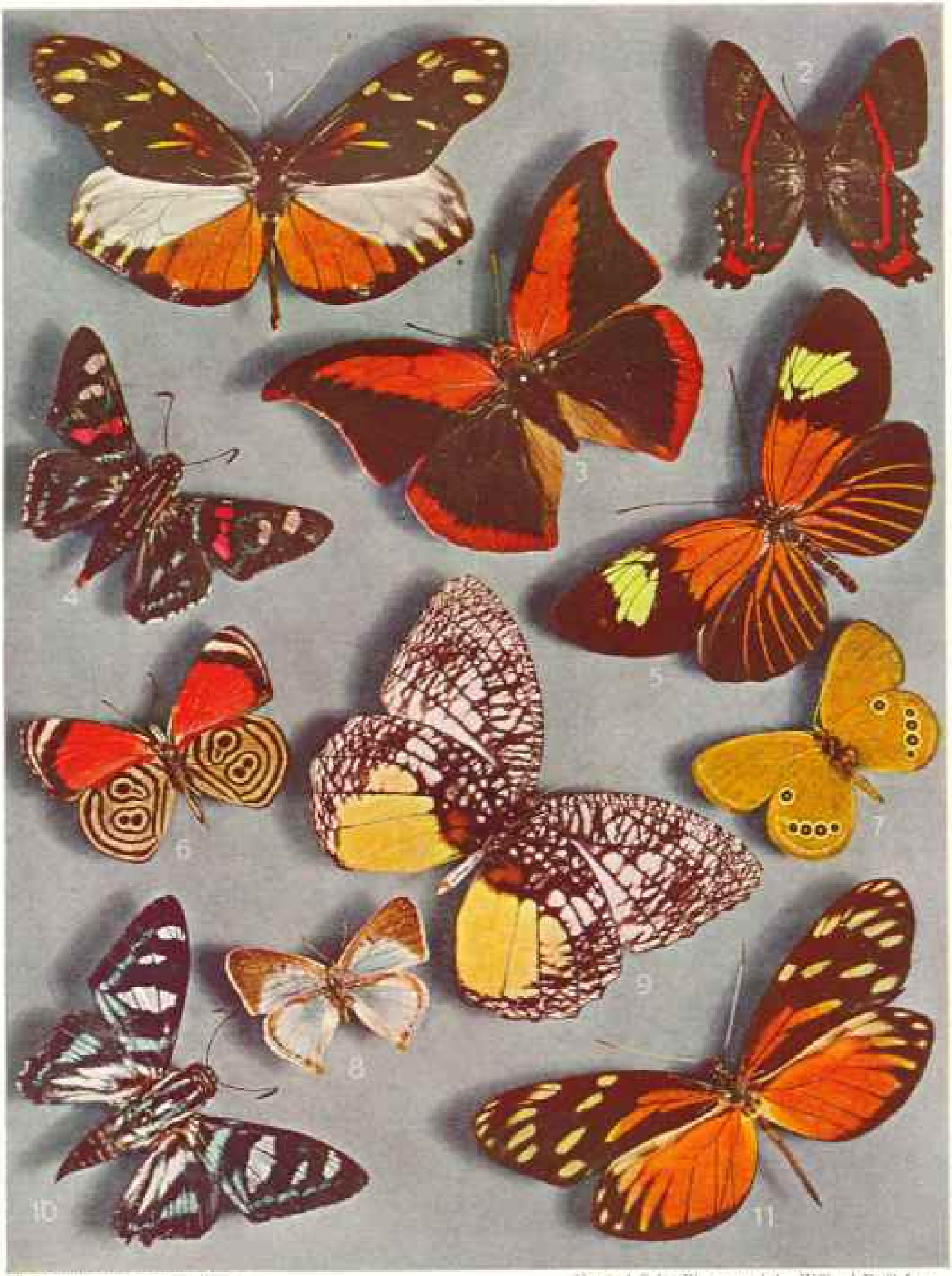
Brush-footed Butterflies
(Nymphalidae)

Largest of all the groups is that including the so-called brush-footed butterflies. In both sexes, though especially in the males, the legs of the first pair are much smaller than the other four, and are not used for walking. They are usually thickly clothed with long hairs and are kept closely folded against the body, so that the insects seem to have only four legs.

 Natural Color Photograph by Willard R. Culver

AMONG NATIVES OF SEVEN COUNTRIES IS THE MAP BUTTERFLY (2) OF CHINA

(1) Oriental Mistletoe White, under side, New Guinea; (2) Map Butterfly, China; (3) Chilean Orange-tip, Chile; (4) Gold-banded Skipper, (see Plate II, fig. 5, and Plate VIII, lower); (5) *Papilio epidaus fenochionix*, Mexico; (6) *Dismorphia fortunata*, Costa Rica; (7) *Parnassius hardwickii*, India; (8) *Dismorphia amphione praxinoe*, female, Central America; (9) same, male.



© National Geographic Society Natural Color Photograph by Willard R. Culver

STRIKING PATTERNS INCLUDE NUMERALS "88," NICKNAME FOR A DAPPER NYMPHALID (6)

(1) *Dismorphia myris*, male, Costa Rica; (11) female; (2) *Ancyluris meliboeus* (Plate III); (3) *Anaea supremus*, Brazil; (4) *Mimoniades versicolor*, Panama; (5) Bartlett's Heliconian, Amazon; (6) *Callicore marchalii*, under side, Costa Rica; (7) *Coenonympha oedippus*, under side, Europe; (8) *Thecla fada*, Costa Rica; (9) *Elymnias vasudeva*, under side, Malay States; (10) *Jemadia gnetho*, Ecuador.

Photograph from Laurence Huley Bowes

HUNDREDS OF THOUSANDS OF BUTTERFLIES AND MOTHS FORMED THIS FAMOUS COLLECTION

The late Dr. William Barnes, a surgeon of Decatur, Illinois, developed one of the world's largest private exhibits of Lepidoptera, and housed it in a specially constructed fireproof museum. A lifelong enthusiast, Dr. Barnes netted many of the specimens himself, and for years maintained agents in the field. After his death in 1930, the United States Government bought the collection and placed it in the National Museum at Washington, D. C. (page 678).

In one kind, at least, our common Black Admiral, or Red Spotted Purple (*Basilarchia arthemis astyanax*), these defective legs are used as little fiddles, producing slight squeaking sounds. Incidentally, all the butterflies that make rasping, creaking, chirping, stridulating, or other sounds audible to human ears, like our Mourning-cloak (*Vanessa antiopa*) and the tropical American Whipcrackers, are members of this group.

In the brush-footed butterflies the pupa is often marked with gold or silver spots, and may even be completely gilded. From this comes the word "chrysalis." No other butterflies have the pupae marked with these metallic colors.

Many colorful and striking butterflies are included in this group, together with some of the dingiest and least attractive kinds. And together with the strongest and most active flyers, we find here perhaps the weakest and laziest of butterflies.

Wherever butterflies are found, this group is represented, but its most spectacular members live in the woods and forests of tropical America.

Most magnificent of all are the huge blue morphos—commonly used for ornamental work—that are so easy to see but so distressingly difficult to catch.

Largest are some of the owl-butterflies, which fly at dusk and have a great round eye in the center of each hind wing, beneath.

Chiefly tree-top livers and difficult to catch are the various kinds of *Agrias* (Color Plate II, fig. 6; Color Plate VII, fig. 8) found in tropical America and much prized by collectors for their brilliant colors and their rarity. The individual of Rodriguez' Agrias (*Agrias rodriguezi*) pictured is the only one that has been caught.

In tropical America live great numbers of equally pretty but smaller and more common kinds of brush-footed butterflies. The males of one of the loveliest of these (Color Plate II, figs. 1, 2; Color Plate III, fig. 7) gives off a strong fragrance of vanilla, as do the males of many other bright-blue butterflies.

Though closely related, others (Color Plate II, figs. 7, 8; Color Plate III, figs. 5, 6) are quite different in their markings. Some (Color Plate V, fig. 6; Color Plate VII, fig. 4) are curious in having marks like numbers, usually "88" or "89," on the under side of the hind wings. These are regarded with more or less awe among the natives.

Not all the pretty butterflies of this group are foreigners; we have some very lovely ones at home. From southern New Hampshire and New York south to the mountains of Virginia lives a White Admiral (*Basilarchia arthemis albofasciata*, Color Plate II, fig. 4) of striking coloration. When it is flying the white is very conspicuous; hence the name.

Many brush-footed butterflies have wings of curious shape. There are the strange Leaf Butterflies (*Kallima albofasciata*, Color Plate VII, fig. 3) of southern Asia which, on the under side, are colored just like a dead leaf, though they are rather bright above. Then there are the Map Butterflies (*Cyrestis thyodamas chinensis*, Color Plate IV, fig. 2) common in southern Asia. And there are numerous interesting kinds (Color Plate V, fig. 3; Color Plate VII, fig. 11) in tropical America.

A special section of this group includes curious long-winged butterflies called heliconians (*Heliconius aeade bartletti*, Color Plate V, fig. 5), very common in the woods in the warmer portions of America. One of these, black with narrow yellow stripes, lives in our Southern States northward to North Carolina.

Another section of the group includes the wood-nymphs, or satyrids (Color Plate V, figs. 7, 9), mostly dull-colored butterflies of medium size or rather small, usually with staring eye-spots on the under side.

Metal-marks

(Riodinidae)

Fascinating little creatures are the metal-marks. As if in compensation for their diminutive size, they are extraordinarily varied in wing shape, hue, and color pattern. Some resemble dull-colored moths. Others are queer little imitations—or caricatures—of swallowtails (Color Plate III, figs. 2, 9), of heliconians and ithomians (Color Plate VII, fig. 10), or of butterflies of other types.

Many are very vividly colored (Color Plate II, fig. 3; Color Plate III, figs. 1, 2, 3, 8, 10), often with almost unbelievably brilliant and changeable iridescence. Usually this is most extensive on the under side, and indeed is sometimes wholly confined to that part (Color Plate III, fig. 10; Color Plate V, fig. 2).

Many, like the two in our Eastern States, are marked with bright metallic dots that are raised above the general surface of the wings, like small metal pegs. These little winged jewels have much the same relation to other butterflies that humming birds have to other birds.

The flight of the metal-marks, though active and nervous, is usually weak and short, but some are strong, swift flyers. Many alight on the under side of leaves or twigs with the wings expanded.

The metal-marks are chiefly day flyers, though some fly only at dawn, and others just at dusk. Many keep wholly in the shade of deep forests, never venturing into the open country.

Most of the metal-marks live in tropical America, where there are about 1,700 different kinds. About 80 live in southern Asia and adjacent regions, 19 in North America north of Mexico, two in Africa, and two in Europe. Many are very local, and many are extremely rare.

Coppers, Blues, and Hair-streaks

(Lycaenidae)

Rivaling the metal-marks as active little jewels are the coppers, blues, and hair-streaks. These are small or even tiny butterflies which as a rule are remarkable for brilliancy of color (Color Plate III, fig. 4) and exquisite variegation in markings (Color Plate V, fig. 8; Color Plate VI, figs. 1, 2, 4, 6, 7, 8, 9; Color Plate VIII, upper), especially in the males. They have a fast and highly irregular flight which, however, is seldom long.

Most of them are pugnacious, bold, and aggressive, flying at any other insects that may come their way, even those much larger than themselves. Nearly all have the peculiar habit, when at rest, of moving

 Natural Color Photograph by Willard R. Culver

COPPERS AND OTHER TINY BUTTERFLIES OFTEN OUTSHINE THE BIG SHOWY SWALLOWTAILS

(1) *Cigaritis acamas*, Syria; (2) *Cigaritis zohra*, Algeria; (3) *Papilio quadratus xpohatus*, upper Amazon; (4) *Axiocerses punicea*, Nyasaland; (5) *Papilio anchisiades idaeus*, Mexico; (6) *Axiocerses harpax*, Nyasaland; (7) *Chrysophanus illacina*, Tibet; (8) *Strymon ontario*, under side, Missouri; (9) *Spindasis mozambica*, Sierra Leone; (10) *Curetis vitula tapajona*, Brazil; (11) Gundlach's Swallowtail, Cuba; (12) *Amaryntkis meneria coccilineta*, French Guiana.

 Natural Color Photograph by Willard R. Culver

GAY VEGETARIANS, AND SOME "FLIES" WHOSE LARVAE EAT INSECTS (1, 2, 5, 6, 9, 12)

(1) *Allotinus fallax fallax*, Philippine Islands; (2) *Gerydus leurchus philippus*, Philippine Islands; (3) Leaf Butterfly, Andaman Islands; (4) "89." *Callicore marchalii*, (see Plate V, fig. 6); (5 and 6) Wanderers or Alder Butterflies, Massachusetts; (7) *Lycaena euphemus*, Europe; (8) Rodriguez Agrias, Guatemala; (9) *Allotinus subviolaceus sitarus*, Borneo; (10) *Ithomeis lauromia*, Peru; (11) *Prologonius hippona druryi*, South America; (12) *Gerydus evolon*, Siam.

Photograph from Laurence Ilsley Hewes

A COLLECTOR MAKES A SIDESWIPE AT AN ELUSIVE ORANGE-TIP

Perched on a desert flower, near a tall cactus plant, is a specimen of the scarce *Anthocharis pima*, a resident of certain remote sections of Arizona. After twice searching in vain for it, Mr. Hewes discovered that the handsome little butterfly lives a life of ease, not appearing until 10 a. m., and flying for only a few days in spring.

the hind wings up and down, the wings of the two sides moving in opposite directions. Though most of them sport in the brightest sunshine, some prefer the shade of woods, which they never leave.

Like the brush-footed butterflies, the lycaenids are cosmopolitan, though most of them are tropical. The coppers and blues live chiefly in the Old World, the hairstreaks mainly in the New.

Lycaenid caterpillars are more varied in their habits than those of any other group of butterflies. Many eat developing seeds, buds, flowers, or tender leaves. Some are fruit borers, and some feed on lichens or algae on the trunks of trees.

A very large number have formed a working partnership with ants, usually for their mutual benefit, though not infrequently to the discomfiture or even detriment of the ants. Bootlegging is the basis for the affection shown by many different kinds of ants for lycaenid caterpillars (Color Plate VIII).

Many, if not most, of these little caterpillars are provided on the back with glands that produce a liquid of which ants are inordinately fond. In return for the honeylike liquid that they get from them, the ants do everything within their power to protect these feeble little caterpillars.

CATERPILLARS EAT ANT BABIES

But certain kinds of caterpillars exact a high price for their favors. Thus the caterpillars of some of the little blues live at first on flower buds, tended assiduously by ants. When partly grown they leave the plants, crawl into the ants' nest, and spend the rest of their caterpillar life eating the ants' babies.

To this the ants make no objection. They value the honey more than they do the lives of their own young.

Other caterpillars feed entirely on ants, giving no favors in return. These are encased in a tough and horny skin, and look like perambulating lozenges. They live in the silken nests of the spinning, or treedriver, ants in southeastern Asia and Australia, devouring their hosts' young at will.

Strangest of all, perhaps, is a limpetlike caterpillar that persuades the ants to feed it. Its head is so very small and pointed that the caterpillar is quite incapable of feeding

Photograph by D. S. Cummings

LOWERING HIMSELF ON A ROPE, HE TRAILS HIS QUARRY IN A GORGE

The collector will go to any lengths to net desirable specimens. Like an alpinist, this one drops down the steep bank of a ravine on the island of Dominica. Equipment in the pouch at his side includes a bottle or box containing cyanide, into which butterflies are put to be killed by the fumes. Then they are pinned in a box or wrapped in small papers.

in the usual fashion. When it meets an ant it thrusts its pointed neck right in between the open jaws of the ant, which proceeds to feed it by regurgitation—just as it would feed another ant.

This limpet caterpillar is the African representative of the Asiatic lozenge caterpillar, and victimizes the same type of ant, a particularly vicious one. Insect diplomacy reaches its highest development in such creatures as the limpet caterpillar that are able to induce ferocious ants, against their will, to feed them.

Not so diplomatic as the last, but far more crafty, is a sluggish caterpillar found in western Africa that feeds on active little running and jumping insects called jassids and membracids, which, when fully grown, can also fly.

How can sluggish, clumsy caterpillars catch insects so very much more active and alert than themselves? These little hoppers produce a secretion of which the ants are very fond. Therefore they are always attended by ants and are quite accustomed to being patted and stroked by the ants' antennae.

This makes things easy for the caterpillars. They simply disguise themselves as ants and in this way deceive their prey until the fatal moment. A caterpillar creeps slowly in the direction of its intended victim, stopping frequently and vibrating the three foremost pairs of legs—the so-called true legs. When it is near its prey it stops, and then again advances with only the first pair of legs vibrating.

A VILLAIN IN DISGUISE

On reaching the unsuspecting jassid the caterpillar allows the vibrating legs to tickle the jassid's wings, just as they would be tickled by the antennae of an ant.

Advancing farther, the caterpillar gradually raises the fore part of its body so as to overhang the jassid, and when well above the intended victim, the caterpillar suddenly drops and seizes it with all three pairs of true legs, immediately biting it behind the head and holding it pressed closely down to the branch. So the deed is done.

This crafty caterpillar is the only one that feeds on insects much more active than itself. Most insect-eating caterpillars feed

ANTS AS BODYGUARDS OF CATERPILLARS WARN WINGED RACKETEERS—"KEEP OFF!"

Parasitic wasps and flies lay eggs in or on the common blue butterfly's caterpillars. When the eggs hatch, grubs destroy the hosts. The caterpillars are tended by ants, which strive to protect them in return for the honey which their "cows" secrete. (Twice natural size.)

Paintings by Hashime Murayama

THESE RED-HEADED CATERPILLARS BUILD TINY HIDE-OUTS FOR DAYTIME REFUGE

They cut wedge-shaped flaps in leaves and fasten them with silk to form peaked tents (upper left, and lower center). Hatching from yellow eggs (upper right corner), they grow rapidly. Then each becomes a pupa (small inset), emerging a Gold-banded Skipper (large inset, and Plates II and IV).

on sluggish, helpless insects, chiefly on aphids (plant lice) or on scale insects. Aphids and scale insects produce a sweet secretion most attractive to the ants, which swarm about them.

These ants, in protecting their tiny "cows" —the aphids and scale insects—also unwittingly protect the little caterpillars that are destroying their "herds."

One of these insect-eating caterpillars is common in eastern North America. It is the young of a small butterfly (*Feniseca tarquinius*, Color Plate VII, figs. 5, 6) that is not often seen unless one makes a special search for it. The caterpillars live chiefly on the white woolly aphids so common on alders growing beside running water that they make the branches appear to have been decorated with broad rings of fluffy snow.

The butterflies with insect-eating caterpillars (Color Plate VII, figs. 1, 2, 5, 6, 9, 12) are all dull-colored, with the sexes almost always quite alike. Nearly all of them are shade lovers.

Although the ants do their best to protect from their enemies the caterpillars of most lycaenids, they are not always wholly successful. All butterflies are victimized by parasites, several or many kinds, particularly in the caterpillar stage. Often these are themselves preyed upon by other parasites within the bodies of the caterpillars. Of such unwelcome guests the lycaenids have an ample quota.

Let us consider a concrete example. One of the loveliest of our butterflies, and one of the commonest, is the familiar little blue of open woodlands and brushy fields (Color Plate VIII, upper).

The figures show the upper and under side of the original female, or type specimen, of *Lycaenopsis argiolus pseudargiolus*, described by Drs. J. A. Boisduval and J. E. Le Conte in 1833, now in the National Museum. As it was collected more than a hundred years ago, it is somewhat faded.

On the dogwood flower to the right are shown two of the very variable caterpillars of this butterfly. These are always tended by from one to three or even four different kinds of ants. One of the ants most frequently seen tending them is the kind shown, *Crematogaster lineolata*.

Sometimes you will see a number of these ants running up and down a stem leading to a dogwood flower. Follow the line of ants and you will find a caterpillar feeding on the flower.

The other insects shown, all of which are parasites, are: Center, slightly to the right, on dogwood bract: A wasp (*Apanteles cyaniridis*), the larvae of which live inside the caterpillars, usually several in each host. Lower right: An ichneumon fly (*Anomalon pseudargiolí*), the young of which also live inside the caterpillars, but only one in each. Left center, flying above the green leaf: Another parasitic wasp (*Hemiteles lycaenae*); the larvae of most of the wasps of this type feed on the young of other wasps within caterpillars. Lower left (fly): A tachinid fly (*Zenillia confinis*), the maggots of which live within the larvae of the little blue.

Whites and Yellows

(Pieridae)

These are butterflies of medium size, almost always white, yellow, or orange, and seldom much variegated. Some, plain above, are prettily marked on the under side (*Delias*, sp., Color Plate IV, fig. 1), and a number have the tips of the fore wings marked with orange (*Eroessa chilensis*, Color Plate IV, fig. 3).

A few in South America depart widely from the general type and resemble, more or less closely, other unrelated butterflies—swallowtails, heliconians, danaids, or ithomians (Color Plate IV, figs. 6, 8, 9; Color Plate V, figs. 1, 11).

The pierids are cosmopolitan, but the great majority are tropical, about equally divided between the Old and the New Worlds. Most of them delight in bright sunshine, coming to rest at once if a cloud obscures the sun; but some are at home only in woods and forests, and one dark and dingy kind in Mexico is a night flyer.

Several are famous travelers and regularly or occasionally migrate in enormous numbers, often flying directly out to sea. One of our smallest yellows sometimes reaches Bermuda in large flocks.

Several butterflies of this group are serious pests, as the common Cabbage White. The younger stages of some others are widely used as human food in Central and South America.

Swallowtails

(Papilionidae)

Swallowtails are mostly large or very large, though a few are medium-sized or small.

Photograph by Amelia Dexter

POISED FOR THE FIRST TAKE-OFF

Some two hours after leaving the chrysalis, the Monarch is ready for its "maiden flight"; no coaching is needed. Without warning, and with scarcely a flutter, it spreads its wings to the breeze and sails out into the early morning sunshine. For about three days it does little but suck honey from flowers, then it fulfills its object in life: the propagation of the species. After a month or six weeks the butterfly dies, leaving a new generation of caterpillars to carry on the life cycle (pages 670 and 671).

Most of the true swallowtails have conspicuous tails on the hind wings (Color Plate I; IV, fig. 5; VI, fig. 11), but many are without them (Plate VI, figs. 3, 5).

The vividly colored males of the giants of the group, the great "bird-winged butterflies," or ornithopteras, of New Guinea and adjacent regions, are perhaps the most magnificent of all the butterflies.

Largest of all butterflies are the dull and somber mates of these handsome males. One of these (*Papilio alexandrae*) measures nearly eleven inches across the wings.

This expanse is sometimes exceeded by the males of a swallowtail living in western Africa, though in this the wings are very narrow. The females of this last are very much smaller than the males, an unusual feature among butterflies.

The size of the giant swallowtails is in striking contrast to that of the smallest butterflies, certain metal-marks and blues, that measure scarcely half an inch across the wings.

Wherever swallowtails are found they include the largest of the local butterflies, except in South America, where none of them attain the size of the largest owl-butterflies or morphos.

Besides the swallowtails proper, this group includes a dozen other types, of which the largest and most important consists of the parnassians, lovely white, very rarely gray or yellow, butterflies (Color Plate IV, fig. 7) characteristic of alpine regions in the Northern Hemisphere.

Three swallowtails of early spring from Washington, D. C., are pictured on Color Plate I. At the top is a Tailless Blue Swallowtail (*Papilio philenor* var. *ecaudata*). The Blue Swallowtail, our local representative of the oriental "bird-winged butter-

flies," ranges from southern New England and Ontario to Colorado and southward to Panama, and is also found in California. In parts of Mexico and occasionally in New Mexico individuals are found with the tails so very short as to be quite inconspicuous.

This variety (*ecauda*) may appear in the Eastern States after a hard winter. I caught the individual pictured near Washington on May 7, 1932. Summer individuals of this butterfly always have long tails and are much larger.

The well-known Tiger Swallowtail (*Papilio glaucus*), shown in the center, lives from Alaska and British Columbia to Hudson Bay and Newfoundland and southward, east of the Rocky Mountains, to Florida and Texas. A different but very similar kind lives in the Rocky Mountain region. In the far north the Tiger Swallowtail is small with the black borders narrow and hair on the head and body long (var. *canadensis*).

About Washington the earliest individuals in spring are like those from the far north. Their children that fly in summer are larger, with broader black borders and short hair. The individual pictured was caught at Washington by Mr. W. Herbert Wagner on April 23, 1935.

The dainty Zebra Swallowtail (*Papilio marcellus*) lives from southern New York to Florida and Texas. The individuals flying in early spring differ from those seen in summer in being much smaller, with narrow dark bands, long hair, and only the tip of the tail white. The one pictured was caught by Mr. Wagner at Washington on April 19, 1935.

Caterpillars of several swallowtails are pests, particularly on orange trees.

Skippers

(Hesperiidae)

These pert, vivacious butterflies are all small, or at best only of medium size. The greater number live in tropical America. They have robust bodies, strong wings, and broad heads. For the most part they are plainly and uninterestingly colored, though a few are pretty (Color Plate V, figs. 4, 10).

Most of them fly by day, preferring the bright sunlight, but a few keep in the shade of woods, and in the Tropics some are evening or even night flyers. The flight is usually very fast and highly irregular, though some are much more indolent than others.

One of the handsomest of our native kinds is the Gold-banded Skipper (*Rhabdoides cellus*, Color Plate IV, fig. 4). An interesting variety (*Rhabdoides cellus* var. *leilae*, Color Plate II, fig. 5) appeared among some that I raised.

More than a hundred years ago Drs. J. A. Boisduval and J. E. Le Conte published a colored plate showing this butterfly, previously unknown, together with a caterpillar and a pupa. The plate was from a drawing by John Abbot, a school teacher who lived in Jacksonborough, Georgia, a town abandoned in 1843. Only once since Abbot's time has the butterfly been found in Georgia—indeed, it is one of the rarest butterflies of the Eastern States.

In 1934 I found it near Great Falls, Maryland, and was able to study its life history and habits.

The life history is here shown in natural color for the first time (Plate VIII, lower).

At the left is a full-grown caterpillar and in the center a fourth-stage one; just beneath the latter is a shelter made by another, still smaller, in the third stage.

