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AUGUST, 1919

CONTENTS

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NATIONAL GEOGRAPHIC SOCIETY

GEOGRAPHIC ADMINISTRATION BUILDINGS
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ORGANIZED FOR "THE INCREASE AND DIFFUSION OF GEOGRAPHIC KNOWLEDGE"

To carry out the purpose for which it was founded thirty-one years ago, the National Geographic Society publishes this Magazine. All receipts from the publication are invested in the Magazine itself or expended directly to promote geographic knowledge and the study of geography. Articles or photographs from members of the Society, or other friends, are desired. For material that the Magazine can use, generous remuneration is made. Contributions should be accompanied by an addressed return envelope and postage, and be addressed: Editor, National Geographic Magazine, 16th and M Streets, Washington, D. C.

Important contributions to geographic science are constantly being made through expeditions financed by funds set aside from the Society's income. For example, 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. So important was the completion of this work considered that four expeditions have followed and the extraordinary scientific data resultant 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, evidently formed by nature as a huge safety-valve for erupting Katmai. By proclamation of the President of the United States, this area has been created a National Monument. The Society organized and supported a large party, which made a three-year study of Alaskan glacial fields, the most remarkable in existence. At an expense of over $30,000 it has sent a notable series of expeditions into Peru to investigate the traces of the Inca race. The discoveries of these expeditions form a large share of the world's knowledge of a civilization which was waning when Pizarro first set foot in Peru. Trained geologists were sent to Mt. Pelee, La Soufriere, and Messina following the eruptions and earthquakes. The Society also had the honor of subscribing a substantial sum to the historic expedition of Admiral Peary, who discovered the North Pole April 6, 1909. Not long ago the Society granted $20,000 to the Federal Government when the congressional appropriation for the purchase was insufficient, and the finest of the giant sequoia trees of California were thereby saved for the American people and incorporated into a National Park.

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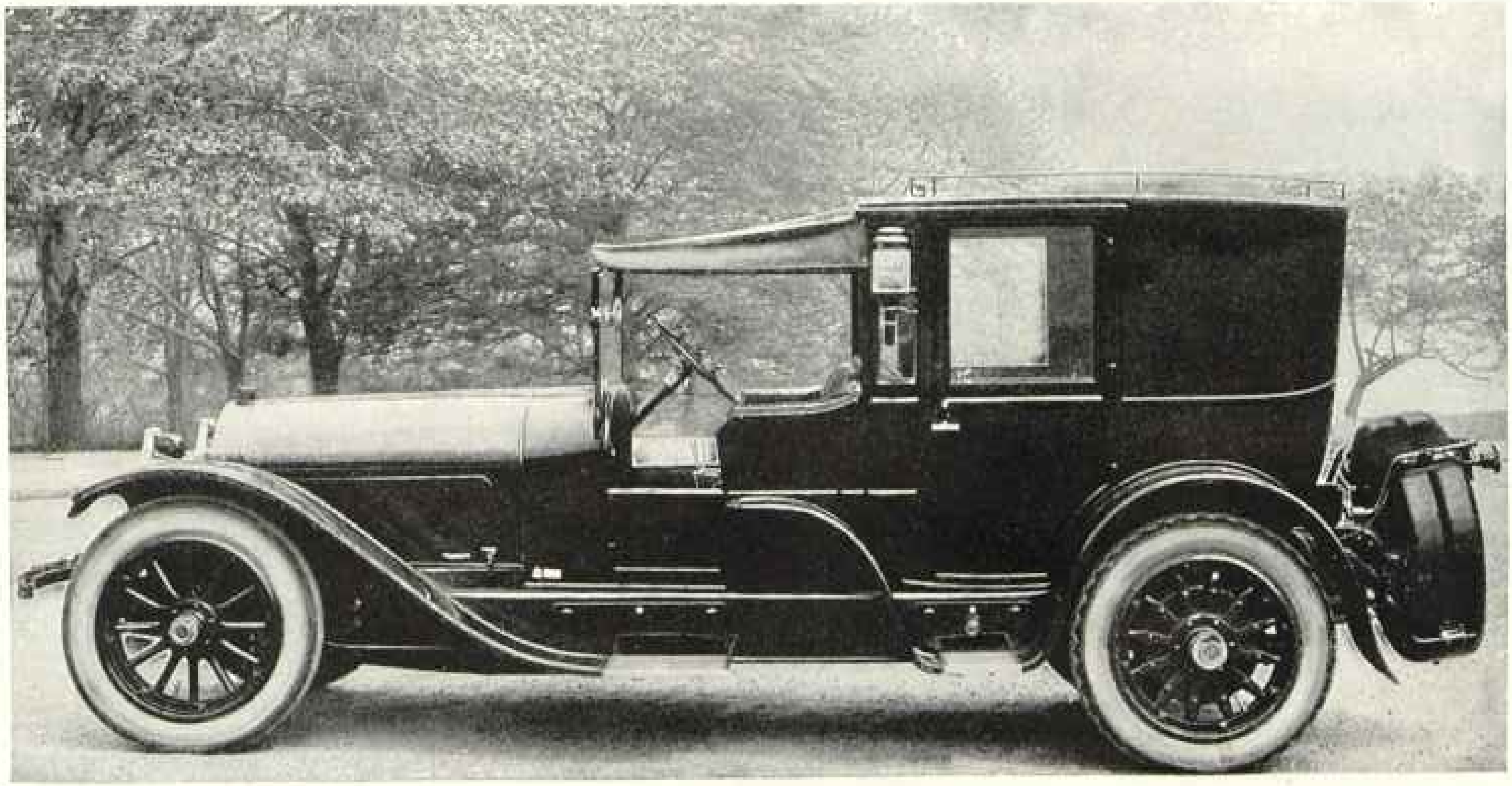