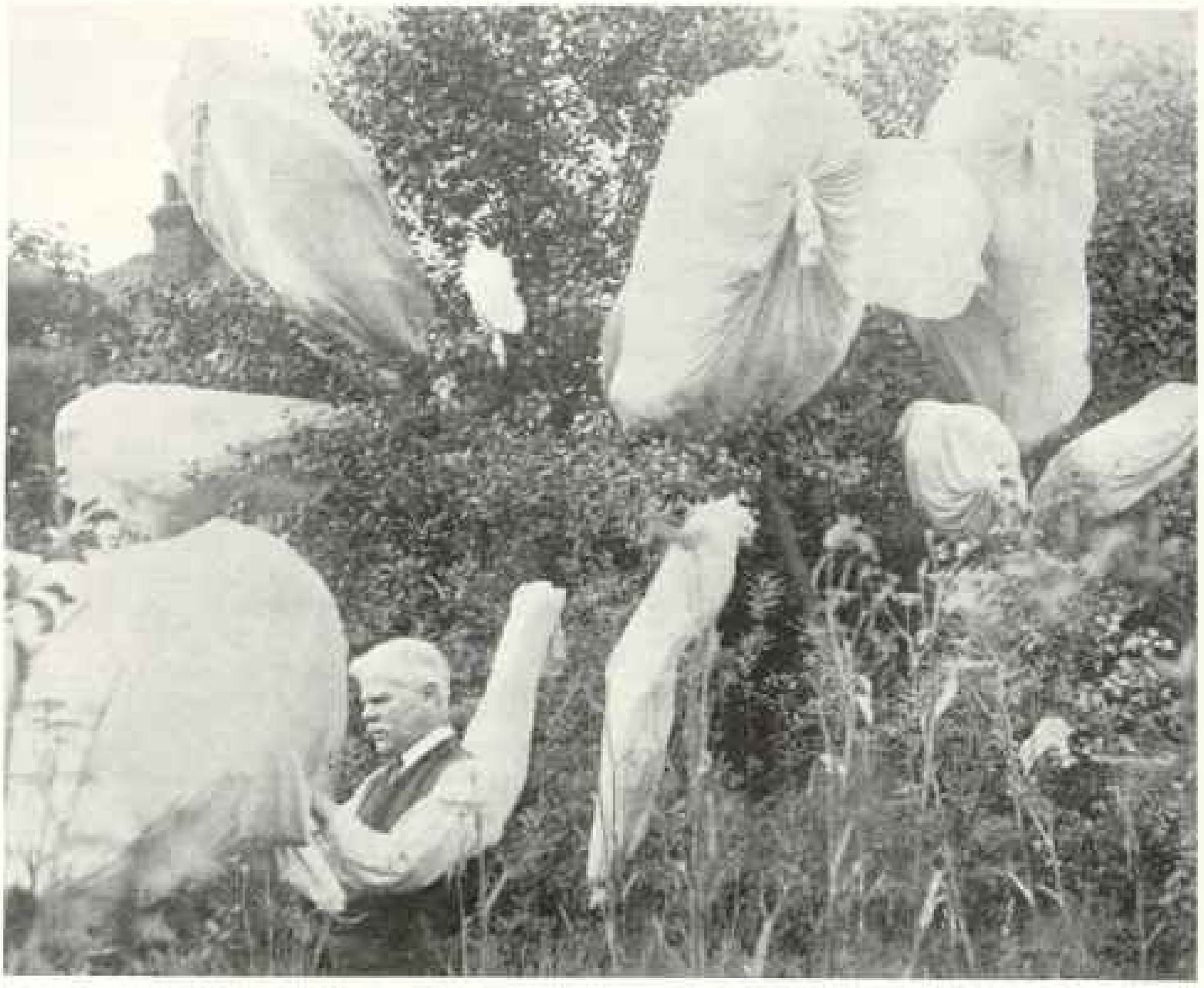
The caterpillars feed only at night, hiding during the day in little tents they make for themselves. They cut two converging lines into the leaf and then fold the resulting wedge-shaped flap over the upper surface of the leaf, bend it into the form of a peaked tent, and fasten it with silk.

Upper, left side: A leaflet with three tents made by a first-stage caterpillar about one-twelfth of an inch long. They like new homes, and are continually making new ones and deserting old ones. When they leave an old one, they always partly destroy it by cutting the silk threads that hold it together.

Lower right, under the petiole of the leaf: The inconspicuous shelter made by a full-grown caterpillar. Two leaves are fastened together by an oval band of silk threads and the surfaces of the leaves are then sparsely lined with silk threads which bulge them outward, forming a lozenge-shaped cavity between them.

Upper right: A string of five light-yellow eggs attached to the under surface of a leaf. Inset, lower left: A pupa; it is really black and very highly polished, but is completely covered with fluffy white wax which protects it against too much moisture. It lies in a flimsy cocoon formed by binding together dead leaves or other rubbish on the ground.

Inset, right center: A Gold-banded Skip-



Wide World Photograph

INSTEAD OF HUNTING SPECIMENS, THIS ENGLISHMAN RAISES THEM FROM EGGS

On his butterfly and moth farm at Bexley, in Kent, he rears thousands of caterpillars, and ships their chrysalises, cocoons, and adults to collectors in all parts of the world. The netting on the food plants protects the caterpillars from their hosts of enemies, and prevents them from straying when they feel the wanderlust, which happens just before they become pupae. If not enclosed, larvae may wander 200 or 300 feet away.

per feeding on flowers of the buttonbush (*Cephalanthus occidentalis*). The food plant of the caterpillars at the locality near Great Falls is the hog-peanut (*Falcata pitcheri*).

ROMANCE AND EXCITEMENT

The six groups of butterflies include a total of nearly 50,000 different kinds. In North America north of Mexico there are 705 kinds, of which 102 live in the vicinity of Washington, D. C. Central and South America are much better supplied with butterflies than North America, having about 20,000 different kinds.

As if to emphasize the wealth in gold hidden in the mountains of western South America, there is found in Chile a butterfly with wings entirely of gold on the under side.

All of glinting silver is a wood-nymph, or satyrid, of central Chile and western Argentina. Though common, it is rather hard to catch because of its rapid flight and the difficulties attendant upon exertion in the high altitudes in which it lives.

Seeming to symbolize the wealth of the Indies, some of the world's most gorgeous butterflies live in the Moluccas, or Spice Islands.

Perhaps the most spectacular of these is a giant swallowtail with a spread of seven inches (*Papilio priamus croesus*). The upper surface of its wings is a vivid, shimmering gold, emphasized, and at the same time relieved, by the deep velvety black of the hinder part of the fore wings.

This golden giant was first discovered by Mr. Alfred Russel Wallace. Of the first one that he caught he wrote: "The beauty and brilliancy of this insect are indescribable."

THE SCIENTIFIC RESULTS OF THE WORLD-RECORD STRATOSPHERE FLIGHT

By Capt. Albert W. Stevens, U. S. A.

Commander of the National Geographic Society-U. S. Army Air Corps Stratosphere Expedition

The Geographic presents with this issue a photographic supplement showing the lateral curvature of the earth as photographed in the stratosphere at an elevation of 72,395 feet during the National Geographic Society-U. S. Army Air Corps Stratosphere Flight over South Dakota on November 11, 1935, at 11:41 a. m. (MST).

The picture is unique in several respects. Not only was it taken from the highest point ever reached by man, 13.71 miles above sea level, but it includes the largest area ever covered by one photograph taken through a single lens, more than that of the State of Indiana, and shows a horizon farther from the lens than was ever before caught on a camera plate, 330 miles. It was obtained at an altitude above 95 per cent of the mass of the earth's atmosphere, and is the first picture ever made with the line of sight between the camera and a far-distant objective—here, the arc of the dust horizon—wholly in the stratosphere.—The Editor.

THE primary purpose in stratosphere flights such as Captain Orvil A. Anderson and I made November 11, 1935, in *Explorer II*, is to lift standard-sized scientific instruments and observers into the thin, clear air far above the earth.* There observations can be made to best advantage of the tremendous flood of sunlight and other radiations that constantly pour in from outside the earth.

These radiations are vitally important to mankind. Some of them are essential to life on the earth; and workers in various fields of science have sought for years to find out more about the radiations themselves, how they affect the gases of the atmosphere as they push their way through them, and how the radiations are modified by penetrating those gases.

The air near the surface of the earth is the dregs of our atmosphere. Because of the weight of the miles and miles of atmosphere pressing down from above, the lower layer of air, especially near sea level, is compressed; the molecules that make up its gases are crowded together so that relatively they have little elbowroom.

The Region of Cloudless Sky

In addition to the particles of the ordinary air, there are numberless molecules of water vapor and carbon dioxide, vast quantities of dust and smoke particles, and floating spores. The air around us seems clear enough as we move about in it day by day, but it is really a sort of "pea soup" mixture when compared to the thin, clean air above the cloud zone.

As one ascends into the atmosphere, whether by climbing a mountain, flying in an airplane, or being lifted by a balloon, he leaves the atmospheric dregs below him. First he rises above the coarser dust and smoke. Then water vapor becomes less and less, until, at six or seven miles above sea level in the middle latitudes, the region is so cold that practically no moisture can exist in it—it is a domain from which the ordinary clouds of the earth are eternally barred by the laws of physics.

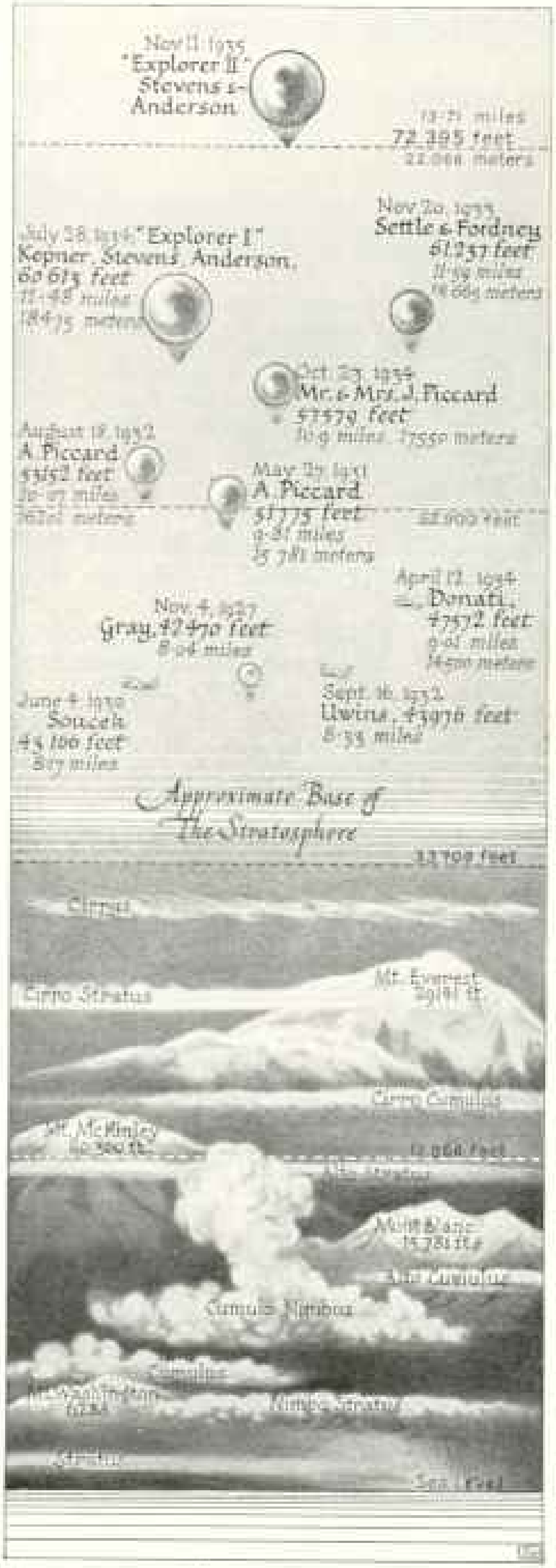
This is the beginning of the stratosphere, a region of cold, clear, thin, dry air, always sun-bathed during daylight hours, and usually free from appreciable amounts of dust.

A major objective of all the manned balloons that have entered the stratosphere in recent years has been the study there of cosmic rays.

When one ascends 17,960 feet above sea level (approximately 3½ miles), half the mass of the atmosphere of the earth lies below him. This altitude, and its relation to the heights of well-known mountains and to the levels at which characteristic cloud forms usually float, are shown by a white dotted line on the pictorial diagram on page 694.

At 33,700 feet, or approximately 6½ miles up (shown by a black dotted line), three-quarters of the atmosphere lies below; and at an altitude of 52,900 feet, or about 10 miles (indicated by a second black dotted line), nine-tenths of the mass of the atmosphere is below. At the level reached by *Explorer II*—72,395 feet, or

* See "Man's Farthest Aloft," by Captain Albert W. Stevens, in the National Geographic Magazine, January, 1936, which told the dramatic narrative of the flight. In the present article are summarized the scientific findings of the stratosphere explorers.



"FLYING HIGH"—INTO THE STRATOSPHERE

The diagram shows how cloud forms mark altitudes in the lower atmosphere, and the heights reached by the most important balloon and airplane flights. Shading is used arbitrarily to indicate density of the atmosphere, greatest near sea level and growing rapidly less upward (p. 693).

13.71 miles above sea level—we were above 96/100ths of the mass of the atmosphere!

WHY SCIENTISTS MUST GO ALOFT TO STUDY COSMIC RAYS

Radiations observed at the surface of the earth are like bullets that have come through a series of increasingly dense mattresses. If many bullets with various energies are fired at the mattresses, only those with the greatest energies will go through all of them; and when only the lightest mattresses stand as obstructions, the bullets coming through will be most numerous.

The history of stratosphere expeditions has been the story of rising through more and more of the atmospheric "mattresses" to a region in which there are more and more of the "bullets" of sunlight and cosmic rays to be observed.

The existence of the radiations called cosmic rays was not known until after 1900. Then it was discovered from experiments by several physicists that if gas is shut up in a hollow steel ball, rays of some sort pass through the metal shell of the ball and steal particles (electrons) from some of the gas atoms (that is, cause ionization of the gas).

Later it was learned that some of this penetrating radiation was made up of rays from radium in the rocks of the earth's crust.

It was found, however, that these radium-born rays could be kept from reaching the interior of the ball by surrounding it with a layer of lead, just as X-ray treatment rooms are encased in sheets of lead to prevent the outward passage of X-rays.

PASS THROUGH LEAD AND STEEL

When the ball was sheathed in lead it was observed that numerous rays still penetrated the interior and ionized the gas—rays driven with energies so much greater than radium rays and X-rays that they passed through the lead and the steel as if those solid obstructions had not been there.

These are the cosmic rays, now believed to be, for the most part, charged flying particles, almost inconceivably small, driven with tremendous energies. They cannot be seen, and are known only by their effects.

The cosmic rays pouring in on the earth are of various energies, and it is only the strongest that can register themselves inside steel balls at the earth's surface. All the way down through the atmosphere some of the rays are exhausting themselves

Photograph by Richard H. Stewart

THE STRATOCAMP HAD A WEATHER BUREAU OF BIG CITY SIZE

A battery of teletype machines brought in detailed weather reports from various parts of the United States and special upper air reports from a score of airfields. Radio data were received from ships both in the Atlantic and Pacific Oceans. Standing are: Private E. D. Laurin, U. S. Army Air Corps; Dr. W. G. Brombacher, National Bureau of Standards; Master Sergeant F. A. Matchinski, U. S. Army Signal Corps. Seated are; Private N. A. Bartlett, Air Corps; Corporal A. R. Harwick, Cavalry; and Capt. W. H. Wenstrom, Signal Corps. The camp weather bureau, with a personnel of nine men, produced four maps daily showing weather conditions.

by plowing through the air gases, tearing electrons from the cores of atoms; and even occasionally colliding with an atomic core itself.

For years scientists have been piecing together facts about cosmic rays and have been particularly interested to learn about them high above sea level in the thin, rare upper atmosphere, where they are most numerous and stronger because not "worn down" by the comparatively heavier gases near earth.

A "SKY-HIGH" LABORATORY WITH A HEAVY LOAD

The stratosphere balloon *Explorer II*, designed to have great lifting power, offered the first opportunity to take standard-sized, and therefore heavy, instruments for cosmic ray measurement to a height of 13 miles and more above sea level.

Dr. W. F. G. Swann and his associates of the Bartol Research Foundation of the Franklin Institute, Doctors G. L. Locher, W. E. Danforth, C. G. and D. D. Montgomery, and Mr. Oscar Steiner devised a system of counters to record the numbers of cosmic rays coming in from several angles above the horizon. The apparatus was constructed of scores of tubes sensitive to cosmic rays, whose responses could be amplified by receiving tubes.

Each row of tubes formed, in effect, a "cosmic ray telescope." One battery of them was arranged pointing horizontally; a second, 10 degrees above the horizon; a third, 30 degrees; a fourth, 60 degrees; and a fifth, vertically.

When, during the flight, the gondola and balloon were rotated by means of the electrically driven fan at the end of an arm, these "telescopes" swept completely around the horizon recording rays coming from various points of the compass.

The cosmic ray counter showed that the number of rays entering the vertical telescope increased steadily up to a height of 57,000 feet. From that altitude to the top

Photograph by Gilbert Grosvenor

SOMETIMES A PHOTOGRAPHER MUST TURN STEEPLE JACK

Richard H. Stewart, GEOGRAPHIC staff photographer with the stratosphere expeditions, works on a lofty perch he built in a pine tree overlooking the Stratobowl to obtain a comprehensive view of the camp.

of the flight, at 72,395 feet, there was a decrease in the number of recorded rays.

WHERE COSMIC RAYS ABOUND

At 40,000 feet the rays from the vertical were 40.1 times as many as those recorded from the vertical at sea level. On the flight of *Explorer I*, July 28, 1934, the number found at 40,000 feet was 42.3 times as many as those found at sea level. During the flight of Dr. and Mrs. Jean Piccard in the autumn of 1934 it was found that the ratio at 53,000 feet was 53.2; while during the flight of *Explorer II* the ratio at that same altitude was 51.5.

At 57,000 feet, during the flight of *Explorer II*, the vertical rays were 55 times those coming in at sea level. This was the maximum value recorded. At 72,395 feet, the ceiling of the flight, the number of rays from the vertical direction had fallen to 42 times those at sea level.

"We believe," says Dr. Swann, "that the explanation of this phenomenon is to be found in the assumption that many if not nearly all of the rays observed are what we may call secondary rays, shot out from the atoms of the air by the primary rays entering from space.

Photograph by Richard H. Stewart

THE TRAP WHICH COLLECTED SPORES FROM FAR ABOVE THE CLOUDS

This apparatus, consisting of a metal casing (left), enclosing a sterile tube coated with a sticky substance, was dropped at 70,000 feet with a parachute attached. During its descent above 36,000 feet, spores of five species of bacteria and five species of molds were collected. Left to right: Mr. Fred C. Meier; Capt. Verner L. Smith of the airship *Enterprise*, in which the mechanism was given preliminary tests; Dr. Lyman J. Briggs, Chairman of the Scientific Advisory Committee for the stratosphere flight; and Dr. Lore A. Rogers (see text, page 704).

"The primary ray is like a bullet flying through a lot of marbles. It is accompanied by a flight of marbles which have been hit by it in its journey. When we get sufficiently high into the atmosphere the number of these secondary rays suffers diminution because there is not enough air above to produce them."

At the surface of the earth, because of the thickness of the atmosphere they must traverse, the number of rays received in the horizontal direction is negligible compared with that received from the vertical.

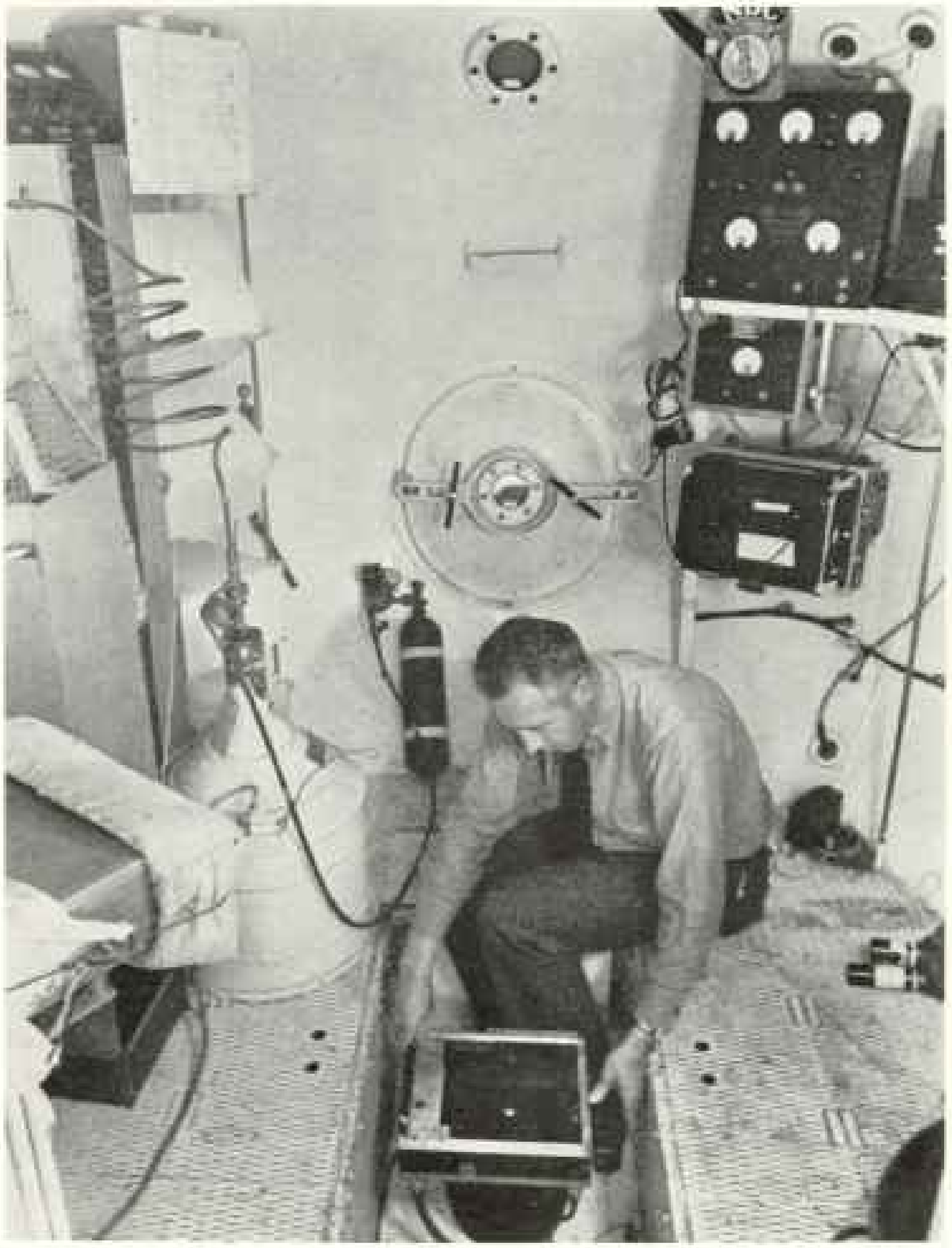
Even at 40,000 feet only a small number of rays were expected from the horizontal as compared with the vertical. Scientists were surprised, therefore, when results obtained more than a year ago gave a horizontal effect as much as 20 per cent of the vertical at 40,000 feet.

Evidently something was happening to prevent the rays from being absorbed in coming horizontally through the atmosphere. It was concluded that the rays which entered the telescopes horizontally had not traveled all the way through the atmosphere in that direction, but had been swung around in their paths by the earth's magnetic influence.

In the flight of *Explorer II*, the number of rays received in the horizontal direction at 72,395 feet was practically equal to the number received in the vertical direction.

A second cosmic ray apparatus taken on the flight was a stoss chamber (see page 701) to record "bursts of energy" caused by cosmic rays striking and disrupting the atoms of metallic materials. This was a Dowmetal shell 20 inches in diameter containing nitrogen gas under a pressure of 250 pounds to the square inch.

The gas was compressed so that there would be more atoms to be ionized. Above the chamber was placed a layer of lead $\frac{5}{8}$ inch thick so that the lead atoms would furnish the necessary targets. Most of the rays would pass through the relatively thin layer of lead—that is, between the lead atoms—and would bring about the usual ionization of the gas in the shell.



Photograph by Richard H. Stewart

THIS CAMERA PHOTOGRAPHED THE EARTH FROM A RECORD HEIGHT

In the "well" 16 inches deep under the floor of the gondola, Louis Hagemeyer, civilian photographer attached to Wright Field, is installing the big Fairchild vertical aerial camera, pointed straight down through the bottom of the sphere, which automatically snapped a picture of the earth below every 90 seconds. From the balloon's "ceiling" it took the highest-altitude pictures of the earth ever made (see page 702). In the center is one of the two manholes of the gondola with its door closed. To the right of the manhole is the hand-operated Fairchild oblique aerial camera, pointing through the gondola wall, which made pictures showing the curvature of the earth on the distant horizon (see photograph supplement to this issue of The Magazine). Above it is part of the radio apparatus. The large flask and coil at the left are parts of the air-conditioning outfit. Beyond the flask and coil is apparatus for counting cosmic rays.

At intervals, however, a ray would strike a lead atom, breaking it into fragments and driving them inside the shell. Such a direct hit would be recorded in the stoss chamber as a burst of energy—a sudden and great increase in the ionization of the gas.

The records show that the bursts of energy, as the balloon rose, increased rapidly, as expected, but not in an extraordinary manner.

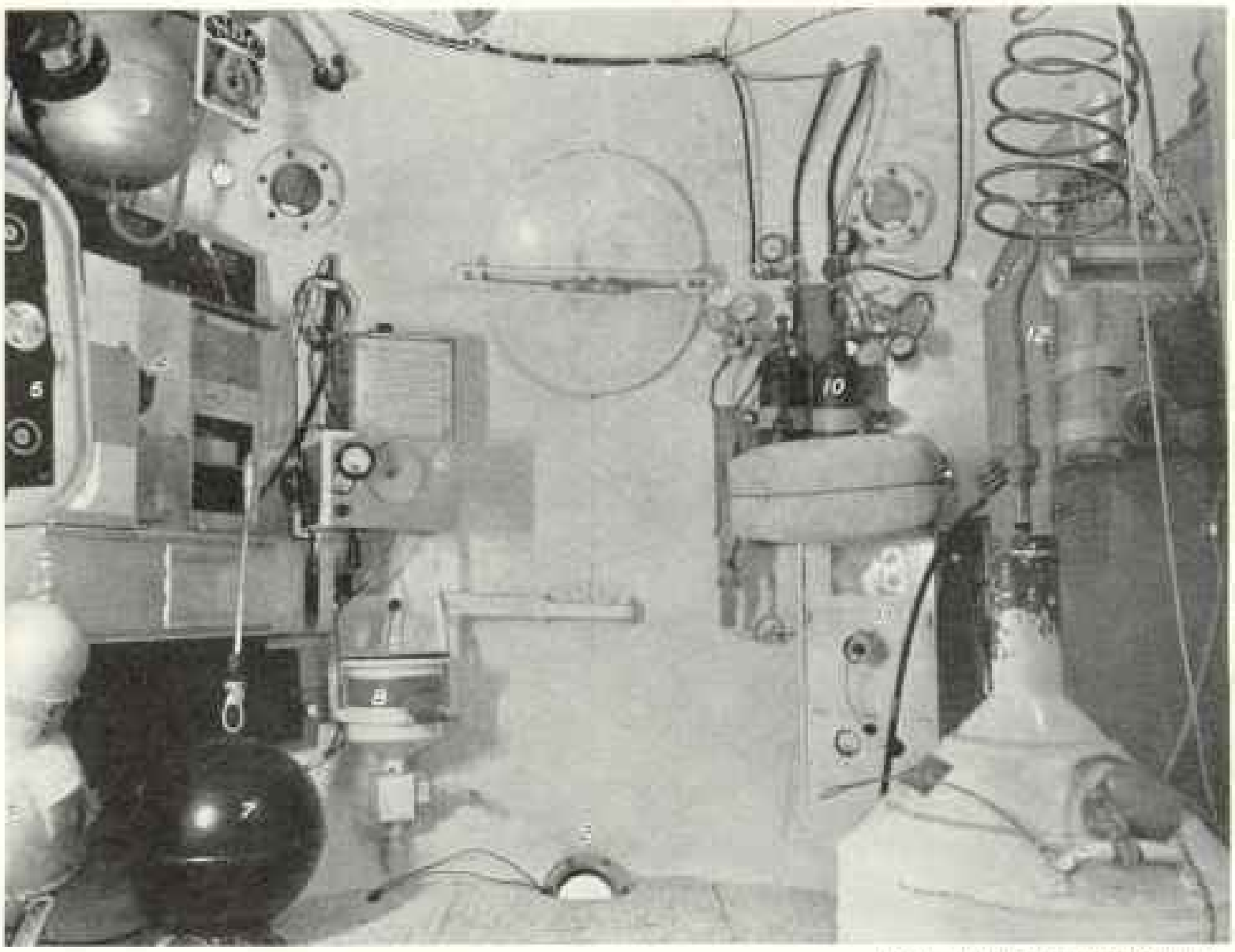
MAKING A RAY "TAKE ITS OWN PICTURE"

We spied on cosmic rays in the stratosphere in a third and surprisingly simple way. We took with us, wrapped in light-proof black paper and attached outside the gondola, two boxes of photographic plates coated with a special emulsion, to see whether rays would plow into the emulsion and make tracks in it.

This new method of studying cosmic rays was developed by Dr. T. R. Wilkins, of the University of Rochester.

When the plates were developed no visible images came up; but when they were viewed through a microscope with high magnification and with special illumination, the individual grains of the emulsion, and now and then a long row of such grains constituting a track, were seen.

In the laboratory it was found that a Radium C′ alpha ray with an energy of 7.7 million electron volts made a track in the emulsion 33 grains long. Our cosmic ray track shown in the photograph is 350 grains



Photograph by Richard H. Stewart

THE GONDOLA WAS A "FLYING LABORATORY" WITH A MAZE OF INSTRUMENTS

Some of the instruments and equipment carried in the gondola are shown in the photograph by numbers as follows: 1—a manhole, with its cover closed; 2—porthole for viewing the earth; 3—chamber of the statoscope that indicated whether the balloon was rising or falling; 4—Factograph cameras which automatically photographed dials of various instruments at short intervals (page 704); 5—oblique camera for photographing the horizon; 6—portion of flask used for collecting samples of stratosphere air; 7—vacuum flask containing reserve supply of liquid oxygen for breathing; 8—hopper for the discharge of ballast; 9—recording portion of apparatus for measuring electrical conductivity of the air; 10—containers of compressed oxygen used to operate, through rubber hose, the valves in the top of the balloon; 11—recording portion of cosmic ray counting apparatus; 12—flask coil and upright cabinet, parts of the air-conditioning apparatus.

long, and if it was made by an alpha ray, the particle, according to Dr. Wilkins, must have had an energy of about one hundred million electron volts (see page 700).

WHERE THE SUNLIGHT IS BRIGHTEST

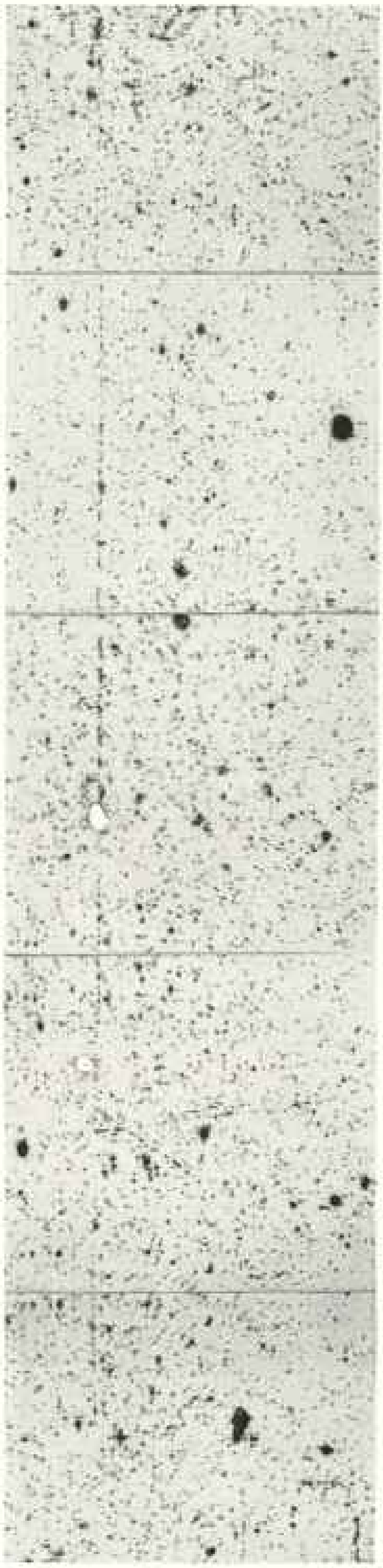
For the study of sunlight, especially of the sun's spectrum, at various altitudes above sea level, two spectrographs were taken along on the flight, one on the outside of the gondola, one on the inside.

They were designed and built by the Bausch and Lomb Optical Company and fitted with cameras made by the Folmer Graflex Corporation.

Rays of sunlight, like cosmic rays, are partly absorbed or intercepted in passing through the atmosphere, especially the shorter wave lengths. The spectrum of the sun far above the earth, therefore, is fuller or longer than the sea-level spectrum. The changes in the spectrum as the instruments rose higher and higher were recorded photographically on ultra-violet-sensitive film especially coated for the flight by the Research Laboratory of the Eastman Kodak Company.

The outside instrument recorded the spectrum of direct sunlight; the inside instrument, the spectrum of skylight from an angle ten degrees above the horizon.

In both instruments cameras automatically made photographs of the spectra, and in the studies now in progress the extension of the short-wave end can be traced as the altitude increased.



Microphotograph by T. R. Wilkins

A COSMIC RAY SIGNS ON THE DOTTED LINE

This is the first published picture known recording the path, clear as a rabbit track in the snow, of a cosmic ray of such high energy, directly in the emulsion of a photographic plate. The ray entered the emulsion at the top of the picture, speeding from outer space with the vast energy of 100,000,000 electron volts, marking its dotted-line track by affecting the silver grains of the emulsion (see page 698). The spacing of the dots indicates the track was made by a high-energy alpha ray, the core of an atom of helium, confirming recent evidence that some cosmic rays are of this nature. The track became visible when the plate was developed and magnified 450 times. The short dotted line slanting across the second section from the bottom has been interpreted as the track of a high-speed proton knocked off from an atom struck by the cosmic ray as it passed through the emulsion at terrific speed.

This shortening of the spectrum at the surface of the earth by the cutting off of the very shortest of the ultra-violet waves of light hides a fact vital to the very existence of life as we know it on the earth.

The ultra-violet waves that fail to get through to the earth's surface are blanketed out, it has been found, by a relatively small amount of ozone mixed in the air above the earth. Ozone is common oxygen, except that three atoms are linked together to form the molecule instead of the usual two.

HOW OZONE PROTECTS LIFE ON THE EARTH

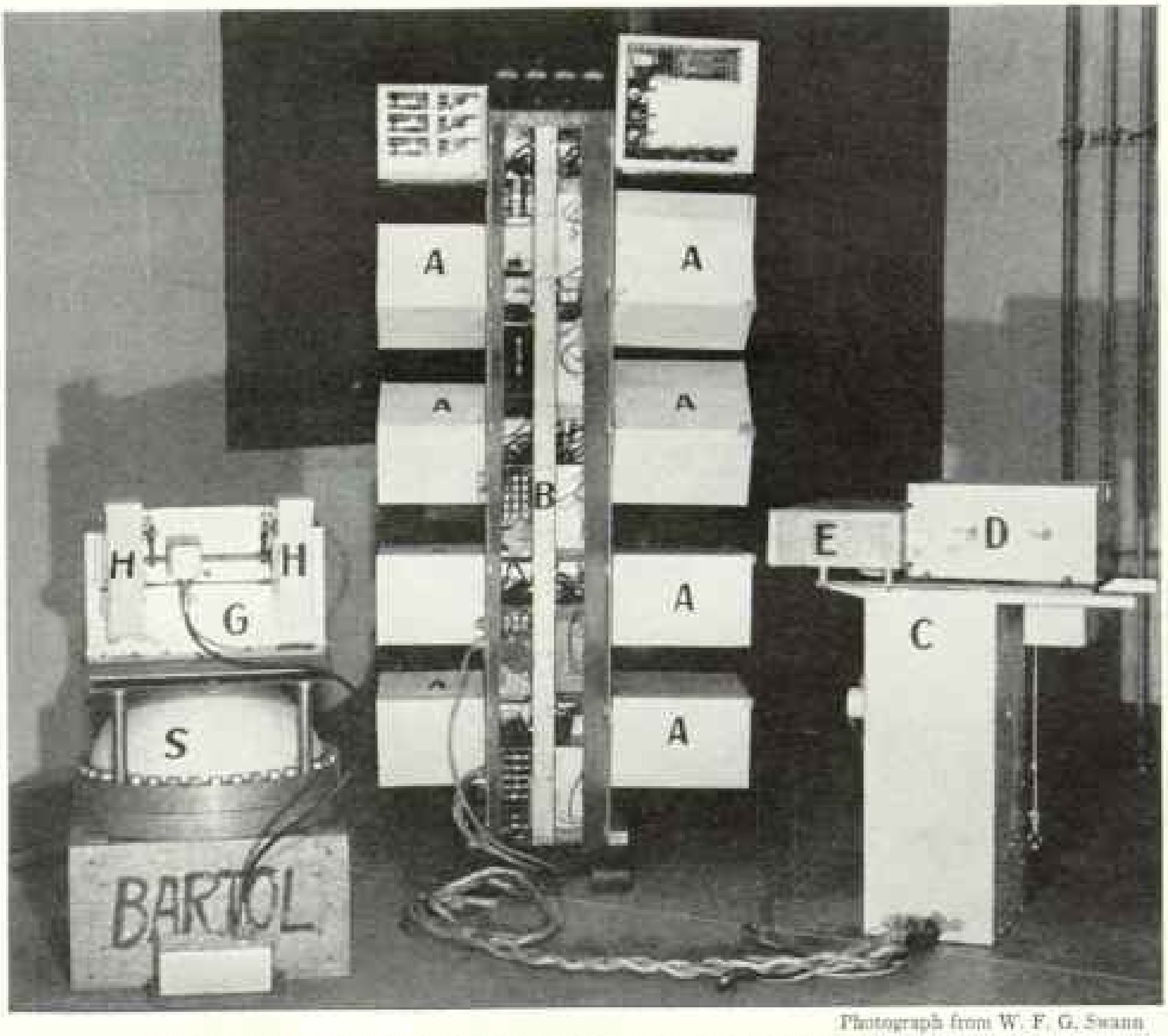
These "lost waves" would prove tremendously destructive if they got through to the earth, Dr. Brian O'Brien and Dr. F. L. Mohler point out in their report on the spectrographic work. If even half of them reached us, because of a decrease in the ozone above us, they would destroy our skins in a few minutes' exposure to the sun.

On the other hand, if still more of the ultra-violet light were absorbed by an increase in the ozone, the human race would probably die out for lack of the essential vitamin D, the "sunshine vitamin," always supposing that we could survive the enormous increase in bacterial growth which this thicker ozone layer would permit.

Therefore, the small amount of ozone in the atmosphere acts as an all-important regulator of life itself.

The spectrographic method used during the flights of *Explorer I* and *Explorer II* measured the proportion of the total ozone left below the balloon at various altitudes. This was done by recording, as the balloon rose, the changing ratio between an ultra-violet wave length not absorbed by ozone, and another ultra-violet wave length which is strongly absorbed by ozone.

The calculations from such spectra are necessarily laborious and not all have been completed for the 1935 flight. However, it has been determined that



Photograph from W. F. G. Swann

THESE BOXES "TRAPPED" VISITORS FROM FAR OUTPOSTS OF SPACE

The ten boxes marked A (top two open) contained cosmic ray "telescopes" pointed at different angles from horizon to zenith. The powerful rays, entering the "telescopes," released electric currents which traveled through the switchboard B to the box, E. There the currents operated shutters corresponding to each telescope, recording flashes of light on moving photographic paper in the camera, D. The currents released by the cosmic rays also registered on ten counter dials in the box, C. The camera D photographed these dials every half minute, along with a level indicator, a compass, and a watch. At the balloon's "ceiling" cosmic rays came almost equally from the horizontal and vertical directions. The sphere marked S (the stoss chamber) contained compressed nitrogen and was covered with a slab of lead. Cosmic rays smashed atoms in the lead and the fragments flew into the nitrogen. This caused a sudden increase in the ionization of the gas which was recorded through the electrical apparatus G and the cameras, H. This equipment was constructed and installed by the Bartol Research Foundation of the Franklin Institute (page 695).

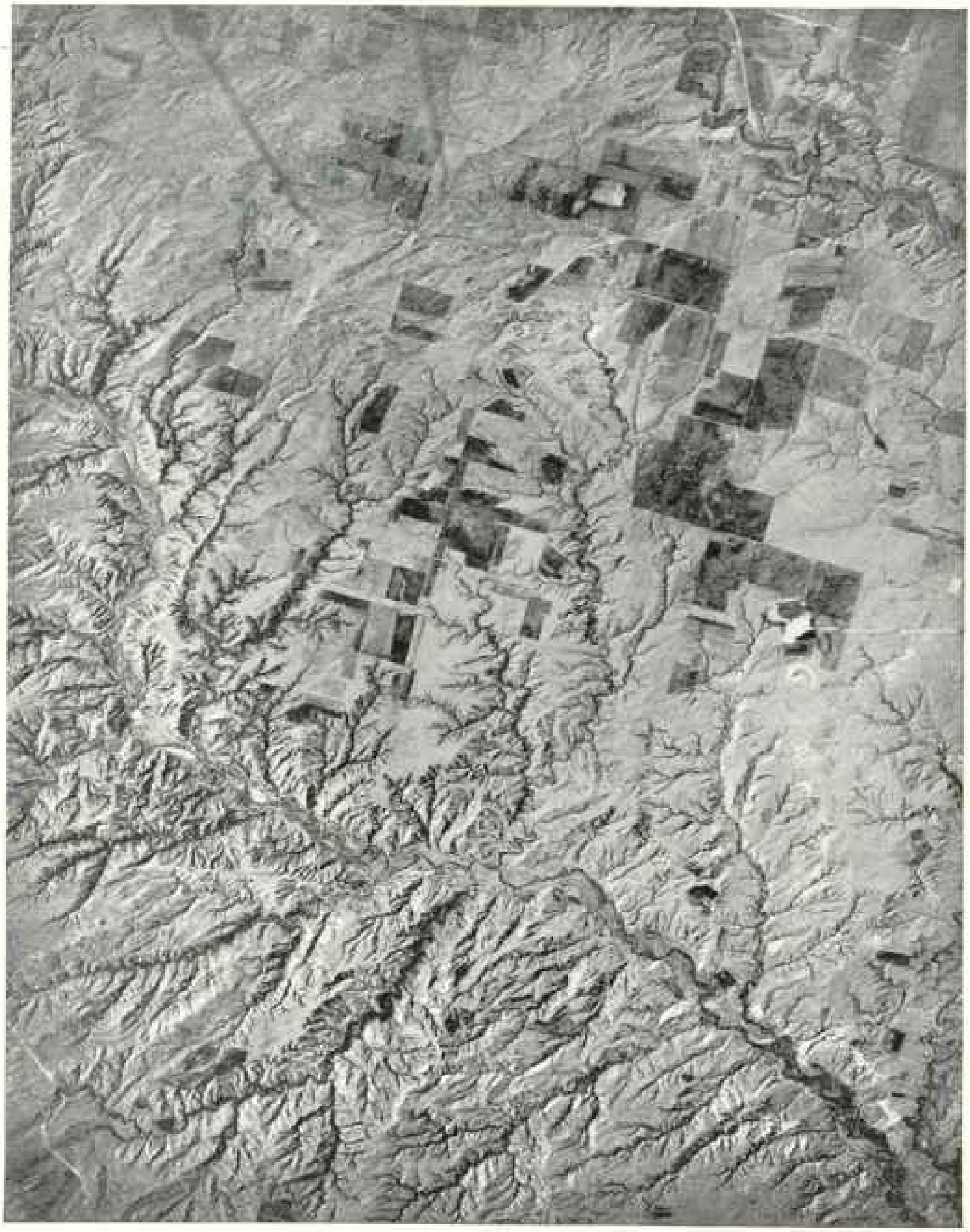
at the altitude of more than 72,000 feet reached by *Explorer II*, twenty per cent of the total ozone lay beneath the balloon.

The bombardment to which the atmosphere is subjected by the endless barrage of billions of cosmic rays causes a marked ionization of the gases of the air.* This ionization, it had been known, grows greater as one rises above the earth into a region of greater cosmic radiation. The more a gas is ionized, the more easily it conducts electricity. The ability of the air to conduct electricity—its "electrical conductivity"—therefore was understood to grow greater as one rises above sea level.

Measurement of this change was another important project during the flight, for never before had electrical conductivity of the air been measured above 30,000 feet.

The electrical conductivity apparatus

* A gas is ionized when some of its atoms are "mutilated" by having electrons torn off. This leaves a positive charge of electricity on the atom and a negative charge on the separated electrons.



THE HIGHEST VERTICAL PHOTOGRAPH YET MADE BY MAN

This exposure, made automatically by an aerial camera with its lens mounted in the bottom of the gondola, was at 11:41 a.m., November 11, 1935, when the balloon was at its world-record height of 72,395 feet above sea level (69,780 feet, or more than 13 miles above the ground), over south-central South Dakota. The photograph covers approximately 105 square miles. The geometrical cultivated fields and the straight section lines at the north (right side of picture) stand out in sharp contrast to grasslands and erosion channels carved by rain water draining into the South Fork of the White River, which extends diagonally across the lower part of the picture. Near the upper right-hand corner (about an inch below the top of the picture) is Parmelee with its small grid of streets. U. S. Highway No. 18, showing as a fine white line, enters Parmelee from the top of the photograph. The white, irregular object approximately an inch in from the middle of the right margin is the official meteorograph suspended 33 feet below the gondola. The two shadowy lines extending inward from the top margin are ropes dangling from the side of the sphere.

was designed and built by O. H. Gish and K. Sherman, of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. It consisted essentially of a metal rod about a half inch in diameter and a foot long, extending vertically along the axis of a chimneylike casing on the outside of the gondola. The rod was insulated at its support by amber. It was charged electrically and connected by a fine wire, through insulating material, to an operating and recording apparatus inside the gondola.

AN ELECTRIC FAN—AT 81 BELOW ZERO!

The top and bottom of the "chimney" were open, and an electrically driven fan in the top constantly circulated air past the rod. The electrical conductivity of the air at any altitude was measured from an automatic record of the time required for the charged rod to give up a definite part of its electricity to the air. When the charge was gone, the apparatus automatically recharged the rod, and measurement of the time of discharge was repeated.

Air has in it both positive and negative ions, and so the electrical conductivity apparatus was constructed to measure either positive or negative charges. At intervals during the flight a switch was shifted, thus alternating the methods of measurement.

The greatest conductivity measured was at an altitude of 61,000 feet, where it was 81 times the sea-level value. At the highest altitude reached by the instrument the recorded value was 50 times the sea-level value.

In the lower few thousand feet of the atmosphere, radiation from the earth helps to ionize the air and so affects its conductivity. At very high altitudes, the shortest of the sun's ultra-violet rays have not been screened out by the atmosphere and they cause ionization of the air. However, throughout most of the region we explored, ionization is thought to be due almost entirely to cosmic radiation.

We have already told of the faultless functioning of our radio transmitting and receiving sets, which kept us in constant communication with earth stations.* We now know something of the characteristics of the signals, from detailed reports that have reached the National Broadcasting Company.

Signals from the 8-watt transmitter in our gondola were heard from coast to coast of the United States even before the balloon left the Stratobowl, and they increased in intensity at most listening points as altitude increased. But above 60,000 feet there was an apparent decrease in the strength of signals as received by several observers, an effect borne out by a direct recording of the signal strength made by R.C.A. Communications at the Riverhead, Long Island, receiving station.

This effect was not anticipated, and so far it has not been possible to find an entirely satisfactory explanation. It may have been caused by the low atmospheric pressure in which the transmitting antenna hung, or it may have been due to some vagary of radio propagation from points outside the troposphere.

Science has long wanted samples of air from the upper regions of the atmosphere to determine whether it differs in make-up, in the proportions of its ingredients, from the air near the earth's surface.

Air is not a chemical compound, like water. It is a simple mixture of gases, mostly nitrogen and oxygen, kept stirred together in the world we know by wind and vertical air currents. Theoretically it is like certain cough medicines whose ingredients would separate into zones, one above the other, if they were not shaken.

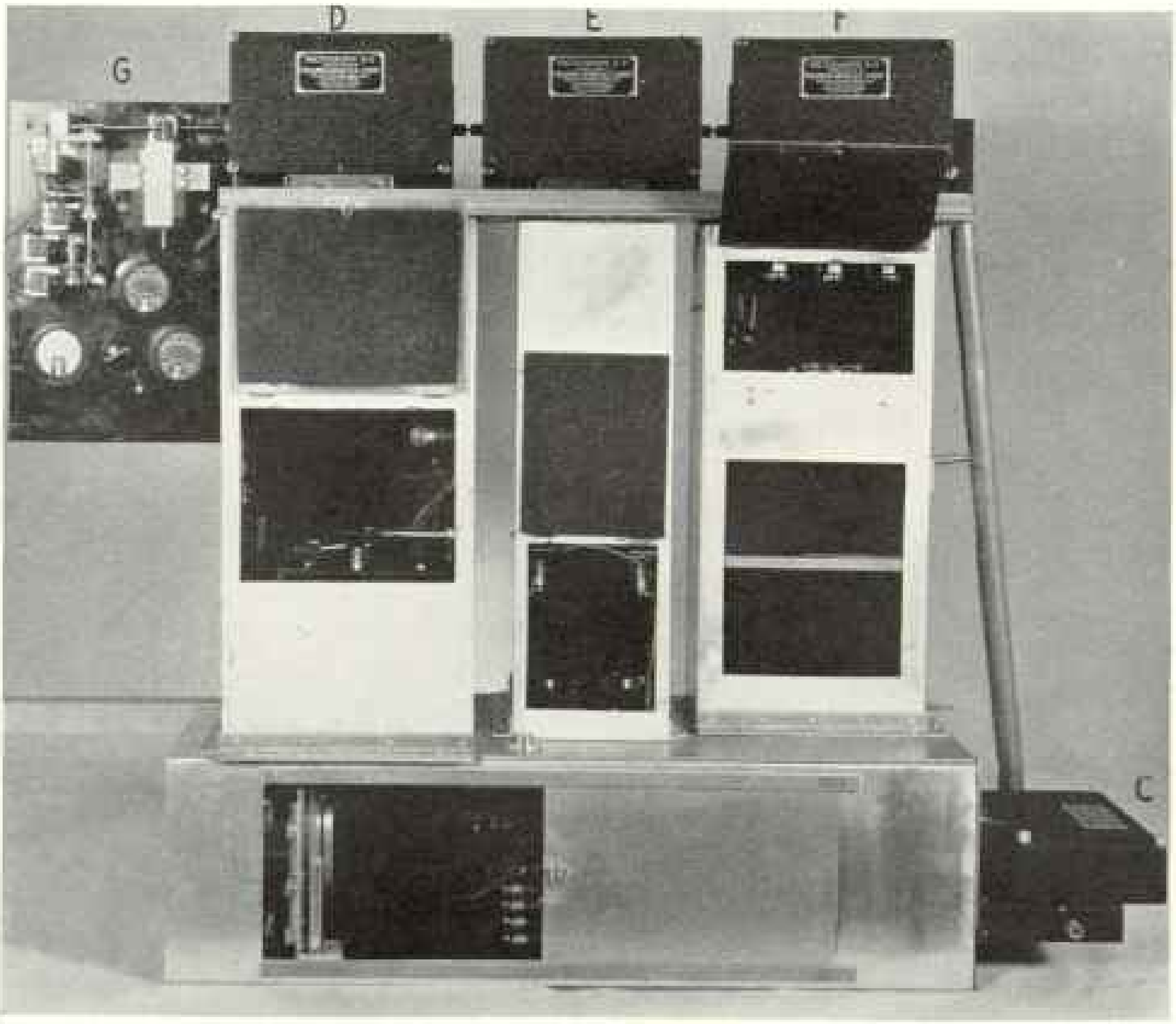
It has been supposed that far up in the stratosphere, since there is no turbulence due to vertical currents, the air gases do tend to separate out. This action should show itself first as an increased proportion of nitrogen, which, being lighter than oxygen, should tend to concentrate upward.

A PRECIOUS TWELVE GALLONS OF STRATOSPHERE AIR

During our flight we obtained two samples of stratosphere air, each of nearly six gallons. When six gallons of rare air, under only one-twenty-fifth of an atmosphere of pressure, is brought down to earth, however, it amounts to less than one quart under our normal pressure.

The two quart samples represent the only sizable samples of air that have ever been captured at such a height above sea level, and their analysis has been undertaken at the National Bureau of Standards by G. M. Shepherd (see page 711).

* See "Man's Farthest Aloft," by Capt. Albert W. Stevens, in the NATIONAL GEOGRAPHIC MAGAZINE for January, 1936.



Photograph from E. S. Hinsline

THIS "AUTOMATIC SECRETARY" TOOK VOLUMINOUS NOTES ON CAMERA FILM

Four Factograph cameras (marked D, E, F, and C) automatically photographed at intervals the readings of dials connected electrically with instruments inside and outside the gondola. Camera D photographed dials of thermometers, a group of levels showing whether the gondola was on an even keel, and a Hamilton watch to show the time each photograph was made. Camera E photographed five Weston photo-electric meters showing brightness of sun, sky, and earth, and a watch; camera F, dials of a magnetic compass, bubble level, and watch; camera C, mercurial and aneroid barometers and a watch. Cameras D and C snapped pictures every 90 seconds; cameras E and F every 15 seconds. The "mechanical brain" labeled G synchronized all these cameras, plus another camera that took readings of the spectrograph inside the gondola and the Fairchild aerial camera in the bottom of the gondola, which took photographs vertically downward (pages 698, 699).

So far, the studies indicate that the composition of the stratosphere is almost the same as that of air at ground level. Very slight differences have been found, but their significance has not yet been established.

Practically no information has been available in the past as to whether spores—the microscopic bodies from which certain molds and bacteria develop—can live in the stratosphere and so be spread to distant regions by air currents. If such living organisms are present in the stratosphere, the fact would be of practical interest to botanists, plant pathologists, and medical men.

The Scientific Advisory Committee determined to attack the problem in two ways. For one test we took up with us, in small quartz tubes fastened to the outside of the gondola, the spores of seven species of fungi. The tubes were open at both ends and were plugged loosely with cellulose yarn.

SPORES SURVIVE WHERE MAN COULD NOT LIVE

Although subjected for many hours to drying, extreme cold, strong light rays,

ozone, and low air pressure, the spores of five * of the species returned to earth with vitality unimpaired. They germinated fully as well as others taken from the same cultures before the flight, and the resulting fungi are now growing in test tubes.

A sixth fungus, *Cladosporium* sp., while recovered in pure culture, showed a very low percentage of germination. Final tests of the seventh, *Hysperium* sp., have not been completed.

For a second test we took along a spore-collecting device designed by Dr. Lore A. Rogers and Mr. Fred C. Meier, of the Department of Agriculture, and Dr. Briggs, to find whether we could collect floating living spores from the air of the stratosphere.

The apparatus consisted of a glass collecting tube four inches in diameter and about seven inches long, its inner surface coated with glycerin. The tube was surrounded by a cylindrical duralumin protecting case.

The ends of both the tube and the case were provided with sterile plugs, and the whole apparatus, including a parachute, was sterilized and placed in a sterile dust-proof bag (see page 697).

We released the device after we started down, at an altitude slightly above 70,000 feet. The filling of an exterior parachute opened the bag and allowed the apparatus and its sterile parachute to fall out. A little later this parachute opened, pulled the plugs from the case, and allowed air to stream into the collecting tube and to be deflected against its sticky inner surface.

The apparatus was so designed that this passage of stratosphere air through the collecting tube continued until an altitude of about 36,000 feet was reached. There a small vacuum can (aneroid), set for the air pressure of that altitude, acted as a trigger, allowing springs to clamp the sterilized cotton-covered disks over each end of the collecting tube, so protecting it until it could be examined under laboratory conditions.

The apparatus was carried safely to earth by its parachute, was recovered by Mr. Frank Brtna, of Academy, South Dakota, and was expressed by him to Washington, D. C., where it was received with the covers safely clamped over the ends of the tube. To avoid all possibility of contaminating the collection tube, a laboratory culture room at the Department of Agriculture had been thoroughly cleaned and kept closed in preparation for the arrival of the apparatus.

Inasmuch as only a very few, if any, spores were expected to be caught by the apparatus, it was obviously hopeless to search for such spores in their normal condition in the tube. It was necessary, therefore, to furnish food to cause them to grow until they multiplied into groups or colonies that could be seen.

A MIDNIGHT VIGIL IN A LABORATORY

A flask of nutrient agar which had been sterilized several days before and then incubated as a test for sterility was waiting. At night, when the building was freer from moving dust than at any other time, the glass collecting tube was removed from its case with the cotton-covered disks still held in place over its ends.

Using every precaution to prevent contamination from the air of the laboratory, Dr. Rogers and Mr. Meier melted a small amount of the sterile agar and introduced it into the cylinder, which was quickly closed and then rotated to spread the agar over the surface of the glycerin covering the inside wall.