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United States—Page 47
Sub-topic: Monuments

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(3364)

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T. H. BAILEY WHIPPLE

formerly manager of the Commercial Section of the Westinghouse Educational Department. It was his duty to help select the men and recommend the kind of training that would make Westinghouse men more successful. Mr. Whipple's additional duties have overtaxed him also with the Westinghouse Department of Publicity as Literary Supervisor.

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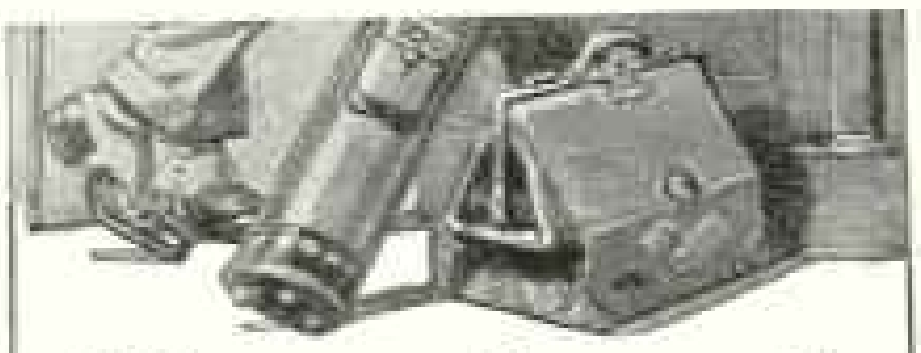