As the agar cooled it formed a soft thin film on the inside of the glass. The cylinder, with both ends still tightly closed, was then placed in an incubator at 30° C. (86° F.) to encourage the development of any bacteria or mold spores which might be present.

Forty-eight hours later growth was visible through the glass wall at ten different points. Dr. Rogers determined that five of the colonies were bacteria and transferred them to test tubes for study. He found they were all aerobic—that is, they grew in the presence of free oxygen—and that they were all spore formers.

These two facts place them in the genus *Bacillus*. This is a large group of bacteria widely distributed and very common in the soil and on plants and other material exposed to dust and soil. The specific names of these five cultures were not determined, but it was clear that they were distinct varieties if not five species.

The other five colonies in the collection tube were found by Mr. Meier to be mold fungi of types which form spores readily in culture. Hence, by studying the fruiting structures under the microscope, they could easily be identified.

* *Brachysporium* sp., *Diplodia* sp., *Rhizopus nigricans*, *Aspergillus niger*, *Helminthosporium sativum*.

Assistance in this identification was given by Dr. A. F. Blakeslee, Carnegie Institution of Washington, Cold Spring Harbor, New York, and by Dr. Charles Thom and Dr. John Stevenson of the Department of Agriculture, all specialists on the particular organisms involved.

When examinations were completed, it was determined that the following fungi had been removed from the cylinder: *Rhizopus* sp., *Aspergillus niger*, *Aspergillus fumigatus*, *Penicillium cyclopium*, and *Macrosporium tenuis*.

Representatives of all of these species have a wide geographic distribution and have been repeatedly collected by Mr. Meier over different locations at lower levels. The spores of all five are extremely resistant to unfavorable conditions, and, being very small, are easily carried in air currents. For example, the globe-shaped spores of *Aspergillus fumigatus* are not more than thirty-two ten-thousandths of a millimeter in diameter.

FUNGI IMPORTANT TO LIFE OF MAN

With the exception of *Macrosporium tenuis*, which grows commonly on dead and decaying vegetable material, these fungi have interesting relationships to man.

Rhizopus is the common bread mold. It also causes decay of fruits and vegetables during the marketing period.

Aspergillus niger is likewise a common cause of fruit rots, especially in the Tropics.

Aspergillus fumigatus has frequently been isolated from unmilled grain, hay, and other stock feeds. As an agent of disease it is constantly encountered as a cause of lung lesions in birds as well as occasionally in man and other mammals.

Penicillium cyclopium is a commonly distributed organism which has been known to cause a bulb rot of onions and tulips.

To test the ability of these five mold spores to live for long periods under conditions of extreme cold, Mr. Meier and Dr. Paul Emmett of the U. S. Department of Agriculture packed them in test tubes surrounded with dry ice, and kept them for 200 hours at a temperature of minus 78 degrees Centigrade (108.4 degrees below zero Fahrenheit).

This was about 27 degrees colder than the coldest temperature encountered in the stratosphere. After this exposure all five of the fungi were found to germinate normally.

After rechecking the operation of the collecting apparatus, and making numerous other tests, Dr. Rogers and Mr. Meier feel safe in assuming that the ten cultures were obtained from the region above an altitude of 36,000 feet.

They point out that there are a vast number of spores of micro-organisms which do not exceed the size and weight of those collected, and which could be carried as high. Having reached such a height, they would be blown long distances before again settling to earth.

The experiment may offer additional explanation of the spread of organisms which cause diseases of plants and animals, as well as a basis for understanding why identical species of micro-organisms are constantly found in widely separated parts of the world.

For a time it was feared that there were no survivals among the fruit fly (*Drosophila*) cultures which we took with us in a package inside the gondola. They were furnished by Dr. L. J. Cole and Professor Victor Jollos, of the University of Wisconsin, to test the assumed rôle of cosmic rays as a major cause of hereditary changes (mutations).

It was found that although the adult flies were all killed, probably by the low temperature inside the gondola, eggs and young larvae survived and gave 98 individuals for breeding experiments.

HOW THE SKY, SUN, AND EARTH LOOKED AT TOP OF FLIGHT

The questions asked us most frequently concern the appearance of the sky, the sun, and the earth from our highest altitude.

All of those who have reported on the appearance of the sky observed during stratosphere flights have told of the deepening of the blue color toward the zenith as the observer rises higher and higher.* We had observed this phenomenon during our flight in *Explorer I* in 1934.

On the 1935 flight in *Explorer II* we attempted to get a photographic record of the sky tints by using a National Graflex camera loaded with Dufaycolor film. We were fairly successful in spite of the difficulty of photographing, through the upper glass-covered porthole, that portion of the sky not obscured by the huge balloon.

* See "Ballooning in the Stratosphere," by Auguste Piccard, in the NATIONAL GEOGRAPHIC MAGAZINE, March, 1933.

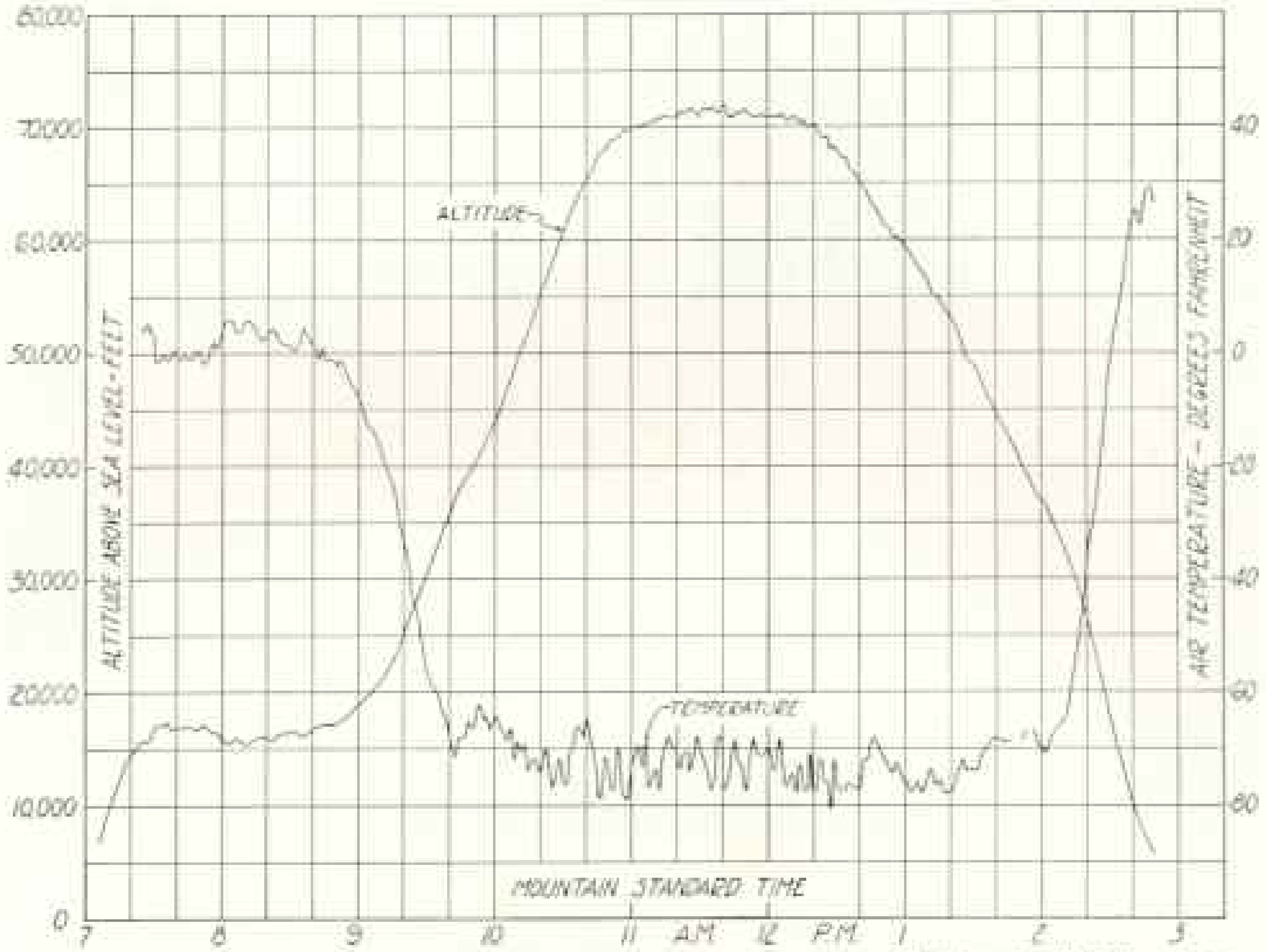


Chart drawn by W. G. Bromhacher

HUNDREDS OF LENS-EYE "NOTES" OF TEMPERATURE AND ALTITUDE ARE CHARTED ON A LOG OF THE FLIGHT

The chart summarizes more than 600 photographs of barometer and thermometer dials, "read" automatically by cameras during the flight. It shows that the highest altitude, 72,395 feet, was reached at 11:41 a.m. (MST). The lowest temperature was nearly 81 degrees below zero Fahrenheit, recorded at 12:27 p.m., when the balloon had descended to 68,000 feet. Irregularities in the altitude line at the top of the chart show how the balloon bobbed gently up and down, sometimes as much as a thousand feet, as it hovered near its ceiling. The jagged waves in the temperature line near the bottom show sharp fluctuations of the air temperatures recorded in the stratosphere, sometimes as much as 9 degrees in three minutes. These fluctuations were probably caused by radiation from the balloon, heated by the sun. The first reversal of the temperature line at 9:42 o'clock marks the gondola's entrance into the stratosphere at 37,000 feet above sea level. The reversal at 2:02 marks the instant of leaving the stratosphere. The altitude line comes to an end at about 6,000 feet at 2:50 p.m., the time at which the motor of the Factograph cameras was cut off. Switching off current to test the thermometer caused breaks in the temperature line just before 2:00 p.m.

The color films, when developed, showed that the dark-blue field of a large flag of the United States, suspended in the balloon rigging, was strikingly lighter than the very dark blue of the sky beyond it.

WHERE THE DEEPER BLUE BEGINS

At the horizon there was a whitish haze which merged a few degrees above into a turquoise blue. At about 30 degrees above the horizon the color was the typical "sky blue" that one observes from the earth straight upward on a clear day. Above 30 degrees the blue rapidly became deeper.

Unfortunately we could not see the sky directly above our heads. Our huge balloon, completely filled out by the expansion of its helium gas, floated immediately above us, blotting out all of the heavens above an angle of about 55 degrees above the horizon. The sky which we could see at this angle, beyond the edge of the balloon, was almost black, with just a trace of blue.

Since, at our altitude of more than 13 miles, we were above 96/100ths of the air, there were practically no dust particles and relatively few gas molecules above us. Consequently there were virtually no targets left to scatter the sunlight; and the sky upward seemed relatively black.

If we could have seen the sky straight up, it probably would have been as black as a

THE NOW FAMOUS PATCH MADE IN TIME TO SAVE THE FLIGHT

On the night of inflation expanding gas caught in a pocket of the balloon fabric and tore a hole 17 feet long. Working in the open, despite nearly zero weather, experts of the Army Air Corps and the Goodyear-Zeppelin Corporation cemented the patch securely. It can be seen in this photograph as a thin strip across the fabric at the level of Captain Stevens' head. Heat from a huge 1,500-watt electric bulb was used to "cure" the patch, and, unlike any other part of the balloon, the seam was reinforced wholly outside the bag.

midnight sky, and doubtless we could have distinguished some of the brighter stars shining in it.

WHERE SUN WAS BRIGHTEST THE SKY WAS DARKEST

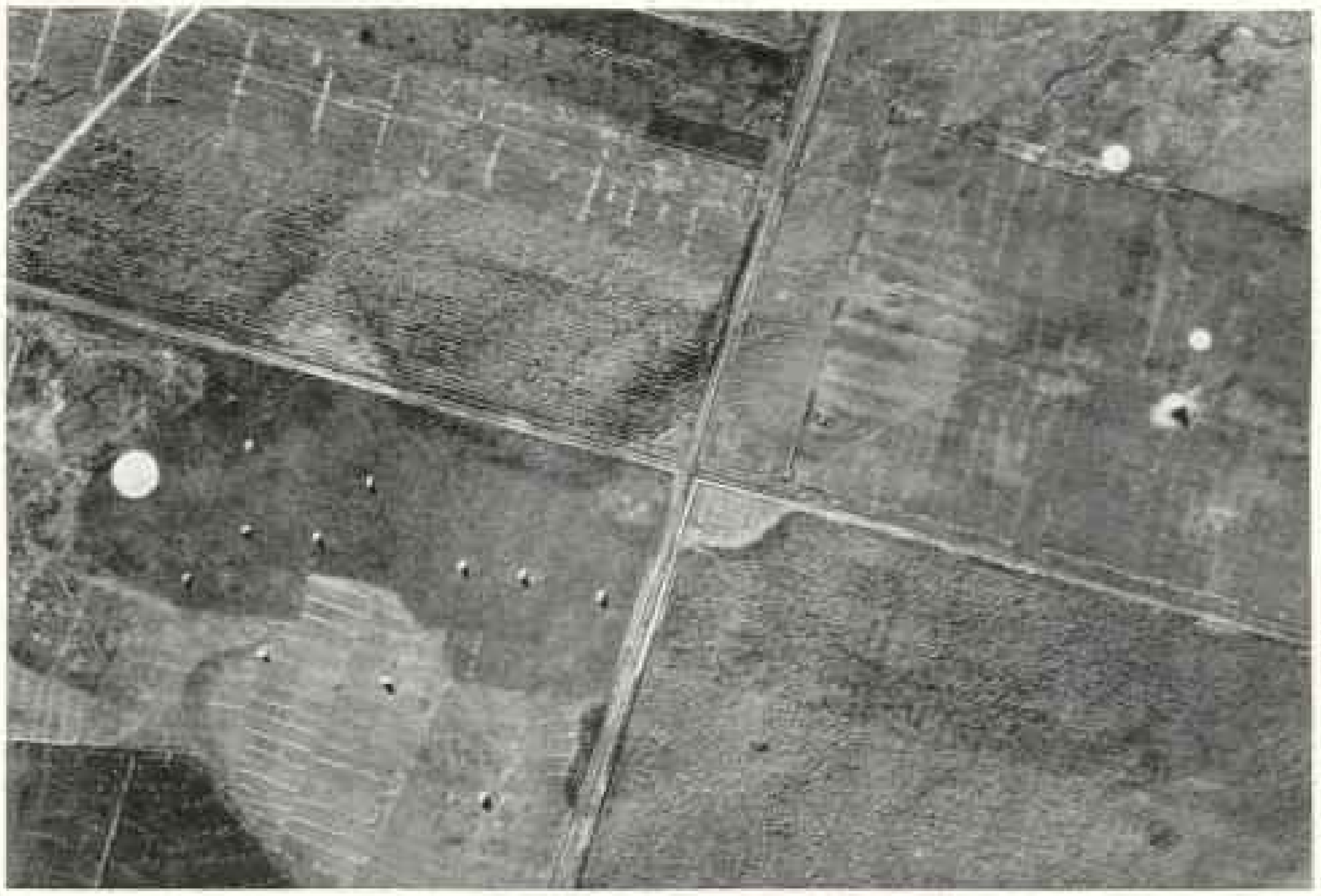
The brightness of the sky, like its color, is determined by the relative number of targets of gas molecules and dust particles present. On the outside of the gondola we had arranged five 1½-inch metal tubes side by side, pointing upward at an angle of 45 degrees and including ten degrees of "vision." At the bottom of each tube was a sensitive photronic cell, which, changing light into electrical energy, made it possible to measure the brightness of the light by means of meters inside the gondola.

The five cells were electrically connected so that in effect they were one instrument. The tubes were at such an angle that no reflected light from the balloon could reach the sensitive faces. Nor could direct sunlight reach the cells except at rare intervals in our flight when the sun was between 40 and 50 degrees above the horizon and the balloon, in rotating, presented the tubes toward the sun.

Readings of the sky brightness meters were made photographically every 15 seconds. A study and tabulation of these readings made since the flight shows a progressive decrease in sky brightness as our altitude increased. At the top of the flight it was only about one-tenth that viewed from earth.

Also on the outside of the gondola, but unprotected by directional tubes, were three additional cells for measuring direct sunlight. Each cell was supplied with its special window; one target had a quartz window to permit ultra-violet light to reach the receiver; another had a filter of special glass to exclude ultra-violet light; the third target was filtered to respond to light in the same manner in which the human eye responds.

The first two instruments showed that the ultra-violet is strongly absorbed in the outer portion of the earth's atmosphere—a fact confirmed by the spectrograph records. The third instrument indicated that the



THREE BATTERIES MAKE PARACHUTE "JUMPS"

This vertical photograph, taken from an altitude of 10,000 feet, about 33 minutes before landing, shows three parachutes, each carrying a heavy battery which had completed its service and was discharged as ballast. Each battery was recovered undamaged.

light received from the sun increased as the balloon ascended, reaching at the top of the flight a value a little over 1.2 times that on the ground.

Although we did not know what the meter readings were, relying on the Factograph automatically to record the values (page 704), we were conscious that the sun was very much brighter; the effect was probably heightened because the contrast was so great between the bright sun and the dark sky from which it shone.

On the ground, one may look directly at the sun without extreme discomfort only on hazy days. As one climbs a high mountain, or ascends into the sky, the sun loses its yellow color and gets whiter and whiter. Our impressions as we looked through a porthole toward the sun, while we were in the stratosphere, were that it was a blindingly white disk of light, clear-cut and sharp, against the dark blue of the sky.

On the flight of *Explorer I*, we noticed that the ropes from which we hung had an unusual phosphorescent glow. At times they appeared larger than normal. It is possible that this was produced by water vapor coming out of the ropes under the reduced pressure of our highest elevation and that what we saw, therefore, was the sun's light on minute quantities of vapor. We have mentioned in a previous article that at times clouds of smoke appeared to roll by the windows of the gondola. It is possible that this, too, was vapor coming from parachute bags, ballast sacks, battery boxes, or ropes.

Only recently I happened to be wearing a very dark-blue suit in the laboratory while working near a quartz mercury-vapor lamp which emits a considerable quantity of ultra-violet light. By the light of a single incandescent lamp some distance away and the ultra-violet light of the quartz lamp, the dark-blue cloth had a peculiar appearance which reminded me more than anything else I have seen of the color of the sky as we saw it looking by the visible rim of the balloon.

Still another brightness cell was mounted on the bottom of the gondola with its face directed downward to measure changes in earth brightness as the balloon ascended. It showed an increase in the *apparent* earth brightness. Most of this effect was due to the increased amount of light which the

earth received from the sun as it rose higher in the sky with the approach of noon. There was also an increase due to the additional amount of light reflected upward from the "sky" below us.

The appearance of the earth as shown by our photographs was not exactly as it looked to our eyes, because we used infra-red-sensitive and red-sensitive film. Form is presented faithfully, but the lights and shadows of the photographs differ from those seen by the eye. Red or brown areas, for example, show white on the photographs.

PHOTOGRAPHING OBJECTS INVISIBLE TO THE EYE

In photographs of distant objects the differences are greatest. Haze that completely blots out human sight is easily penetrated by infra-red rays, so that properly equipped cameras can photograph objects invisible to the eye, through the haze.

As we looked outward through the portholes of the gondola, at the greatest height from which an eye has ever looked earthward, we could see only about 175 miles. Beyond this, earth and sky merged together in a band of white haze that prevented us from seeing the great sweeping curve of the horizon. But our camera, loaded with infra-red-sensitive film, cut through the haze and clearly recorded the upper surface of the dust-laden air of the troposphere.

Although our vertical aerial camera took its pictures automatically, the aerial camera which pointed toward the horizon was operated by hand. Shortly after we reached our ceiling I made several exposures with this camera. One of these resulting pictures, enlarged, showing clearly the curved horizon, is published as a supplement to this issue of THE GEOGRAPHIC.

We knew a few days after our flight that the altitude reached, as determined by the official sealed meteorograph, was 72,395 feet above sea level.

NEW FACTS ON UPPER AIR CURRENTS

Detailed studies have not yet been made of the speed of drift of the balloon, and therefore of wind velocities; but velocities at one or two levels have been determined. From the vertical photographs it has been found that while the balloon was hovering at and near its ceiling, it was drifting from southwest to northeast at a speed of 41.6 miles per hour.

From the ground observations, a velocity at ceiling slightly less than this was computed. The observers on the ground found that the balloon reached a horizontal speed of 43.1 miles an hour at a lower level during its descent.

Explorer II at no time entered a current of air drifting to the west, as did *Explorer I*, in 1934, at about an altitude of 60,000 feet. In our latest flight we drifted to the southeast from the time of our take-off until we reached approximately 17,000 feet.

While rising from 17,000 to 37,000 feet, the base of the stratosphere, we drifted in general eastward, and, above that level, north of east. During the descent we again entered an air current drifting from northwest to southeast. Toward the very last we encountered a light ground wind blowing to the north.

Our ideas on velocities of wind in the stratosphere have changed in the past three years. At the time when we first chose South Dakota as a starting point, one of the reasons, aside from the natural advantages of the Stratobowl, was the fact that we had 1,200 to 1,700 miles of the United States to drift across, southeastward or eastward. For more than 1,000 miles we had flat, level country in which to make a landing before reaching mountains.

It was thought, from the speed of drift of Commander T. G. W. Settle's balloon in November, 1933, that the balloon *Explorer I* might easily travel a thousand miles or more in ten or twelve hours. But the results were different. On the first flight we drifted a little more than 300 miles in ten hours, and on the second flight we drifted 230 miles in eight hours.

The average velocity of about 30 miles an hour does not give the whole story. At 60,000 feet on the first flight we were drifting very slowly at 8 miles an hour and, in fact, had started to drift in the reverse direction, or westward. On the second flight, at 60,000 feet and higher, we always continued north of east at a speed of about 42 miles per hour.

This evidence should not be taken to mean that the velocities at altitudes from 60,000 to 72,000 feet are likely at all times to be between 8 and 42 miles per hour; for it must be remembered that our stratosphere flights are made at times when the weather is nearly perfect, free from much wind on the ground, and with a high-pressure condition existing over a large area around the take-off point. Whether this

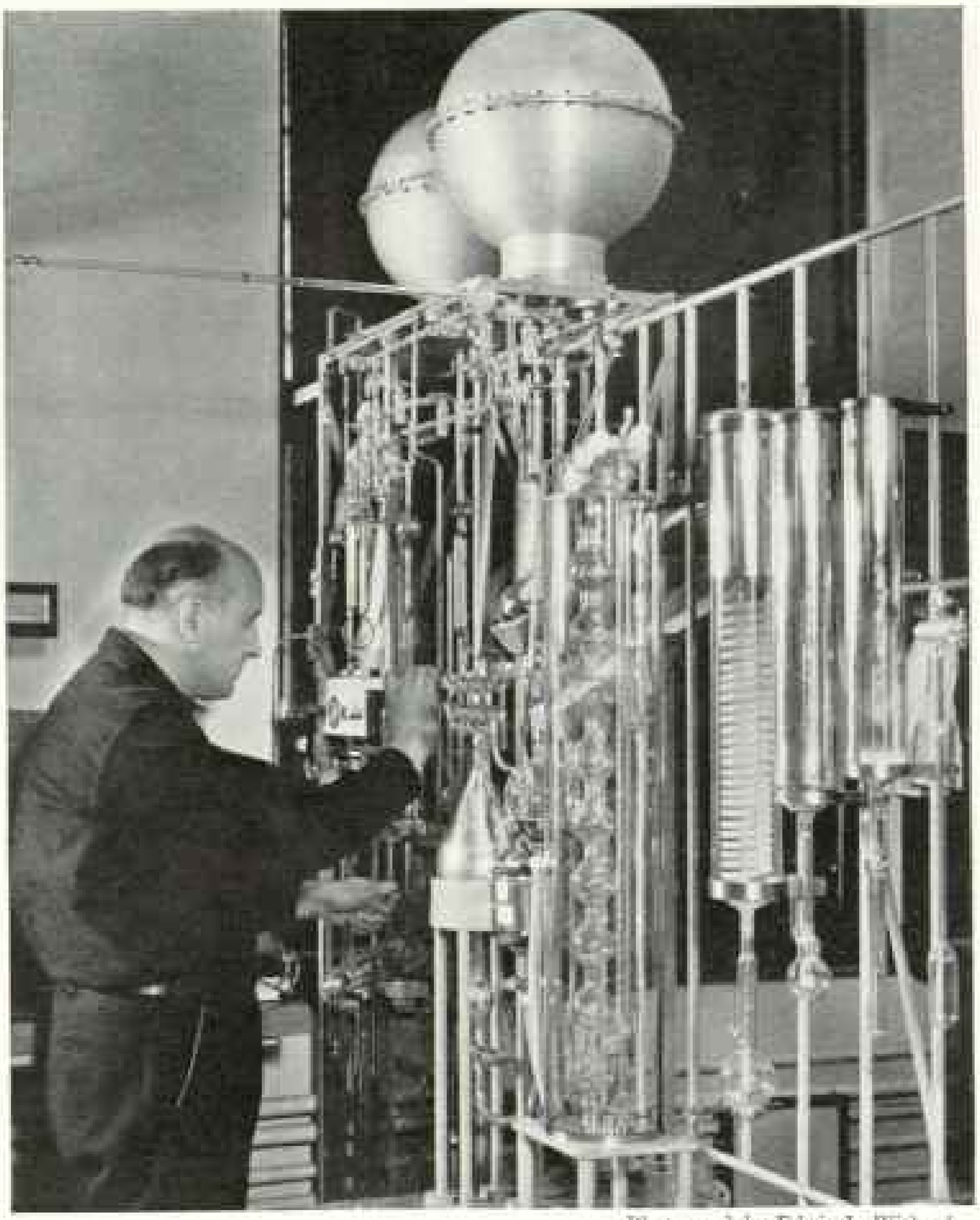
high-pressure condition, resulting in low air velocities in the lower levels of the atmosphere, also results in low velocities in the stratosphere, is debatable.

It also happens that most of our sounding balloon observations are apt to give moderate wind velocities in the stratosphere, because sounding balloons can be observed at levels of 40,000 to 80,000 feet by telescopes only on days that are fairly clear.

Such days more often exist when there are high-pressure conditions, which are exactly the sort of days upon which stratosphere flights must be made. On days when a low-pressure condition exists, clouds are apt to be overhead, thereby preventing the following of sounding balloons by telescopes.

When there are extremely high velocities in the stratosphere, a sounding balloon may drift so fast as to be beyond range of a telescopic station before the balloon has attained a level as great as that achieved by *Explorer II*.

On Commander Settle's flight there was such a wind velocity in the stratosphere that, after he reached that region, he drifted from a point near Akron, Ohio, almost to the Atlantic Ocean, a distance of 350 miles in less than five hours.



Photograph by Edwin L. Wisherd

ANALYZING STRATOSPHERE AIR—TOO THIN FOR ANY LIVING THING TO BREATHE AND LIVE

Some of the extremely thin air of the stratosphere at 70,000 feet above the earth was trapped by allowing it to rush into six-gallon containers, through valves in the gondola wall. Two containers, pumped free of all air before the flight, and sealed, here are mounted on top of apparatus for air analysis at the National Bureau of Standards, with G. M. Shepherd conducting the tests. Preliminary results indicate that air at 70,000 feet above sea level contains proportionately slightly less oxygen than air at the surface of the earth, but its composition does not differ as much from the air we breathe as some scientists had expected (see page 703).

On the day that Commander Settle ascended there was practically no wind, all day long, on the ground. It was an Indian summer day, cloudless and extremely hazy. Yet on this day there was a great air movement aloft.

This haze, on the day mentioned, was confined to the lower level of the atmosphere, and once Commander Settle got to 15,000 feet the air was quite as clear as it was on our flights.

CONQUERORS OF THE SKY ENROLLED IN HALL OF EXPLORATION FAME

General John J. Pershing, life trustee of the National Geographic Society, presents Capt. Albert W. Stevens (right) and Capt. Orvil A. Anderson (third from right) with the Hubbard Gold Medal, The Society's highest award, previously bestowed upon only ten other heroes of geography. At the left is Dr. Gilbert Grosvenor, President of The Society, who presided at the ceremony before a distinguished audience in Constitution Hall, in Washington, D. C., December 11, 1935 (see opposite page).

Even though the tabulation and analyses of records are still far from complete, a number of new facts have been added by the flight to our store of knowledge.

Cosmic rays measurable by their ionization effects, coming in from the vertical direction, increase in number from sea level to a certain altitude (57,000 feet during the flight of *Explorer II*), then decrease in number as the measuring instrument rises;

At 72,395 feet such measurable cosmic rays coming from the horizontal are as numerous as those from the vertical;

The first records were obtained of "bursts of energy" from atom disruption by cosmic rays up to 72,395 feet;

The flight resulted in obtaining the first track ever made directly in the emulsion of a photographic plate by a cosmic ray of the alpha-particle type having the enormous energy of 100,000,000 electron volts;

The first values were obtained by means of laboratory-size spectrographs, of sun spectra and sky spectra up to 72,395 feet;

A photograph made from the stratosphere was the first to show the curved top of the troposphere (marked by the dust which extends up to that altitude) and it also showed the curvature of the earth;

The first values were obtained for electrical conductivity of the air between 30,000 feet and 72,395 feet above sea level;

The first large samples of air were secured from an altitude above 70,000 feet, showing practically no change in the ratio of nitrogen to oxygen;

The first knowledge was obtained that living spores float in the atmosphere above 36,000 feet;

The first demonstration was made that spores will withstand physical conditions in the stratosphere up to 72,395 feet, for at least four hours;

The first natural color photographs were taken of the sky at high altitudes in the stratosphere;

The first records were obtained showing brightness of the sky at 72,395 feet (one-tenth that when viewed from the earth);

The first record was made of the brightness of the sun at 72,395 feet (20 per cent greater than when viewed from the earth);

Vertical photographs of the earth were made from a higher altitude than ever before (72,395 feet above sea level);

The first radio signals were sent to earth stations from a station as high as 13.71 miles above the earth.

HUBBARD MEDALS AWARDED TO STRATOSPHERE EXPLORERS

Presentation by General Pershing

FOLLOWING the successful ascent of Captain Albert W. Stevens and Captain Orvil A. Anderson to the highest altitude ever reached by man, the National Geographic Society presented to each of them its Hubbard Gold Medal.

The presentation was made on behalf of The Society, December 11, 1935, by General John J. Pershing, in Constitution Hall, in Washington, before members of The Society and their guests. After the presentation of the medals, Captain Stevens, Captain Anderson, and Captain Randolph P. Williams, ground officer for the flight, made their first public reports of the expedition and showed motion pictures and lantern slides of photographs taken during the flight.

DR. GROSVENOR'S ADDRESS

Dr. Gilbert Grosvenor, President of the National Geographic Society, who presided at the meeting, said:

"Members and friends of the National Geographic Society:

"It has been an extraordinary privilege for the Board of Trustees, the staff and the members of the National Geographic Society to cooperate with the U. S. Army Air Corps in stratosphere researches during the past two years. The longer we have worked with the gallant, resourceful, and brainy men that constitute the Army Air Corps the deeper has grown our admiration for the intelligence, efficiency, and fervor that animate every member of that remarkable corps.

"The National Geographic Society wishes also to pay tribute to the band of enthusiastic physicists and experts who, under the suggestive and wise guidance of the Chairman of the Scientific Advisory Committee, Dr. Lyman J. Briggs, assembled the technical apparatus and arranged the scientific program for what will rank as one of the most productive, as it was one of the most dramatic research expeditions of modern times.

"General John J. Pershing, beloved by all Americans, is the fifth soldier in the history of our country to achieve the exalted rank of General of the Armies of the United States. General Pershing has honored and aided the National Geographic Society for many years as an active and inspiring member of its Board of Trustees. Tonight he has consented to speak in his capacity as trustee of The Society. I have the honor to present General Pershing."

GENERAL PERSHING'S ADDRESS

General Pershing, in presenting the medals, said:

"President Grosvenor, members and guests of the National Geographic Society:

"Within the past year our Society has sponsored or participated in a series of extraordinary expeditions which have added important facts to world geography and altered the maps of two continents.

"The gallant Admiral Richard E. Byrd, whose second expedition to South Polar regions was supported by a substantial grant from The Society, returned with proof that the vast Antarctic land is a single continent.

"The Society's Yukon Expedition, under the leadership of the youthful Bradford Washburn, achieved the first crossing of the mighty St. Elias Range, discovered new glaciers and peaks, named two of the latter for King George and Queen Mary in honor of their Silver Jubilee, and mapped 2,000 square miles of territory.

"We are gathered tonight to honor two men who have climbed to the greatest distance yet reached above sea level, and have brought back to earth an amazing collection of scientific data from this remarkable height.

"It is for me a personal pleasure to take part in this ceremony because the Air Corps of the United States Army was joint sponsor of the expedition, and because this memorable ascent was made on Armistice Day, a memorable anniversary in our history.

"The studies of this expedition in many scientific fields, such as those bearing upon weather prediction, cosmic ray research, upon farming problems and radio transmission, illustrate the diverse activities of the National Geographic Society and the resourcefulness and enterprise of our peacetime Army.

"It is gratifying to recall that the Stratosphere Expedition of November 11th is only one of a number of assaults on the

battlefront of science in which the Army and The Society have been allies.

STEVENS AND ANDERSON WORTHY OF ARMY'S FINEST TRADITIONS

"In this instance the Army had representatives worthy of its finest traditions in the men who commanded and piloted the stratosphere balloon—Captain Albert W. Stevens and Captain Orvil A. Anderson.

"In both airplanes and balloons, as Chief Photographic Officer of the First Army of the American Expeditionary Forces, Captain Stevens, as an observer and photographer, secured valuable information of the enemy and his movements, and by persistent laboratory work improved military photography. He continued, after the Armistice, to perfect the art of map making from aerial photographs.

"At the headquarters of the National Geographic Society hang two of the world's most remarkable photographs made by Captain Stevens. One is the first photograph taken showing laterally the curvature of the earth; the other is an aerial photograph showing the advancing shadow of the moon on the earth during a total eclipse of the sun.

"Captain Stevens was one of three officers trapped in the heavens when the 1934 stratosphere balloon tore at nearly twelve miles aloft. With his two companions he jumped safely by parachute as the balloon finally exploded. For their courage and skill Major Kepner, Captain Stevens, and Captain Anderson were awarded the Distinguished Flying Cross by the Secretary of War.*

"Captain Anderson likewise had distinguished service in the World War. He is a skillful airplane pilot, airship pilot, and free balloon pilot, and is one of the few officers holding all four flying ratings bestowed by the U. S. Army Air Corps.

"Based on their rare experience during the World War, these two officers have continued to improve themselves in their chosen profession. They have not limited their activities to the mere performance of routine duties, but have taken advantage of the opportunities afforded them and have become experts in their particular line. They stand out today as striking examples of the possibilities of what may be achieved by persistent effort.

"Captain Stevens and Captain Anderson, the Army and the Nation are proud of your recent achievements in the flight of *Explorer II* one month ago when you reached an altitude of 72,395 feet. We are honoring you tonight not for setting a record, but for carrying aloft 64 instruments and pieces of scientific apparatus to the highest possible altitude because there they were most effective in exploring the secrets of the skies.

"You, Captain Stevens, devised and adapted some of these instruments and planned their operation. You, Captain Anderson, piloted this aerial laboratory nearly two miles higher than man has flown before, and you brought to earth this unique cargo of scientific instruments as safely and as gently as if they had descended in an elevator.

"I take pleasure in presenting to you, Captain Stevens, and you, Captain Anderson, the National Geographic Society's highest award—the Hubbard Gold Medal."

* For Captain Stevens' "thoroughness of preparation and professional attainments of the highest character in the execution of this flight," and for Captain Anderson's "coolness and confidence in piloting the largest balloon ever flown," the War Department awarded them, February 18, 1936, the Oak Leaf Cluster to their Distinguished Service Crosses. This award takes the place of a second award of the Cross.

SOUVENIRS OF STRATOSPHERE FLIGHT

Members have shown keen interest in the bookmarkers made from the cloth of the stratosphere balloon, *Explorer II*. A few of the markers remain, and any member who has not yet received one may obtain it, without cost, as long as the supply lasts, by addressing a request to the Treasurer, National Geographic Society, Sixteenth and M Streets, N. W., Washington, D. C.

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To carry out the purposes for which it was founded forty-eight years ago, the National Geographic Society publishes this Magazine monthly. All receipts are invested in The Magazine itself or expended directly to promote geographic knowledge.

Articles and photographs are desired. For material which The Magazine can use, generous remuneration is made. Contributions should be accompanied by addressed return envelope and postage.

Immediately after the terrific eruption of the world's largest crater, Mt. Katmai, in Alaska, a National Geographic Society expedition was sent to make observations of this remarkable phenomenon. Four expeditions have followed and the extraordinary scientific data resulting given to the world. In this vicinity an eighth wonder of the world was discovered and explored—"The Valley of Ten Thousand Smokes," a vast area of steaming, spouting fissures. As a result of The Society's discoveries this area has been created a National Monument by proclamation of the President of the United States.

The Society cooperated with Dr. William Beebe in a deep-sea exploration of undersea life off Bermuda, during which a world record depth of 3,028 feet was attained August 15, 1934, enabling observations of hitherto unknown submarine creatures.

The Society also had the honor of subscribing a substantial sum to the expedition of Admiral Peary, who discovered the North Pole, and contributed $100,000 to Admiral Byrd's Antarctic Expeditions.

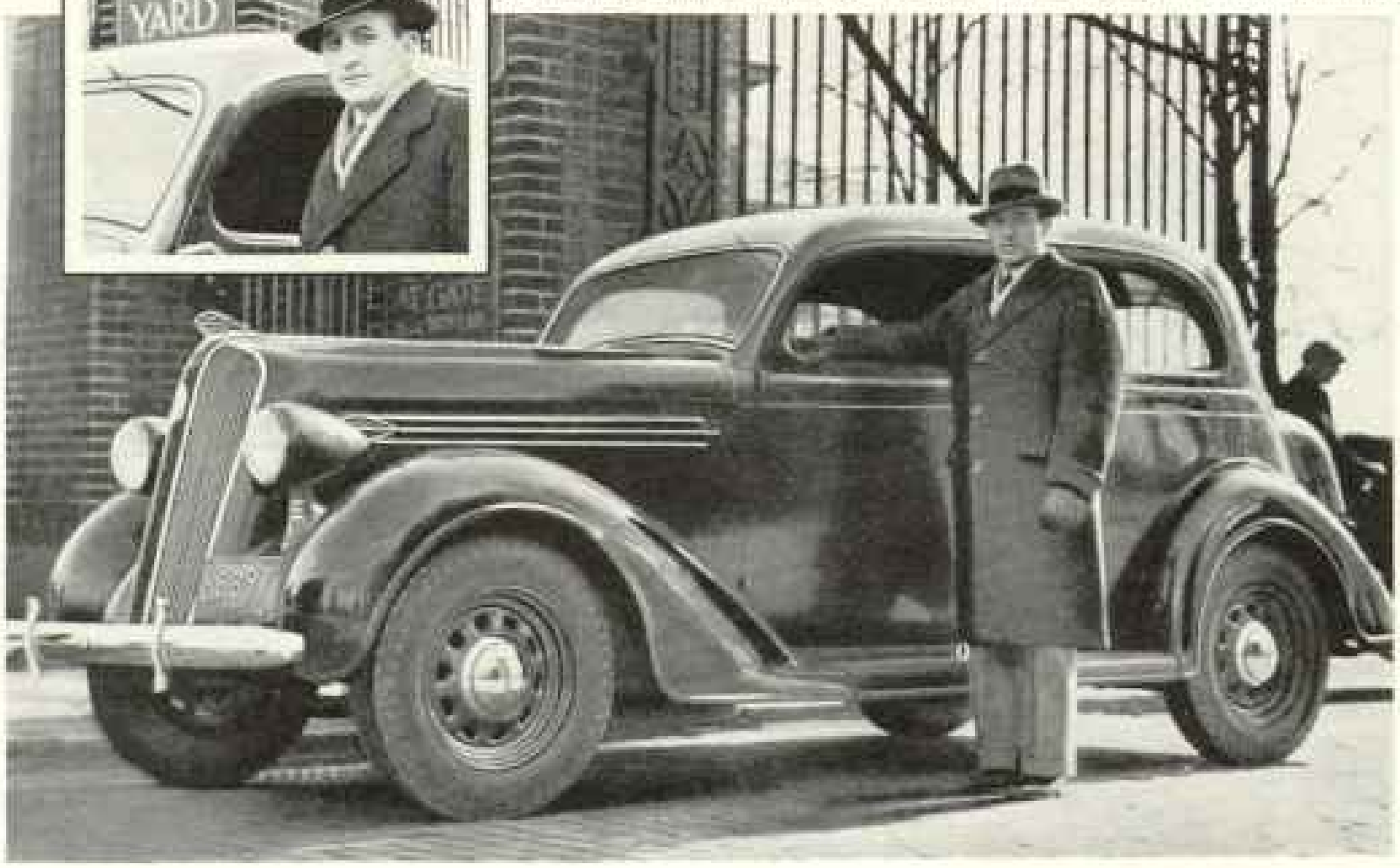
The Society granted $25,000, and in addition $75,000 was given by individual members, to the Government when the congressional appropriation for the purpose was insufficient, and the finest of the giant sequoia trees in the Giant Forest of Sequoia National Park of California were thereby saved for the American people.

The Society's notable expeditions to New Mexico have pushed back the historic horizons of the southwestern United States to a period nearly eight centuries before Columbus crossed the Atlantic. By dating the ruins of the vast communal dwellings in that region, The Society's researches have solved secrets that have puzzled historians for three hundred years. The Society is sponsoring an ornithological survey of Venezuela.

On November 11, 1935, in a flight sponsored jointly by the National Geographic Society and the U. S. Army Air Corps, the world's largest balloon, *Explorer II*, ascended to an officially recognized altitude record of 72,395 feet. Capt. Albert W. Stevens and Capt. Orvil A. Anderson took aloft in the gondola nearly a ton of scientific instruments, which obtained results of extraordinary value.

"A Sweet-Running Motor is Music—to Me"

CERTIFIED INTERVIEW WITH WALTER ZEPKE, AIRPLANE DEVELOPMENT, PHILA.



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HERE is convincing evidence that highway accidents *can* be avoided. Ab Jenkins, the famous race driver who holds more speed records than any other man in automotive history, drove a million miles on Firestone Gum-Dipped Tires over the highways of every state in the union without an accident of any kind. What a tribute to the reserve safety built into Firestone tires—what a reward for careful driving!

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Firestone

Painting by Rockwell Kent

BEAUTY AND PROTECTION
BY SHERWIN-WILLIAMS

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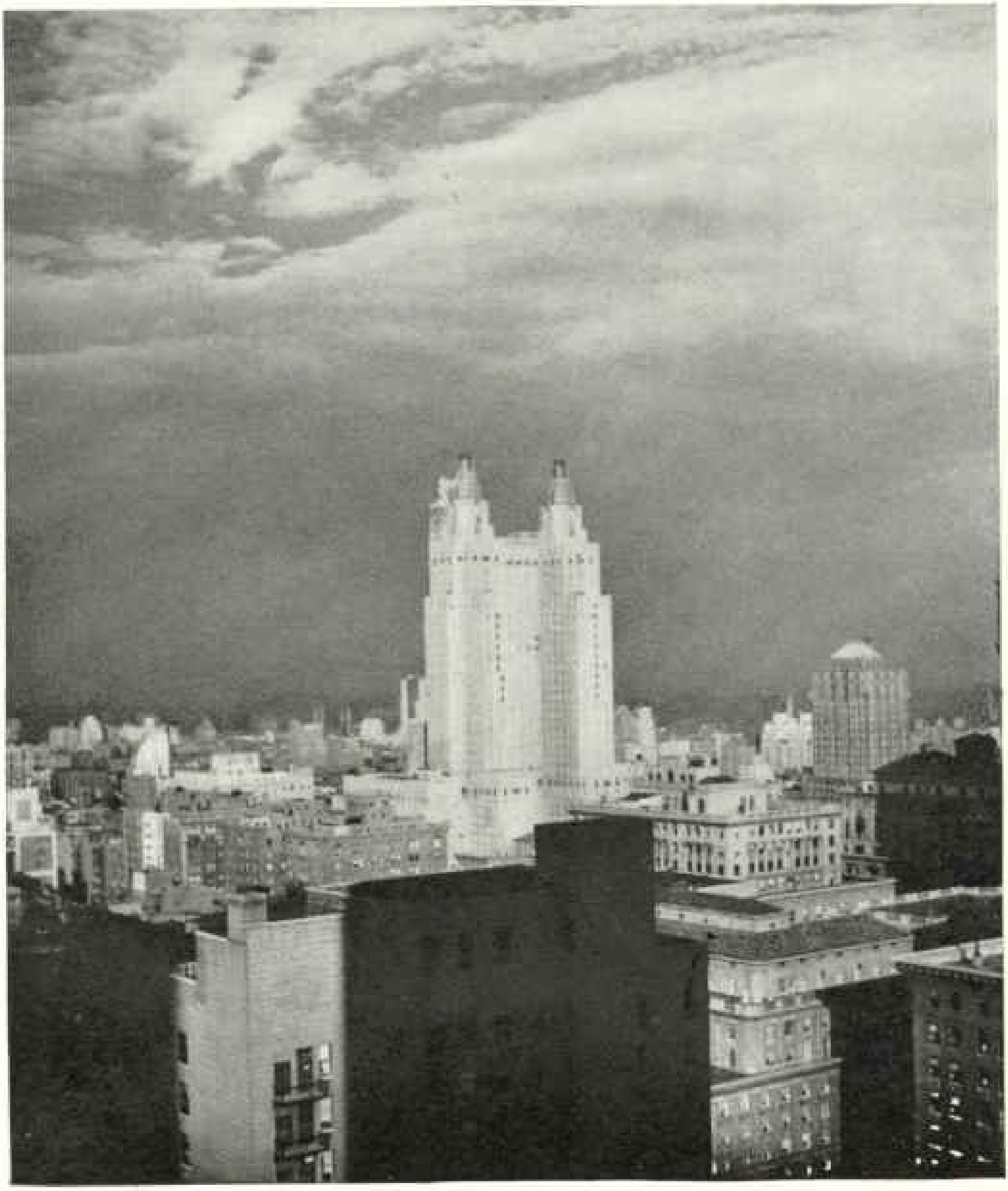
The Sherwin-Williams dealer in your locality will give you free of charge a copy of the beautiful Home Decorator. Or write direct to the Sherwin-Williams Co., Department B-1, Cleveland, Ohio.

SHERWIN-WILLIAMS PAINTS

ALL YOU NEED TO KNOW ABOUT PAINT



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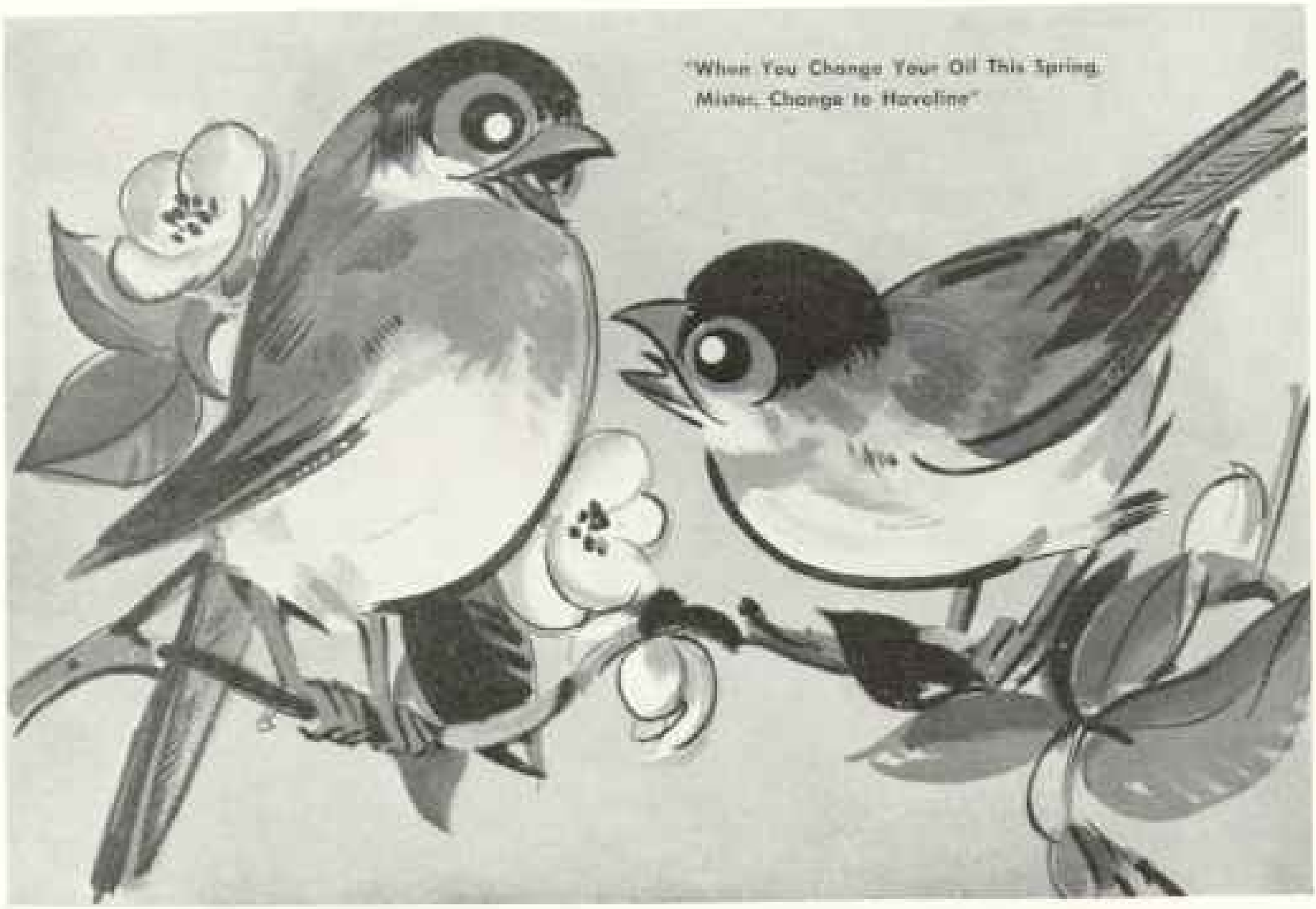

DON'T SAY *"Change it"* THIS SPRING

YOU spend two or three dollars to change from winter to summer oil.

You make this change for just one thing —to protect the motor from the results of hard driving on hot, dry summer days.

So don't *just* say, "Change the oil, please." When you buy the 5, 6, 8 or 10 quarts you need, ask *specially* for an oil that is *tarfree.*

Even some good oils lose their stability—and wear out quickly under terrific pressures and temperatures of modern high-speed motors.

Get an oil that really resists heat—*keeps* its viscosity at high temperatures—and keeps a tight compression-seal that gives you new car power and "pick-up." *In other words, get Havoline.*

The patented "Furfural" process behind Havoline prevents tar deposits in your motor. These may gum up your piston rings and make your car grow "old"—lose power and pep—if you use some other oils.

Havoline is a real premium paraffin base oil, refined by our special "Furfural" process. It keeps your motor "young" and powerful.

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30¢ for S.A.E. 30 or any other S.A.E. grade recommended by the maker of your particular car. The Dependable Dealer who sells Havoline has a Lubrication Chart which tells just which grade and how many quarts to put in your crankcase.

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Buick 8

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$765 to $1945 are list prices of the new Buicks at Flint, Mich. Standard and special accessories groups at extra cost

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For itineraries, literature, maps, etc., write Dept. 307

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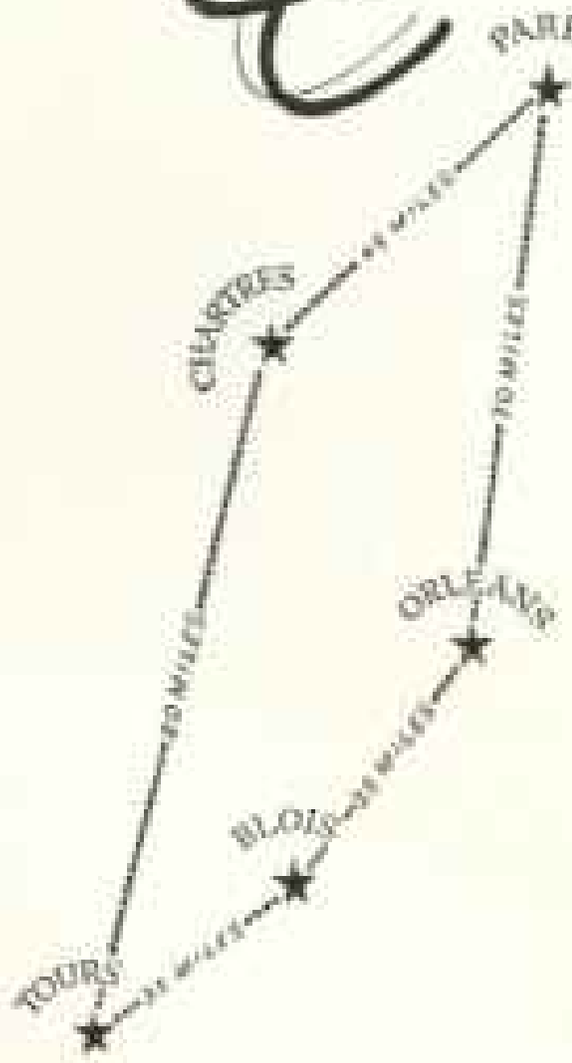
THE PROVINCES OF FRANCE

Touraine



THE map shows you how easy it is to include Touraine in your visit to France this summer. Let your Travel Agent tell you about hotel rates . . . railroad fares (specially low for American visitors) . . . automobile hire (or perhaps you want to take your own . . . it's easy).

From Orleans, from Blois, from Tours . . . fascinating cities in themselves . . . special bus routes make it easy for you to see the magnificent Renaissance chateaux of the valley of the Loire . . . Amboise, Chenonceaux, Chambord . . . their names alone call forth all the splendors of the 16th Century.

And they're set in the most charming countryside you can imagine . . . dotted with inexpensive little inns where you can take a postgraduate course in fine eating (the Tourangeaux are experts), and savor the agreeable wines of Touraine.

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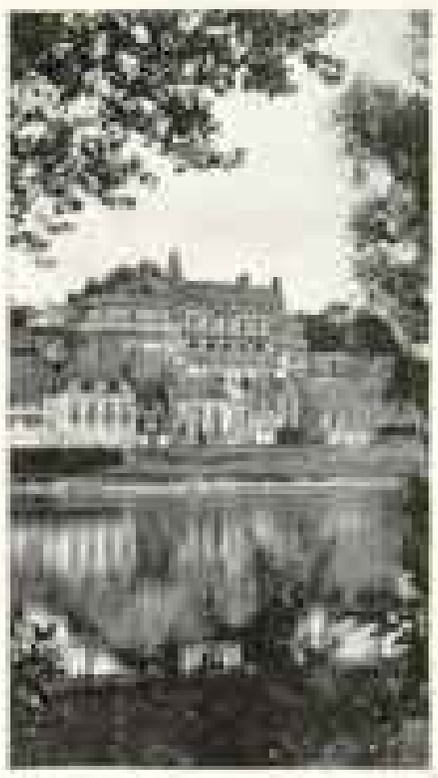

Photographs courtesy of French Railways

To England and France: Normandie, May 12 • Ile de France, June 11 • Paris, June 6 • Champlain, May 23 • Lafayette, June 27 (via Boston, June 28)

French Line

610 Fifth Ave. (Rockefeller Center), New York

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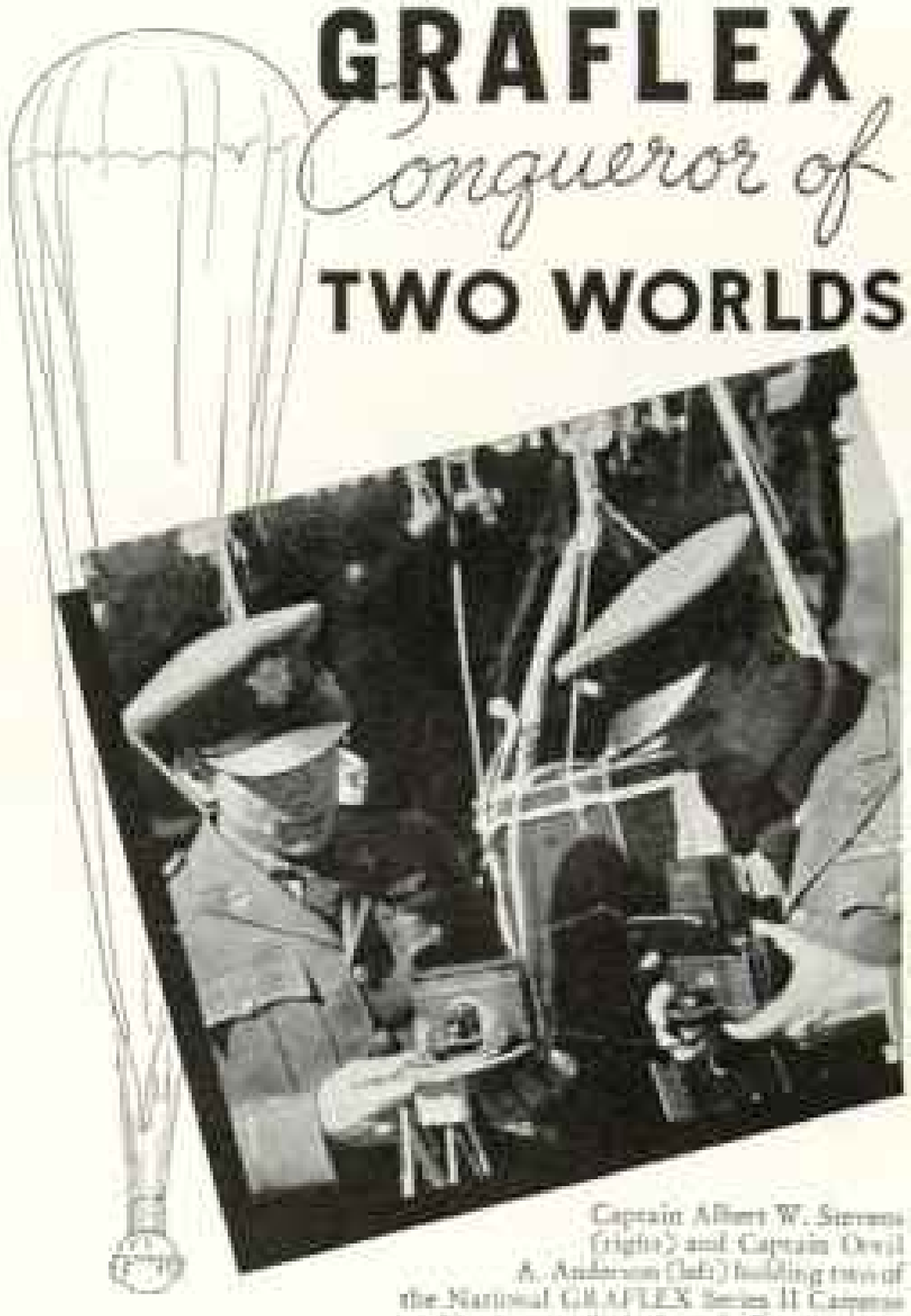

Captain Albert W. Stevens (right) and Captain Orvil A. Anderson (left) holding two of the National GRAFLEX Series II Cameras used in the 1933 flight into the Stratosphere.

NEARLY fourteen miles above the earth a battery of three National GRAFLEX Series II and six GRAFLEX Factograph Cameras clicked . . . recording . . . conquering an unknown world—the Stratosphere! With the Factographs more than 4200 perfect exposures were made—an astounding record! And National GRAFLEX, using Dufaycolor film, brought back the first indelible record of the colors of the Stratosphere! No wonder Captains Stevens and Anderson chose GRAFLEX for this scientific assault upon the unknown! More evidence, indeed, why thousands of amateur and professional photographers everywhere use GRAFLEX equipment to capture sights and scenes of the world in which we live.

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THE tangy air of the snow-capped heights ...the scent of sage and pine and saddle leather...the tug of a hungry trout...these, to some, are all a vacation need include. Others would trade them all for the thrill of a surfboard glide, the lift of a wave and snap of a bellying sail, the tingling shock of a plunge in the foaming surf, or lazy relaxation on the sand.

Curiously, Nature has blessed Southern California with *both* mountains (including Mt. Whitney, the nation's highest) and an ocean, with pleasure islands near the shore.

And if neither mountains nor ocean fills *your* vacation requirements, Los Angeles County and its neighbors offer you still other things this summer: Sports: golf, tennis, polo, riding, hunting, auto races—your favorite, whatever it may be. A summer average temperature of only 69.4°—clear, rainless days; nights cool enough for blankets. Fascinating industries—citrus, oil, movie-making, shipping. Daytime and evening thrills in celebrity-filled Hollywood. The foreign flavor of palms and orange groves, ancient Spanish Missions and nearby Old Mexico. World-known resort cities like Los Angeles, Pasadena, Long Beach, Glendale, Beverly Hills, Santa Monica, Pomona and others.

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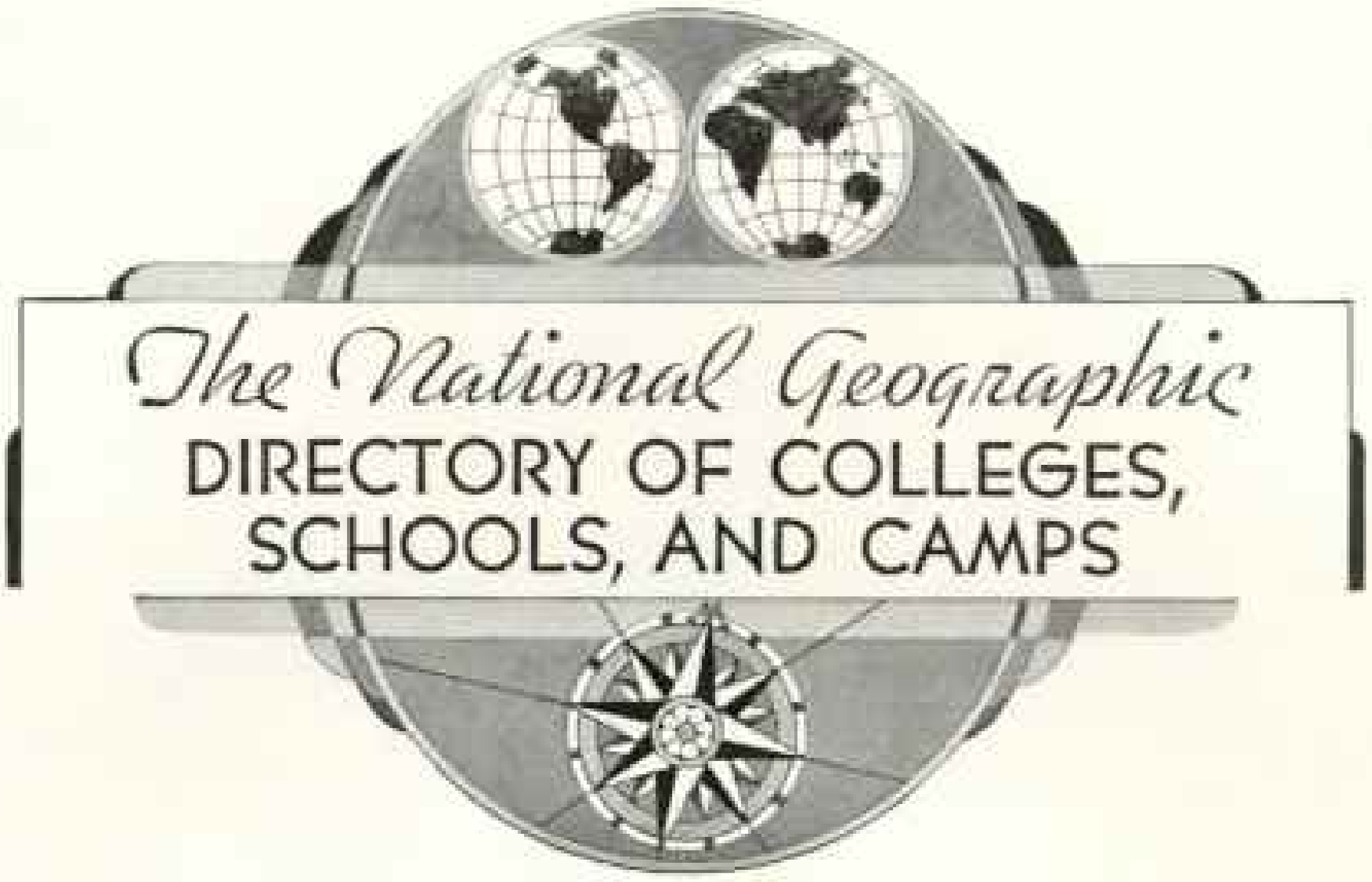

The National Geographic DIRECTORY OF COLLEGES, SCHOOLS, AND CAMPS

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The National Geographic Directory of Colleges, Schools and Camps

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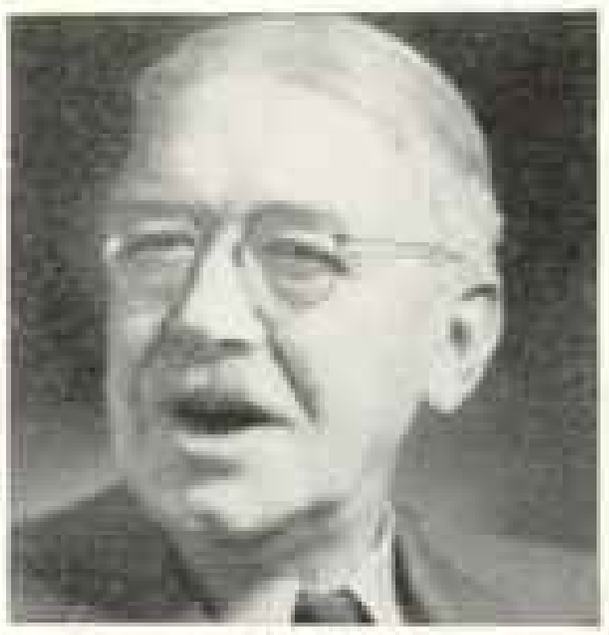
My experience as a marksman has made me intolerant of anything mechanical that is not efficient . . . the new Dodge scores a bull's-eye with me. I have had no mechanical trouble . . . it rides and drives like a dream.



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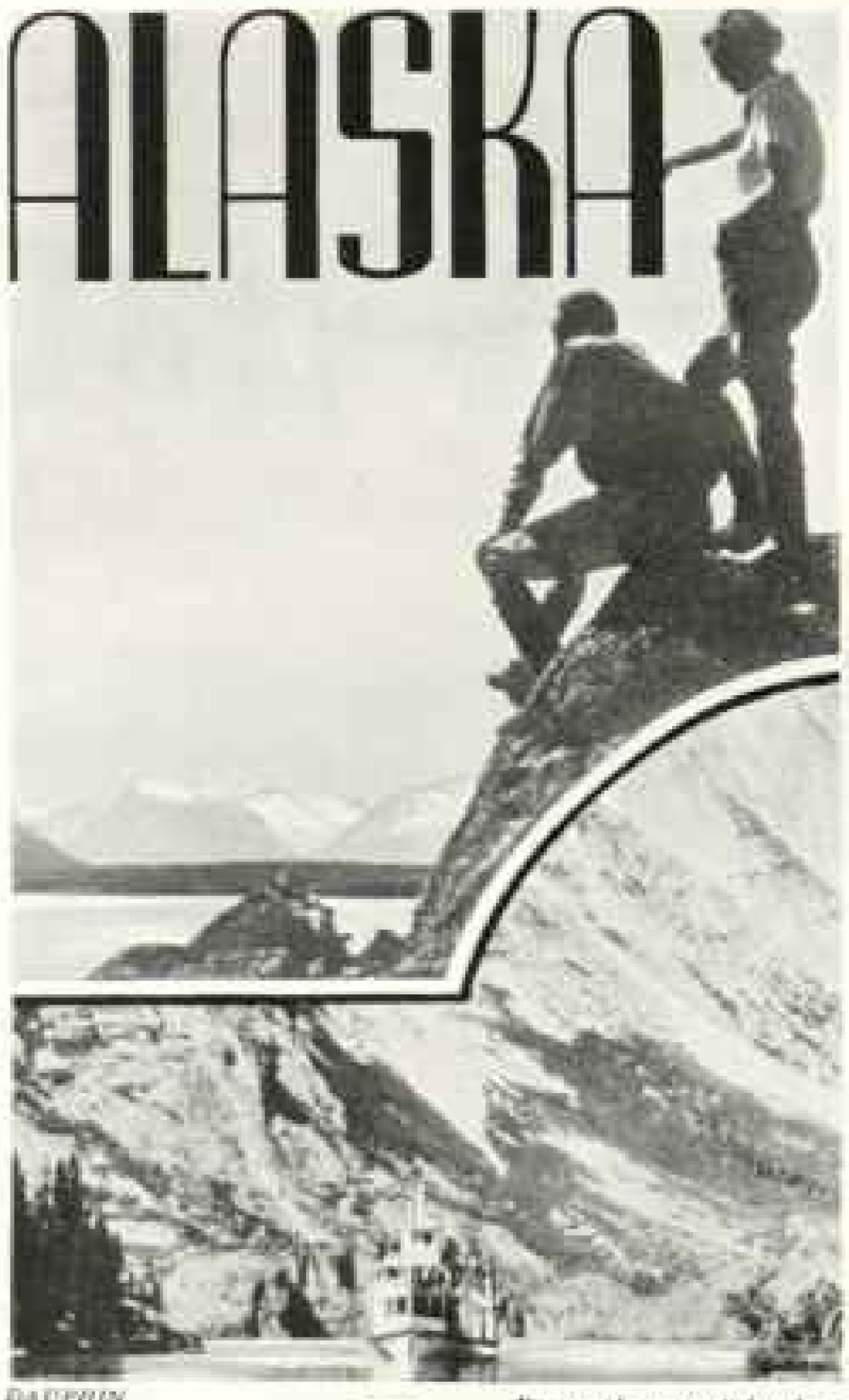

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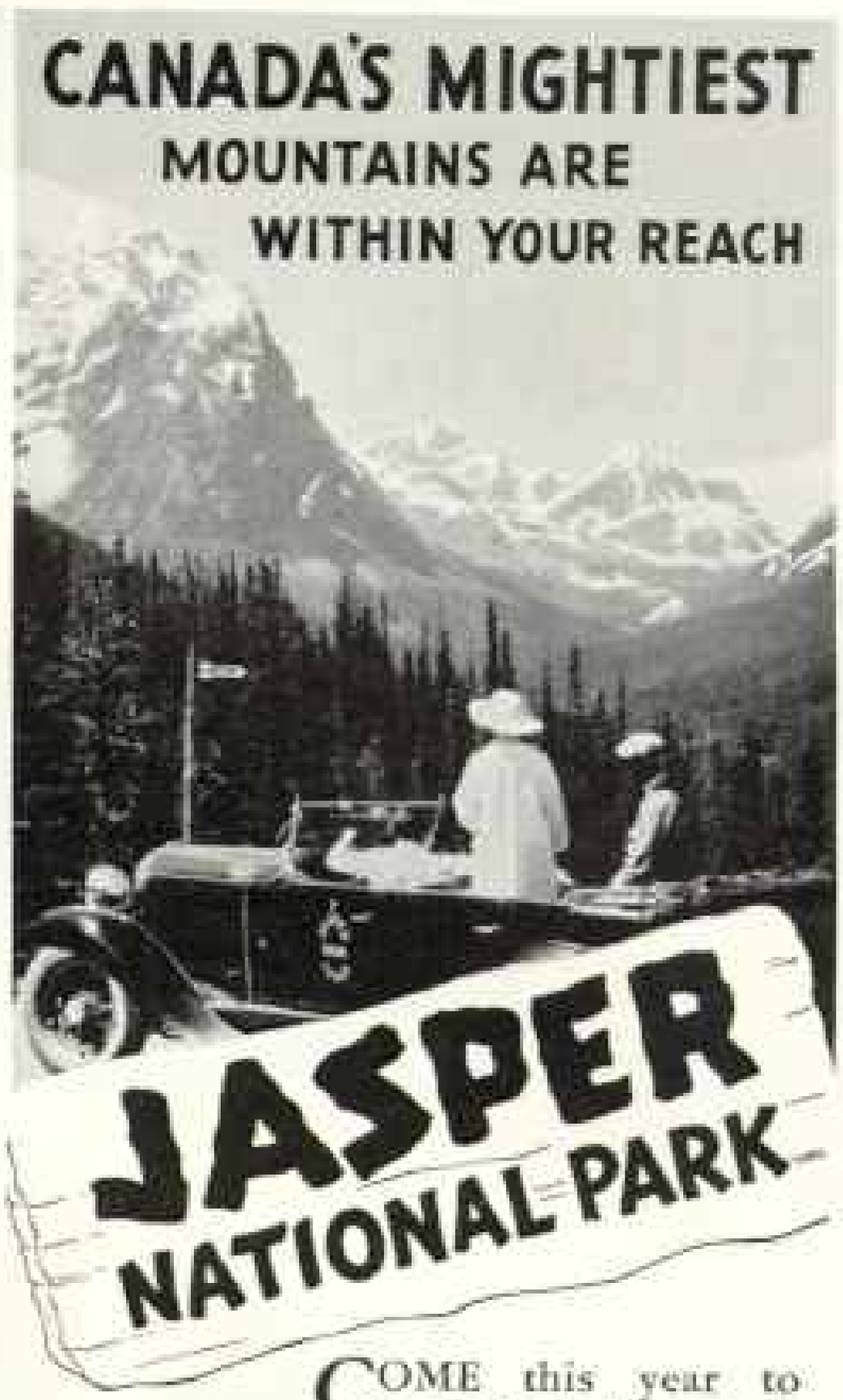

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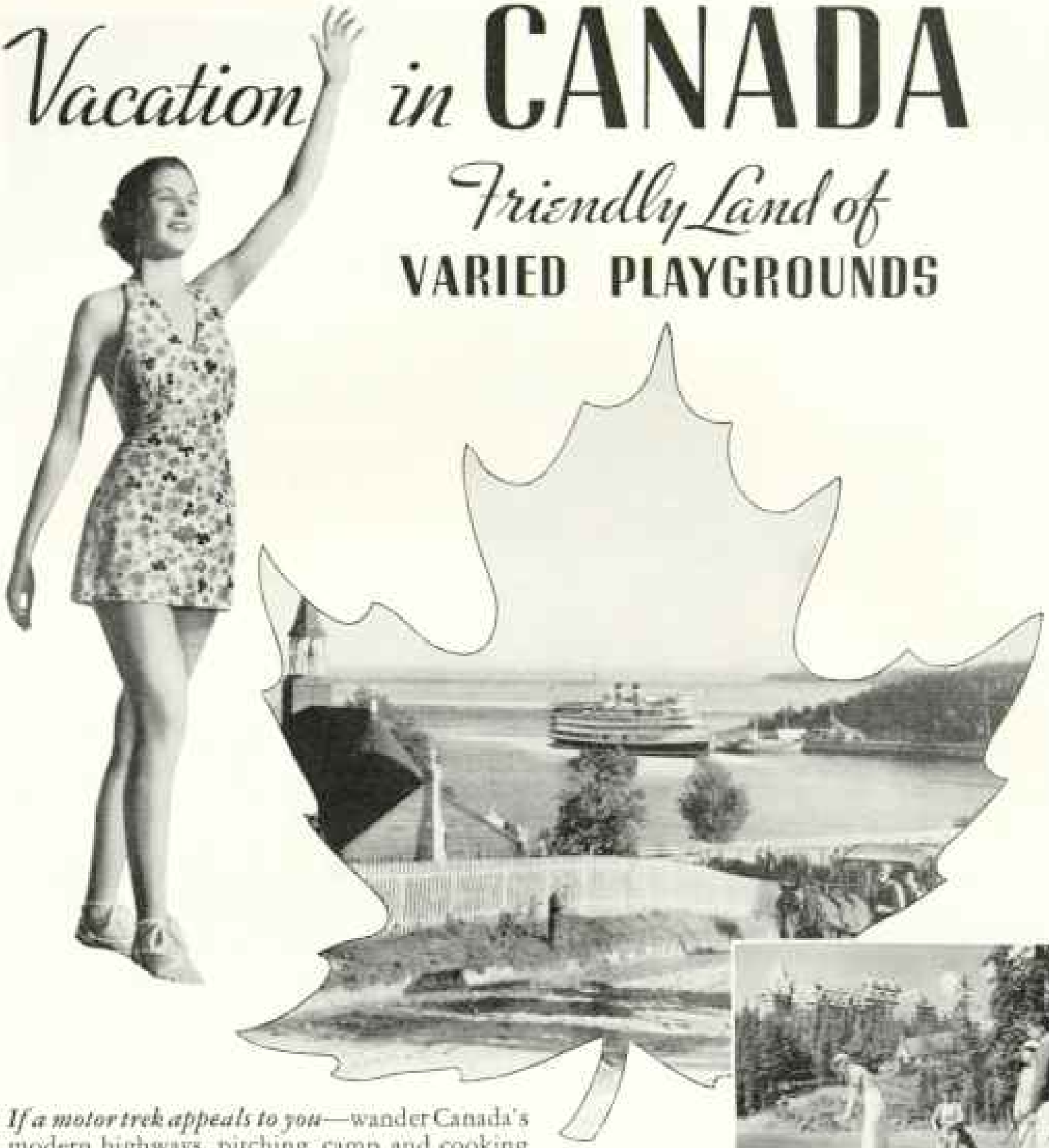

If a motor trek appeals to you—wander Canada's modern highways, pitching camp and cooking your own meals, if you like, along the way. *Take a seaside or lakelands cottage*—where sunny days are packed with delight for all the family, and cool nights lure you to blissful sleep. *Are you a fisherman?*—Canada's unspoiled fishing grounds invite you to battle game fish at their fighting best. *Do you prefer the gay life?*—here are delightful summer colonies where you can ride, golf, swim, dine and dance. *Perhaps you'd prefer a train or bus tour, or a waterways cruise*—revealing all the varied glories of the Canadian scene. For information, inquire at your nearest Canadian railway or steamship office. Or write for free maps and illustrated literature to Dept. E536.

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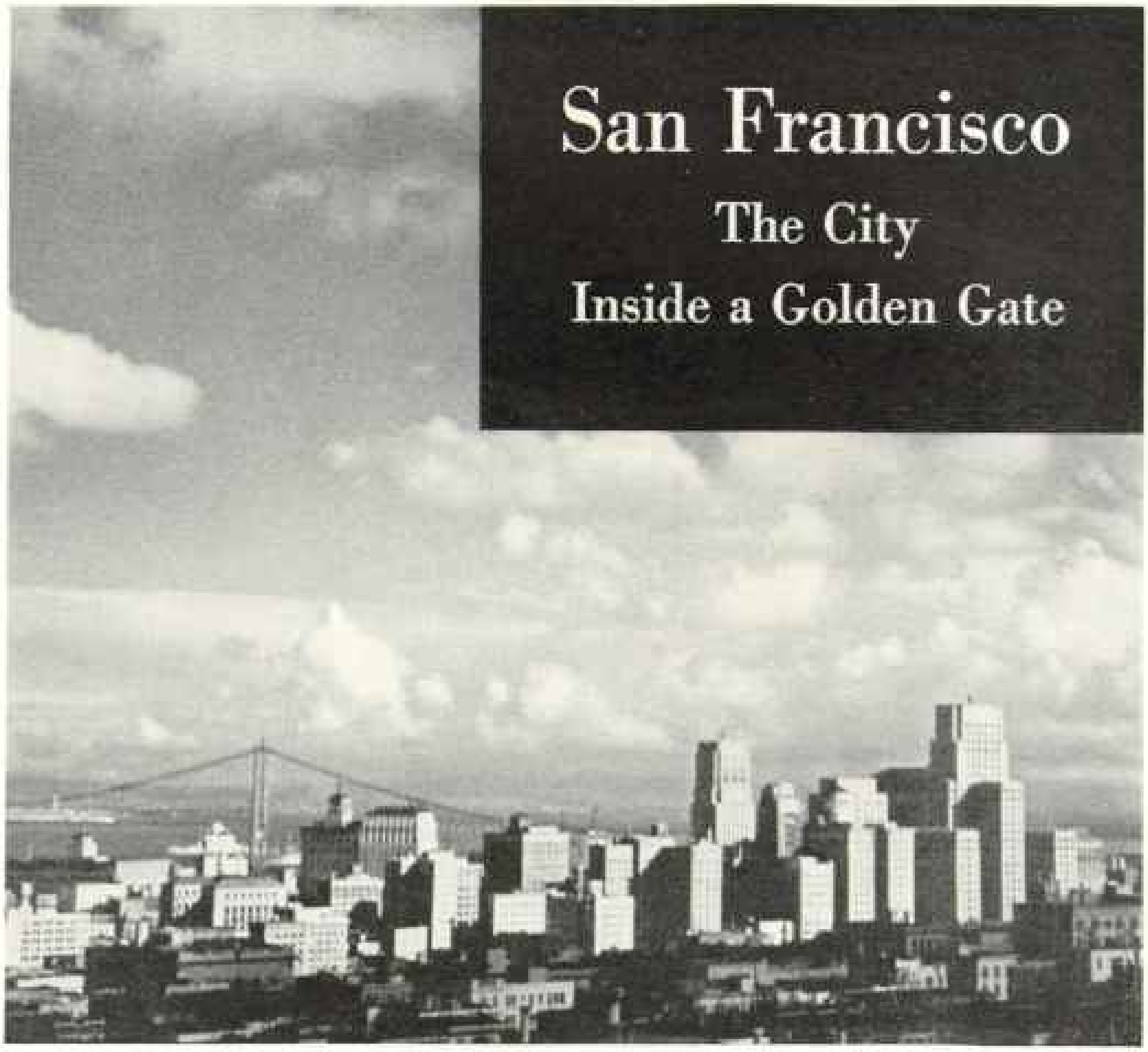
San Francisco

The City Inside a Golden Gate



LUCKIESE

IMAGINE for a minute a city built high on fourteen mighty hills, edged almost all the way around by cool blue waters... air-conditioned by a million miles of ocean.

Such is San Francisco... the city inside the Golden Gate, in the very center of the California vacationland.

In only a few hours' ride from its cosmopolitan flower-decked streets, you'll find yourself in the great Sierra range... in the sheer-walled Yosemite Valley or on mile-high Lake Tahoe, or going through the famous Gold Towns of the days of Forty-Nine. Even closer is the shade of giant Redwoods (trees older than the Pyramids)... and the beach that rims the lovely Bay of Monterey, where you'll find rare Del Monte, Carmel, and Santa Cruz.

Back again in San Francisco, you'll watch the building of the world's two greatest bridges from the storied waterfront. See the largest Chinatown outside of China. Visit the Mission Dolores and the Spanish Presidio. Enjoy the fascinating life of famed hotels and restaurants.

San Francisco's crisp, invigorating climate (all year through) renews the spirit in you. And this city gives that spirit plenty of leeway.

An illustrated book we'd like to send you free tells all about it (and gives costs in full detail). Send for it today. And plan to spend this summer here. Come by motor car or boat or plane or train. Special roundtrip fares will be effective May 15 on all railroads.

Tell anyone to come to California for a glorious vacation. But advise those seeking employment not to come here at this time. When opportunity arises California will gladly make it known.

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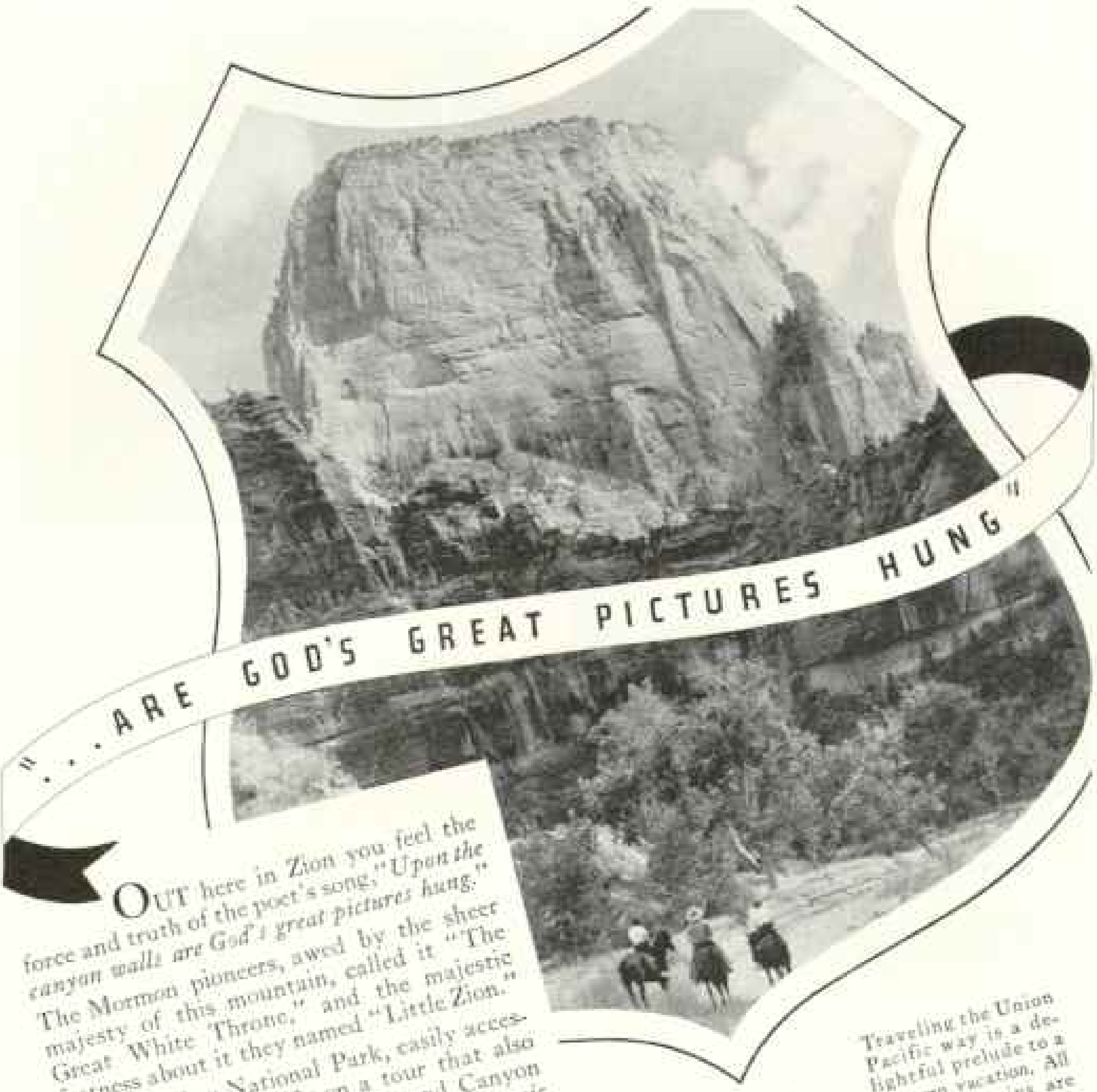

OUT here in Zion you feel the force and truth of the poet's song: "Upon the *canyon walls are God's great pictures hung.*"

The Mormon pioneers, awed by the majesty of this mountain, called it "The Great White Throne," and the majestic fastness about it they named "Little Zion."

Now Zion is a National Park, easily accessible via Union Pacific on a tour that also includes Bryce Canyon and Grand Canyon National Parks—*the most thrilling scenic tour on earth.*

You can easily see this Southern Utah Wonderland in connection with a vacation trip to Yellowstone, Colorado, the Dude Ranch country, California or the Pacific Northwest.

Traveling the Union Pacific way is a delightful prelude to a Western vacation. All through trains are completely air-conditioned. New economies and comforts for coach travel.

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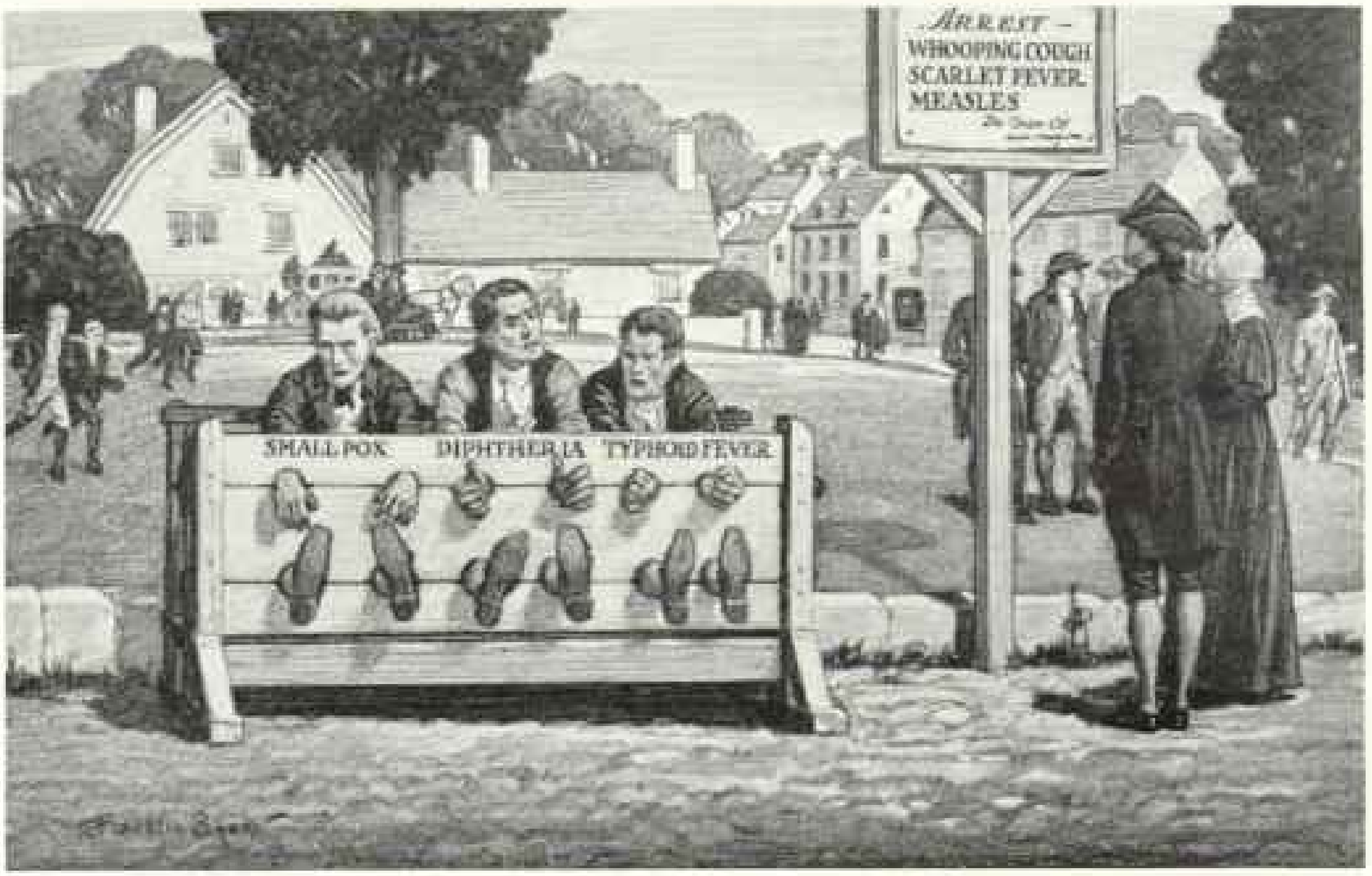


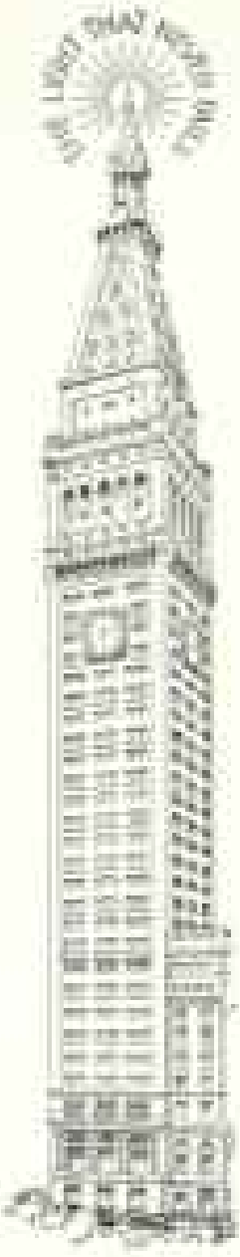
Arrest these Enemies

WHAT wouldn't mothers and fathers have given in Colonial days to guard their children against the diseases which today your doctor can prevent?

Three of the scourges which formerly took thousands of lives can be kept under control. Every child, and adult too, can now be protected against smallpox, diphtheria and typhoid fever.

Smallpox has practically disappeared in the States where vaccination is widely practiced. In communities where families ignore this protection, it still smoulders, though protected families are safe.

Diphtheria is rapidly being stamped out by immunization against it. Nevertheless, 3,000 children in this country died of it last year. Have your baby inoculated when he is six months old. A later test will determine whether or not further inoculation is desirable. Then, should diphtheria break out in your neighborhood, he will be immune.



Typhoid claims comparatively few victims except where suitable sanitary and preventive medical practices have been neglected.

Your doctor can tell you of the means that are used to check epidemics of scarlet fever, whooping cough and measles—and of the vaccines, antitoxins and serums which soften the attacks of these diseases and make the after-effects less damaging.

If, when you were little, you escaped serious consequences from any or all of these diseases, you were lucky. Don't let your child run the same risks. At the time of your child's regular physical examination, the doctor will be able to advise concerning immunization and the building up of resistance against disease.

Send for free copy of "Out of Babyhood Into Childhood." Address Booklet Dept. 536-N.

Keep Healthy—Be Examined Regularly

METROPOLITAN LIFE INSURANCE COMPANY

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ONE of the first business telephone transactions on record, and probably the first over "long distance," was between a Travelers man and the father of Alexander Graham Bell—concerning an accident insurance policy.

A publication of that period quaintly observed: "This, we think, is the latest novelty in accident insurance, and a fresh demonstration of the usefulness of Prof. Bell's invention. It is not only capable of transmitting the human voice over long distances, but preserves every articulation distinctly, and is no doubt destined ere long to be of great practical value."

Prophetic words! Both the telephone and The Travelers have come a long way since that day in 1877. Both have grown into vast service networks that cover the entire continent.

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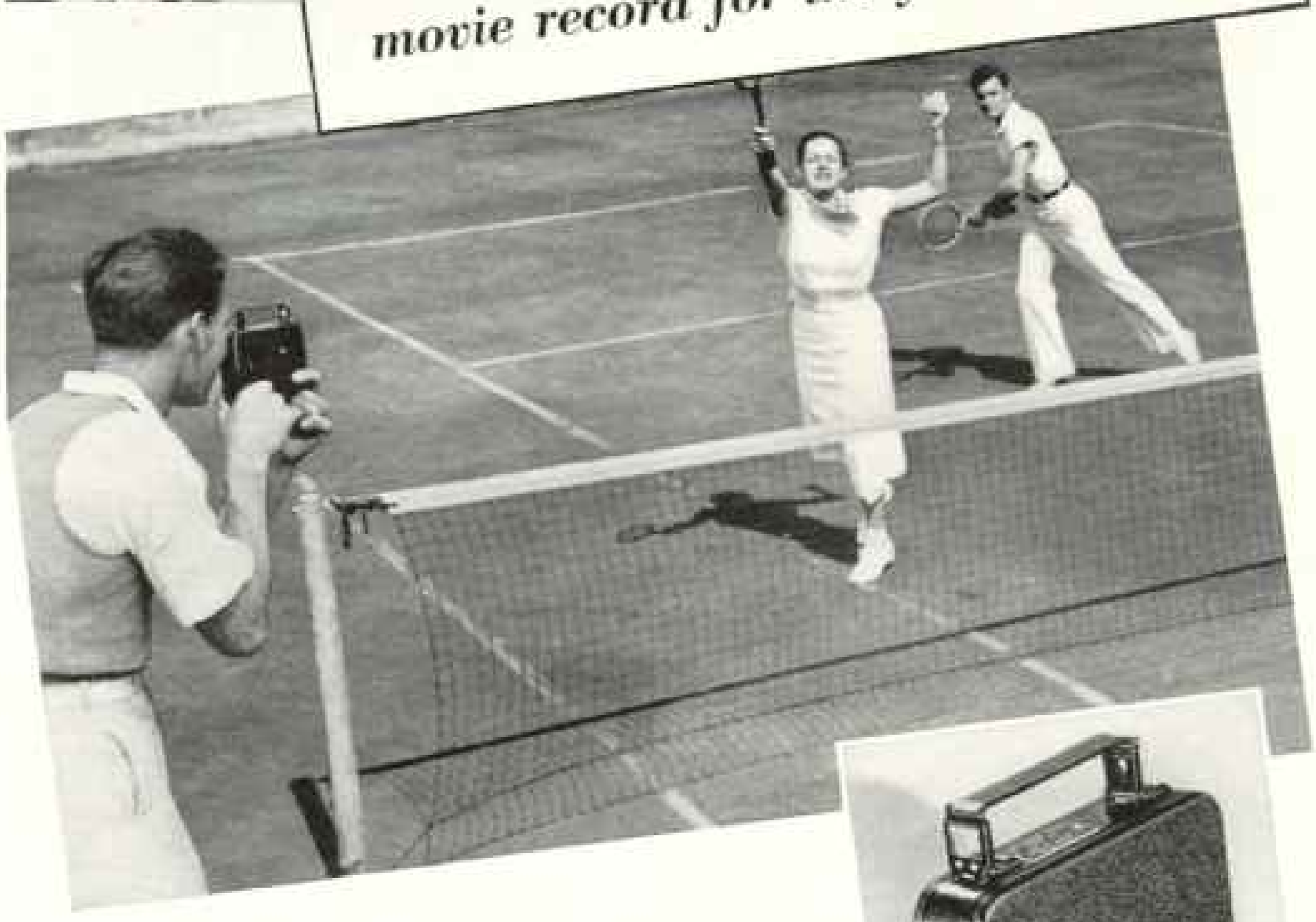
Pink Shower Tree Photographed in Natural Color in Hawaii

He's going through college on a small allowance

. . . yet he can afford to make a movie record for the years to come



HE is making the most of every college day . . . and doing it on a pretty small allowance, too. There's a future for men like this. Still—he can afford to make a movie record . . . packed with the scenes and action of his alma mater . . . preserved for the years to come. For a new camera and film have made movies so inexpensive.

Ciné-Kodak Eight has taken movies out of the "luxury class." It was designed for all those people who wanted to make movies—but thought they were too expensive.

With this new camera, movies cost but a few cents a scene. Let your dealer show you the Eight—today . . . Eastman Kodak Company, Rochester, N. Y.

Ciné-Kodak Eight

. . . home movies at less than 10¢ a "shot"

● Home movies at a fraction of their former cost. A twenty-five foot roll of Ciné-Kodak Eight Film runs as long on the screen as 100 feet of amateur standard home movie film. The Eight makes 20 to 30 movie "shots"—each as long as the average scene in the newsreels—on a roll of film costing $2.25, *finished, ready to show.* Ciné-Kodak Eight is small, sturdy—costs but $34.50.

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Weekly at Midnight . . . . Cabin Class $162 up
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"You can reach me by telephone" . . . you say it casually, but there is assurance in your voice. For you can depend on telephone service. You call a number and a voice answers—across the street or across a continent. It's so easy to do—you have been doing it for years. Use has dimmed the wonder of the telephone.

Yet the wonder grows—there is no ending to telephone progress. Service is quicker, clearer and more accurate. Improvements are made each year. Things once thought impossible are now accomplished fact. Tomorrow will see still greater achievement.

That is the pioneering spirit of American enterprise. American initiative and American resourcefulness have given this country the best telephone service in the world.

Obviously this did not just happen. It has been brought about by the development of the Bell System over the past half-century. Time has proved the rightness of its plan of operation. Quick, dependable, universal service makes it possible for you to talk to almost every one, everywhere, and to say confidently—"You can reach me by telephone."

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We drove for countless miles along the shores of the Blue Pacific

On the very Western rim of this continent lies 400 miles of magnificent Oregon coastline. It is unique in beauty, charm and in variety of recreations. Paralleling its entire length is the marvelous Oregon Coast Highway (U.S. 101), one of the great scenic drives of the nation. This splendid paved road is alongside white beaches level as the floor, then hundreds of feet above the pounding surf, then straight down green forest aisles, through clearings where wild azaleas bloom, through canyons of Scotchbroom in blazing fragrance, past miles and miles of orchid-like rhododendrons.

Best of all, Oregon beaches are unrestricted. There is driftwood for fires everywhere. There is agate hunting, surf fishing, clam digging—or resort life, if you wish.

Come to Oregon this summer. Send for our folder today. It will point the way to a new, different and economical vacation.

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Please send me your illustrated folder about Oregon.

No other trip can equal a cruise Round the World. And you can make it this year on a luxurious President Liner for only $8.21 per day... First Class! The route is via Havana and the Panama Canal to California and Hawaii ... Japan, China and the Philippines ... then the Malay States, India, Egypt, Italy and France, and back across the Atlantic to New York. And you'll play all the way on broad, sunny decks, swim in an outdoor pool ... sleep in an outside stateroom, eat splendid American food.

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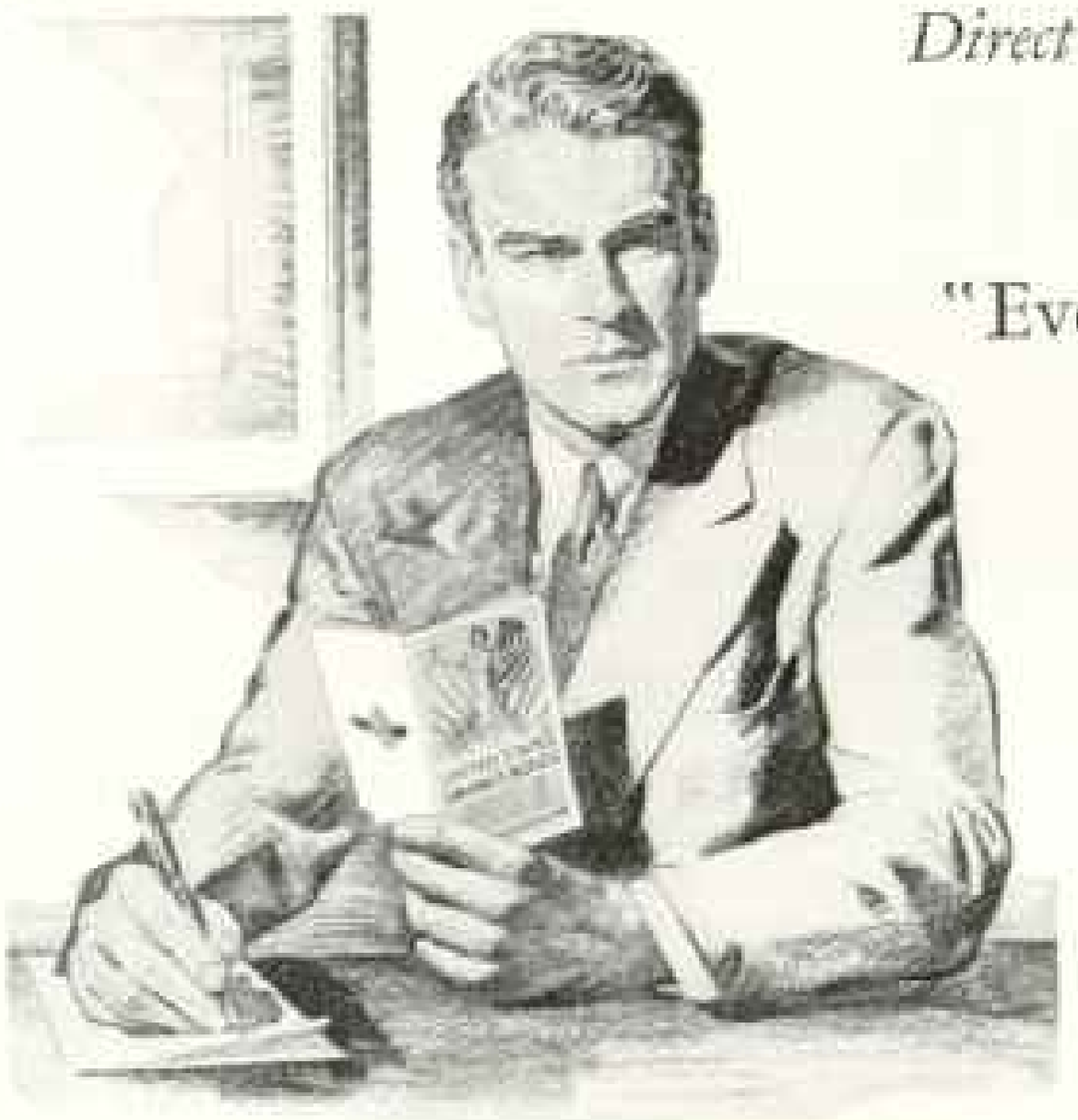

"Every $750 I invest now will provide me with $1,000 cash in ten years. In the meantime my Savings Bond is free from price fluctuation."

☆

MORE than 1,400,000 United States Savings Bonds, representing in excess of $350,000,000, maturity value, were sold during the year ending March 1, 1936. As the limitation of individual ownership is restricted to $10,000, maturity value, issued during any one calendar year, this first year's sale was attained only through wide distribution to investors throughout the entire nation.

MONEY FOR THE FUTURE

Many investors have written the Treasury Department stating that they are regularly purchasing United States Savings Bonds in sufficient amounts to provide, among other things, funds which may be used in the future—

TO EDUCATE CHILDREN...TO PROVIDE A RETIREMENT FUND...TO TAKE CARE OF DEPENDENTS TO CREATE A CASH ESTATE...TO ACCUMULATE FUNDS FOR TRAVEL AND RECREATION.

United States Savings Bonds are issued in convenient denominations of $25 to $1,000. They differ from other Government bonds in that they do not pay interest at stated intervals, but are sold at a discount. They increase in cash redemption value at the end of the first year after purchase and each six months thereafter until they mature in ten years. At that time the face value will be paid.

These bonds may be redeemed at any time after sixty days from date of purchase at fixed cash redemption values, which are never less than the purchase price. Hence, these bonds are free from price fluctuation and may be depended upon for definite future needs.

Whether you are planning to build a cash reserve for your later years, or an educational fund for your children, a sure means toward accomplishing these and other worth while purposes is afforded by regular investment in United States Savings Bonds.

Your Investment Increases 33⅓% in 10 Years

$18.75 ... increases in 10 years to ...	$25
$37.50 ... increases in 10 years to ...	$50
$75.00 .. increases in 10 years to ..	$100
$375.00 . increases in 10 years to ..	$500
$750.00 . increases in 10 years to .	$1000

Redeemable at any time after 60 days from issue date

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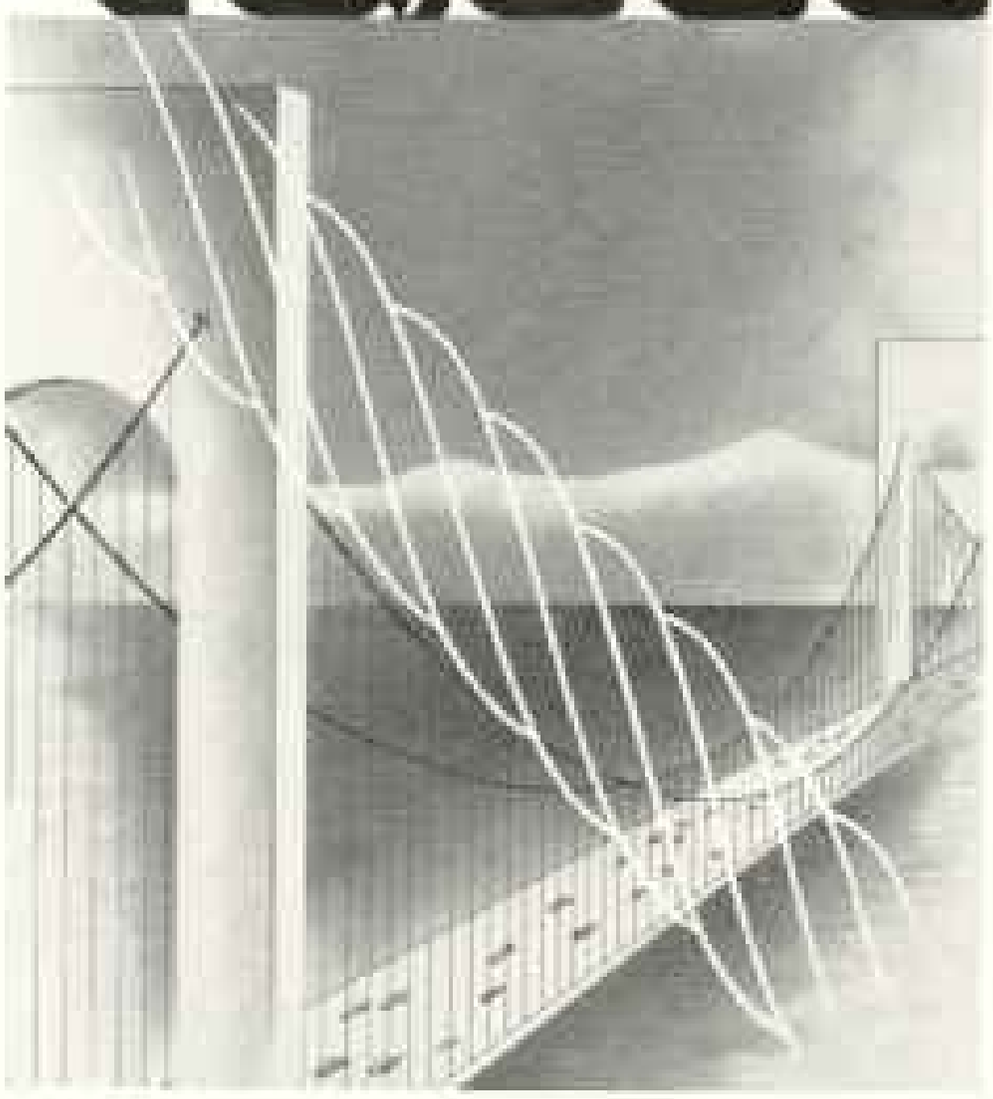

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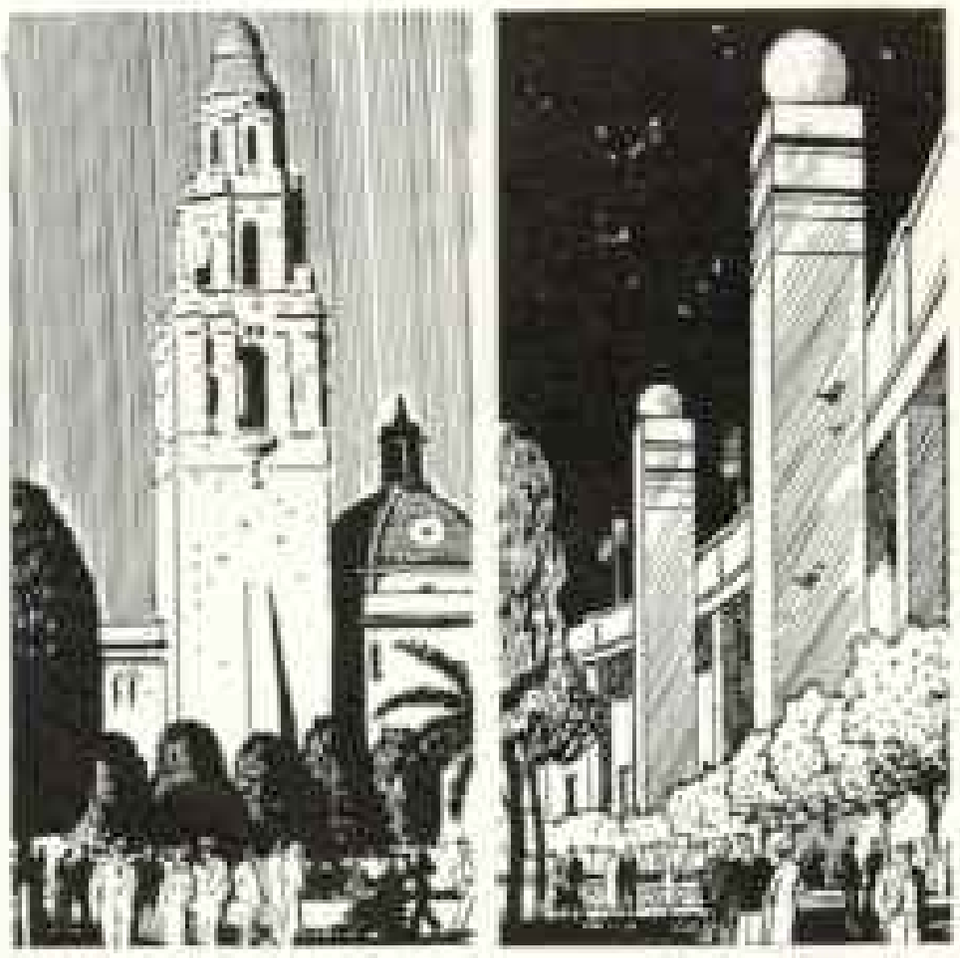

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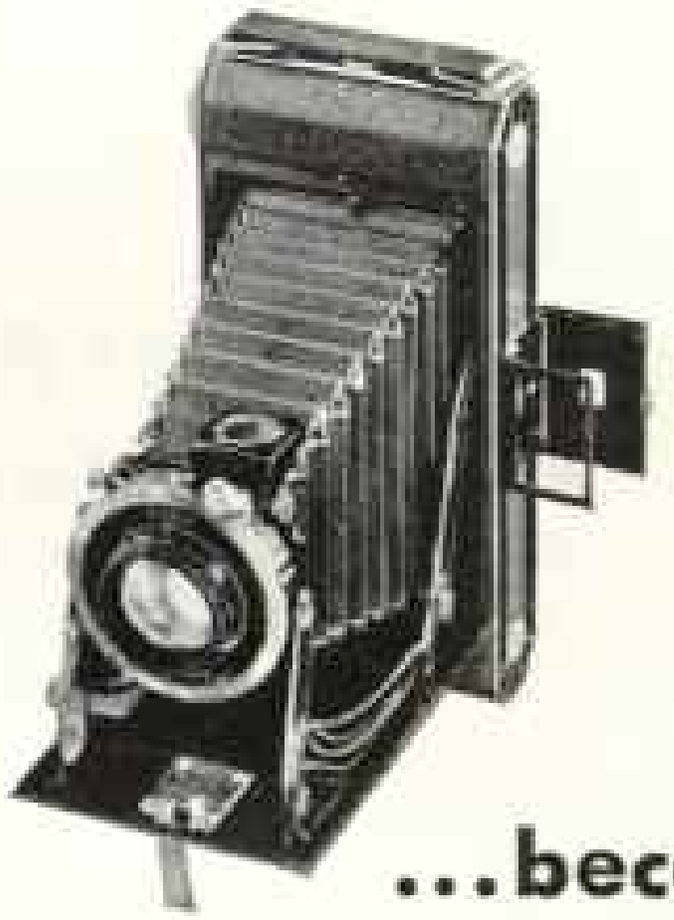

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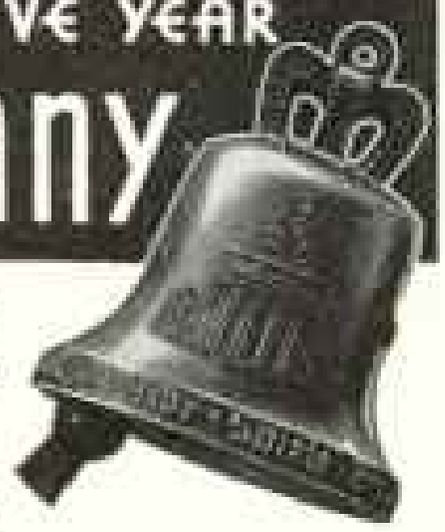

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Bringing the Stratosphere into the Laboratory

A Message

To the Members of the National Geographic Society

IN THIS ISSUE of your Magazine, Capt. Albert W. Stevens brings to you the fascinating story from many laboratories of science, announcing results of the 1935 Stratosphere Expedition sponsored by your Society and the U. S. Army Air Corps. Also included in this issue is a 14 x 25-inch aërial photograph taken at the highest altitude ever reached by man (72,395 feet above sea level), showing for the first time the division between the troposphere and the stratosphere as well as the actual curvature of the earth.

The Expedition and the profusely illustrated accounts which have followed are notable examples of the important exploratory and educational work which The Society has intensively pursued for 48 years.

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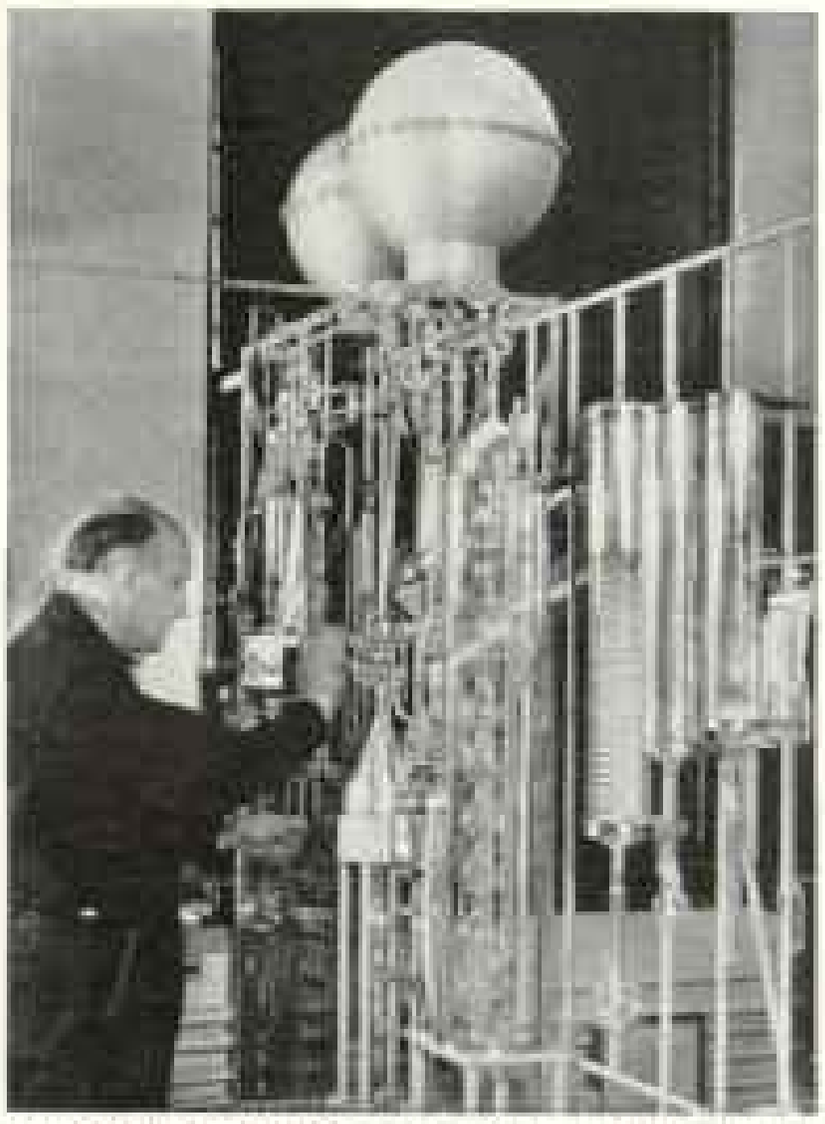
Your action will be gratifying not only to your nominees, but also to your Society, for each new member helps extend its explorations and scientific researches.



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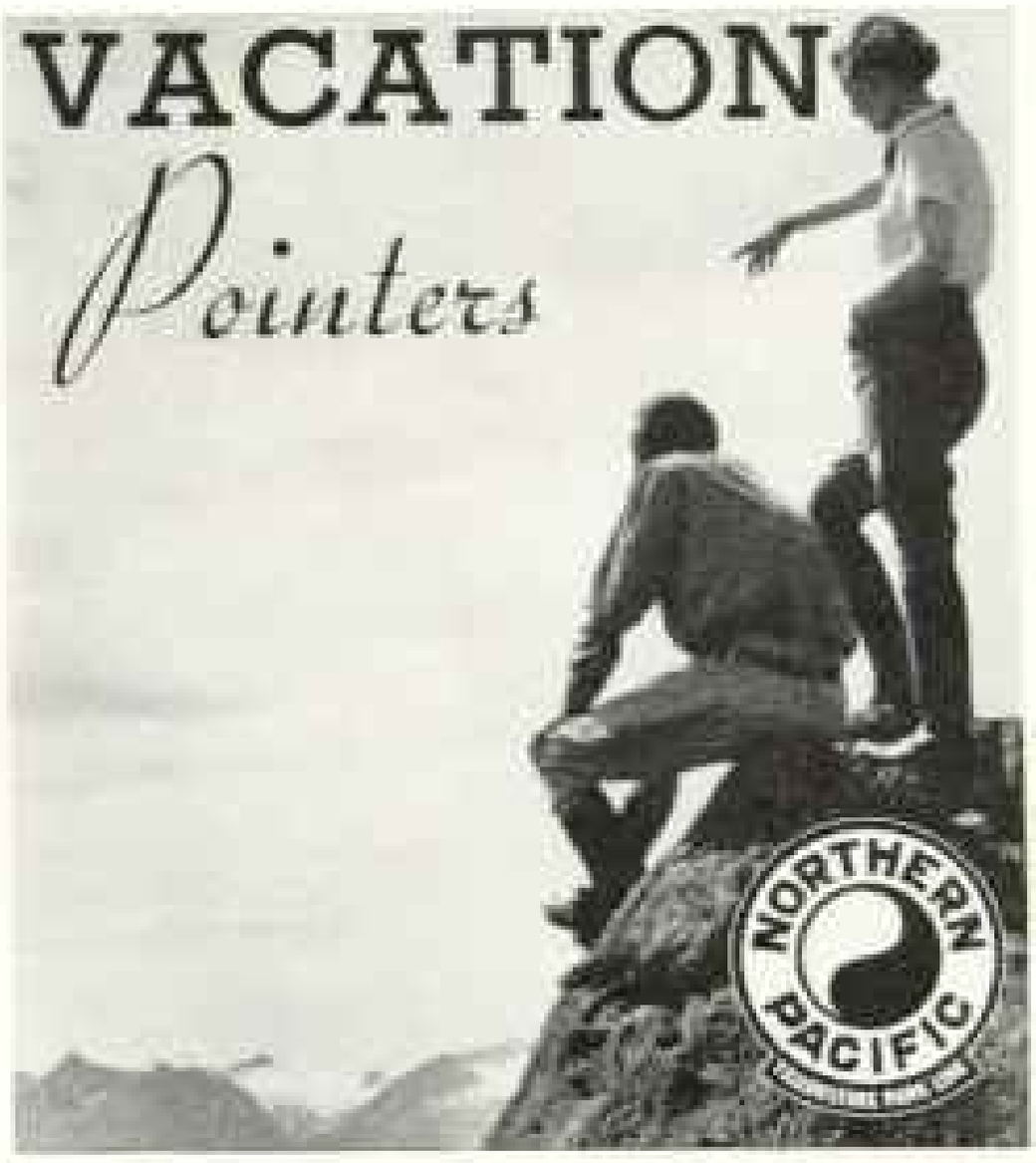

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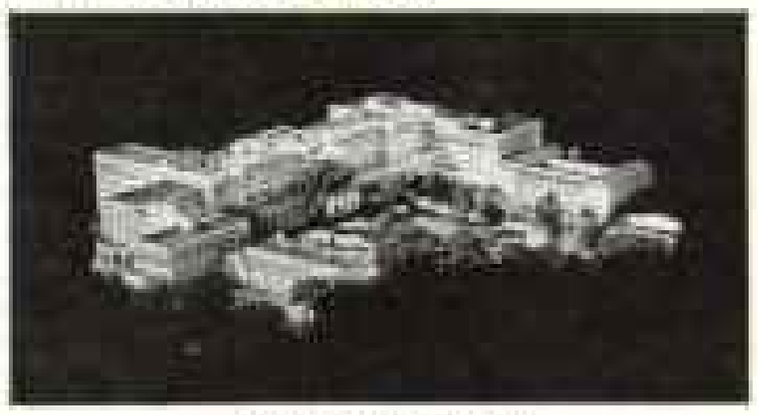

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Manoir Richelieu. A brilliant resort on the St. Lawrence. All sports. June to September. Apply 129 Victoria Square, Montreal, or travel agents.

Quebec

Chateau Frontenac. Overlooks St. Lawrence and old-French city. Suites, 670 rooms, bath. European Plan. CANADIAN PACIFIC or write hotel.

Tadoussac

Hotel Tadoussac. On famous Saguenay. Golf, fishing, etc. June to September. Apply 129 Victoria Square, Montreal, or travel agents.

NEW BRUNSWICK

St. Andrews-by-the-Sea

Algonquin Hotel

In cool sea air from Passamaquoddy Bay. Famous golf course — replica Scottish namesake. Tennis, bowling, bathing, boating. Trout, bass and salt water fishing, motoring. Music, dancing, entertainment in Casino. Attractive rooms, bath. American Plan. Open June 27-Sept. 7. See your travel agent, CANADIAN PACIFIC, or write hotel.

ONTARIO

Toronto

The Royal York. Center of city. Overlooks Lake Ontario. Suites, 1129 rooms, bath. European plan. CANADIAN PACIFIC or write hotel manager.

"Where shall we stay?"

NATIONAL GEOGRAPHIC MAGAZINE'S HOTEL SECTION

The New England States

MAINE

Bar Harbor

The Malvern Hotel and Cottages. A hotel with personality, charm and homelike atmosphere at Maine's Famous Coast Resort. Moderate Prices.

Kennebunkport

"Breakwater Court." American Plan, accommodating 200 guests. Beautifully located on ocean. Excellent surf bathing and sports. R. T. Norton, Mgr.

York Harbor

Marshall House

The Marshall House, modern brick construction, encircled by ocean and river, spacious private grounds, located in Maine's oldest town, a community of cultured and distinctive summer residents. Golf, tennis, seabathing, boating. Also The Emerson, high class hotel, same management. American plan. Booklet. G. L. Moulton, Manager.

MASSACHUSETTS

Boston

The Copley-Plaza faces beautiful Copley Square. Single rooms from $4.00; double from $6.00; Suites from $10.00. Arthur L. Race, Managing Director.

Northampton

Wiggins Old Tavern and **Hotel Northampton.** An Inn of Colonial Charm. Authentic Collections American Antiques. Excellent Food. Rooms $2.00 up.

Massachusetts (continued)

Springfield

Hotel Stanehaven. Newest Fireproof Transient $2.50 up, also Residential one to three room suites. Excellent Food. Lewis N. Wiggins, Management.

Swampscott

New Ocean House. Where the New England Coast is most picturesque. Private beach. Best clientele. Open May 15. Booklet. Clement Kennedy, Pres.

NEW HAMPSHIRE

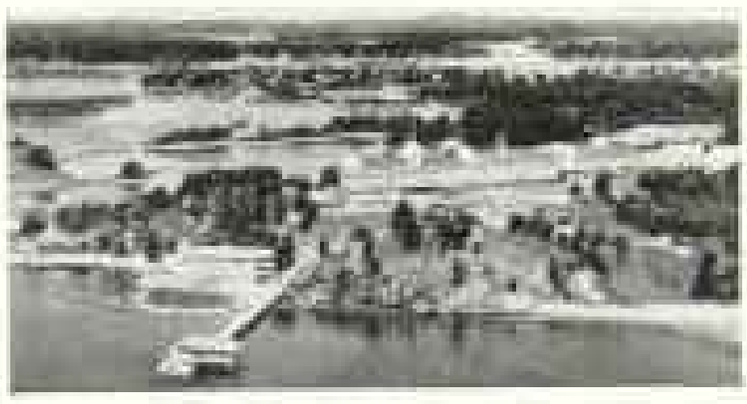
Hanover

Hanover Inn at Dartmouth College. Superb golf, tennis, recreation. Central for White Mountains, Green Mountains. Open all year. Illustrated booklet.

Lake Sunapee

Sea Nipi Park Lodge and Cottages. On beautiful Lake Sunapee. 9 and 18 hole Golf Courses. Always good fishing, every water sport. No hay fever.

Portsmouth



The Wentworth by-the-Sea

A delightful summer home late June to early September. Old in its hospitable charm; modern in its appointments. Privately owned facilities for entertaining relaxation. Golf—Tennis—Ocean Swimming pool; etc. Write for attractively illustrated folder containing complete information and picture map.

New Hampshire (continued)

White Mountains—Crawford Notch

Crawford House. Famous for its location, its atmosphere and its service. Discriminating people return each summer. Write for rate diagnosis.

White Mountains—Dixville Notch

The Balsams. Leading resort. 18-hole golf, tennis, swimming, riding. Fireproof. Dancing. No hay fever. $8 up. Am. Plan. N. Y. phone Pe 6-8215.

White Mountains—Whitefield

Mountain View House

Dignified and charming in its hilltop setting overlooking the White Mts. A private estate of 3,000 acres offering every outdoor sport, including golf, polo, riding, tennis, swimming. Our maintenance of the highest standards has consistently attracted a distinguished clientele. Season June 15-October 15. W. F. Dodge & Son, Proprietors.

VERMONT

Lake Morey—Fairlee

Bonnie Oaks Inn and Bungalows. All Sports. 75 rooms with baths and fireplaces. Baby Oaks, with supervised play. May to Dec. Folders. E. H. Fuge.

Woodstock

Woodstock Inn. Charming resort hotel in Green Mountains. 18 hole Golf. Tennis. Beautiful roads. Open June to late October. On U. S. Route No. 4.

Many distinguished resort hotels make their appearance in THE NATIONAL GEOGRAPHIC MAGAZINE'S Hotel Section this month for the first time. They join a group of outstanding city and resort hotels whose messages are regularly to be found here.

No doubt you have already given some thought to plans for your coming summer vacation. Examine these concise advertisements. They offer a range of choice extending from Maine to California and from Alberta to Venezuela. All hotels listed will welcome your request for descriptive literature. Write early, and in writing "Mention THE GEOGRAPHIC—It Identifies You."

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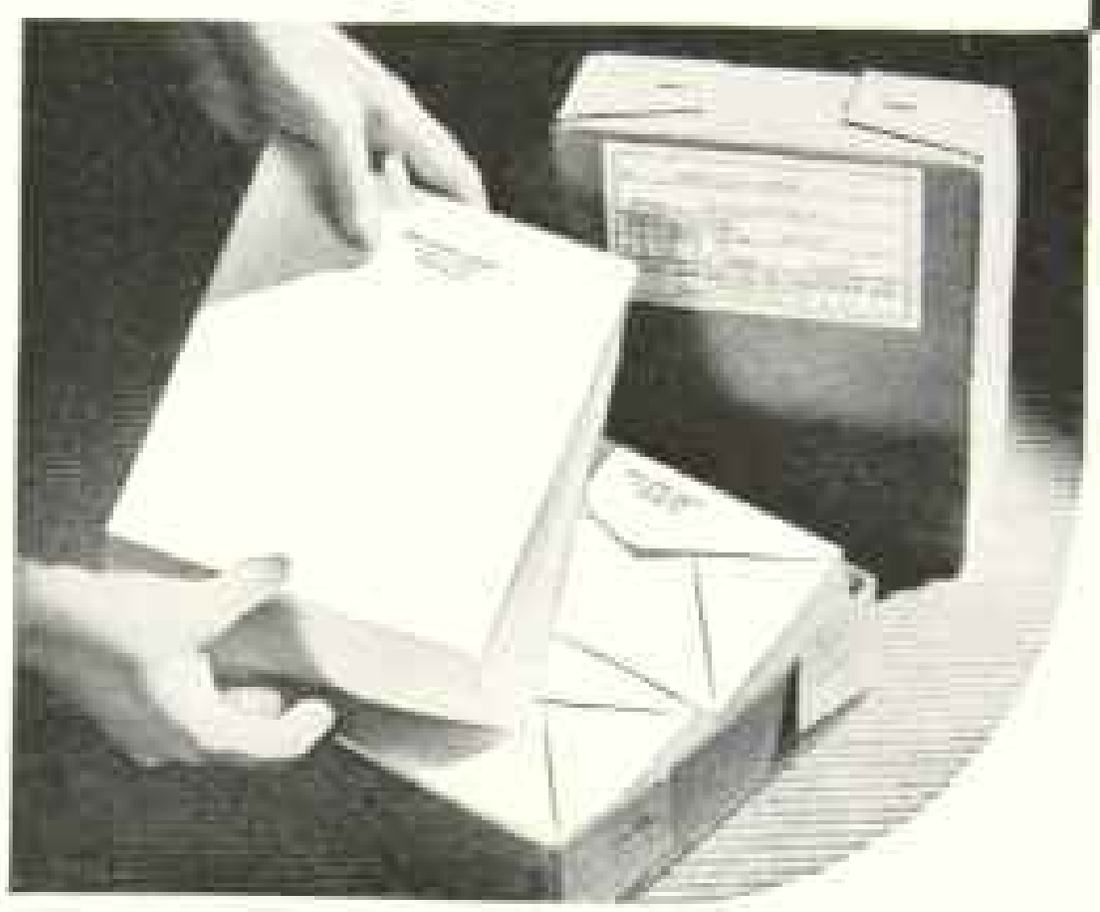

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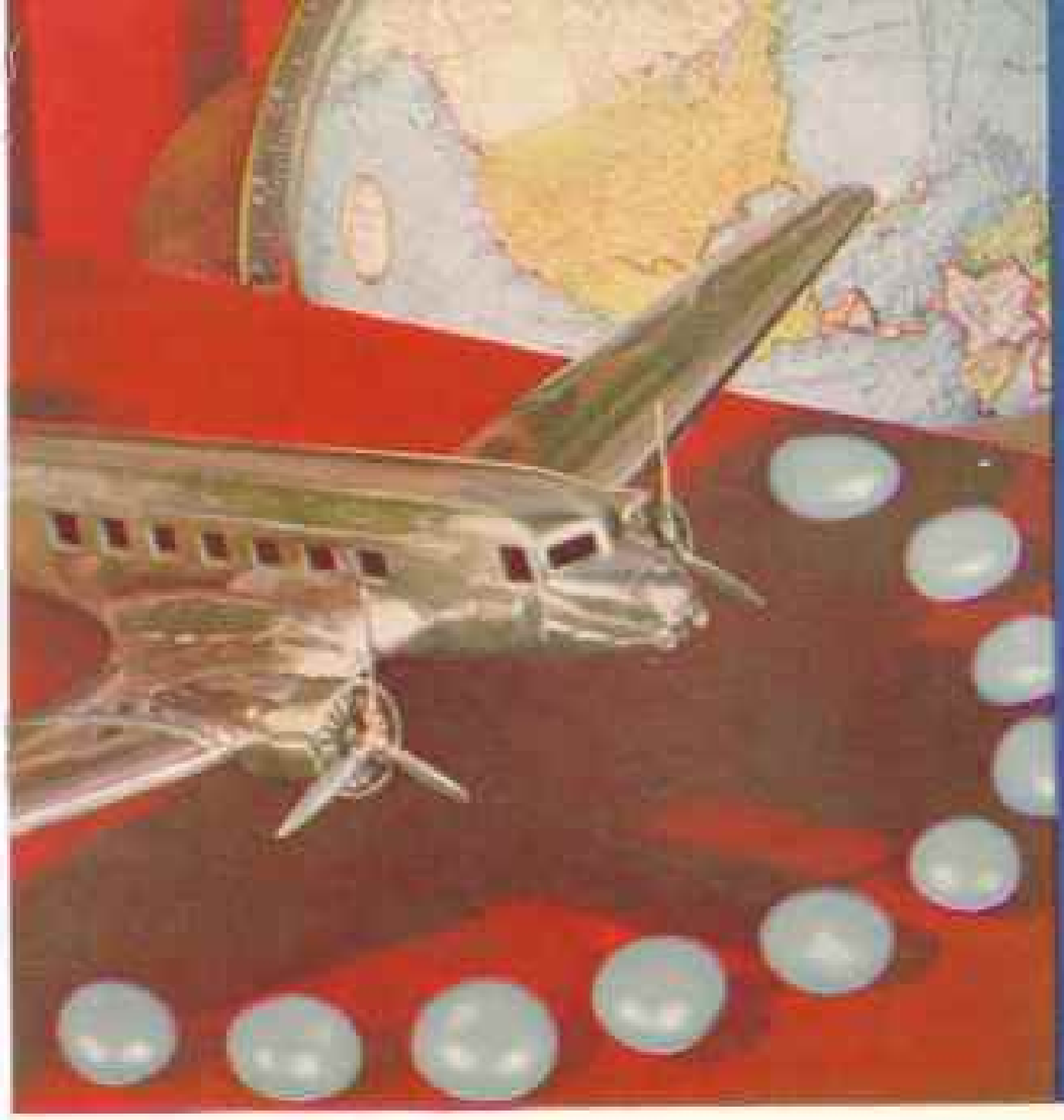

THEY WERE THE SEEDS OF SPEED

ONLY FIFTY *fleeting years ago this spring, young Charles Martin Hall held in his hand the first shining pellets of commercial Aluminum. They were the seeds of speed.*

For Hall had made a semiprecious metal into a common metal; had released its lightness to be made ready for the streamlined trains, the buses and trucks, and the swift all-metal airplane of our generation.

Transportation and Aluminum have come of age together.

The slow trains and the buggies of the early nineties had little need for the lightness of Aluminum, because the means whereby modern speeds are attained had yet to be developed and perfected.

The saga of transportation is one of concurrent development of motive powers, steam, gasoline, and electricity; of roadbeds and highways; of concrete and metal and rubber; of hesitant wings maturing into commercial flight.

In that progressive development there always comes a time, in the search for speed to shrink time and distance, when each field of transportation needs lightness for lightness sake.

The airplane's need was first and most acute. Aviation had to have lightness coupled with great strength. It found Aluminum ready, made ready by years of steady, plugging progress.

Nature made Aluminum light, but its strength and versatility came from years of scientific research in quiet laboratories and on test floors. Pioneering studies in stresses and strains. Engineering tests that no common metal had ever been called upon to meet. Development of special heat-treated alloys. Methods to cut costs.

By these things, speed was given wings.

Aluminum was ready to answer the call for lightness in all moving things: the automobile engine piston, the bus body, the truck body, all moving parts, all mass-in-motion, and finally, the streamlined railroad trains.

The engineering profession gave the challenge. The metal-working industry mastered the quirks. Great mills with costly equipment were built to produce the rolled sheet and structural shapes that were to be needed, before ever an order was on the books. Millions of dollars of earnings were plowed back into preparation for the day when transportation engineers would begin to write lightness into their specifications.

Engineers in quest of lightness staked their professional reputations on Aluminum's ability to stand the gaff of rail and air and highway service. To them an appreciative industry expresses its thanks for their confidence, its homage for their vision.

For the day of lightness is here. The swan song of needless weight is being sung. Aluminum has become the *speed metal* of a new and faster age. Side by side with the older metals it is giving you faster transportation, with greater safety and economy.

A FIFTIETH ANNIVERSARY MESSAGE FROM

ALUMINUM COMPANY OF AMERICA