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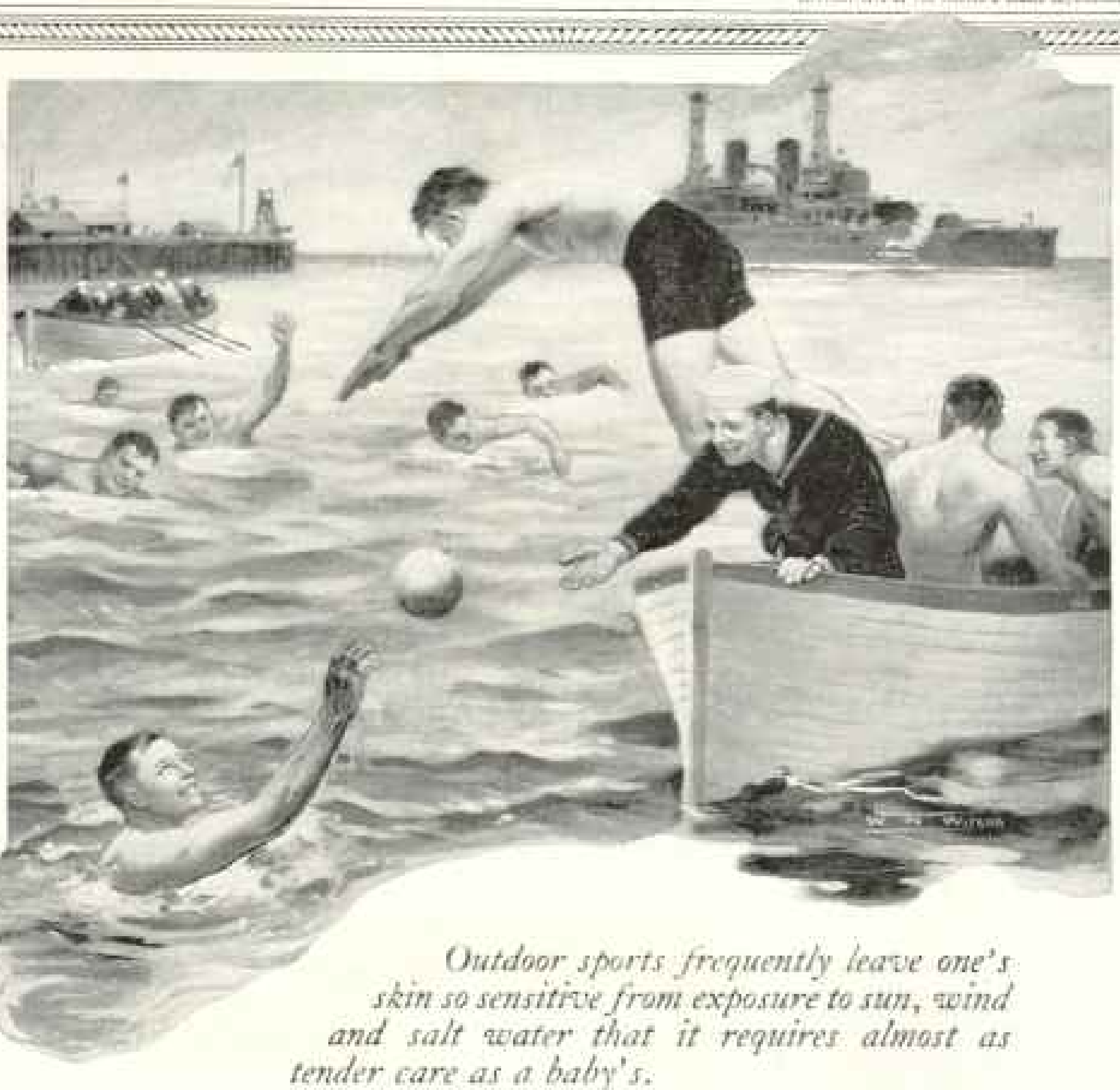

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VOL. XXXVI, No. 2 WASHINGTON AUGUST, 1919

THE NATIONAL GEOGRAPHIC MAGAZINE

THE GEOGRAPHY OF GAMES

How the Sports of Nations Form a Gazetteer of the Habits and Histories of Their Peoples

BY J. R. HILDEBRAND

A CURIOUS paradox: the maddest war men ever fought has had a tendency to turn the world to simple, wholesome play.

Your Englishman no longer makes excuse for the time he spent at the bat or in the saddle. Centuries of cricket, tennis, and riding to the hounds fortified his home land in time of terrible stress. Some five million Americans, many of them snatched from desk and counter, are pouring back, having sensed the tang of open sky and outdoors while playing their games, football to ping-pong, behind the lines, as they waited to get into the biggest game of all.

And other men from every clime—black, yellow, and tan—carry home the games they saw these sturdy Britishers and wiry Americans playing. The French played, too—played in a way peculiarly expressive of their national temperament.

GAMES A KEY TO GEOGRAPHY

Note the reverse of the picture. Germany, with clanking armor and unsheathed sword, gone stale from overtraining for the fight she picked, may find in her neglect of play one reason for a colossal failure at arms and her maladroit diplomacy.

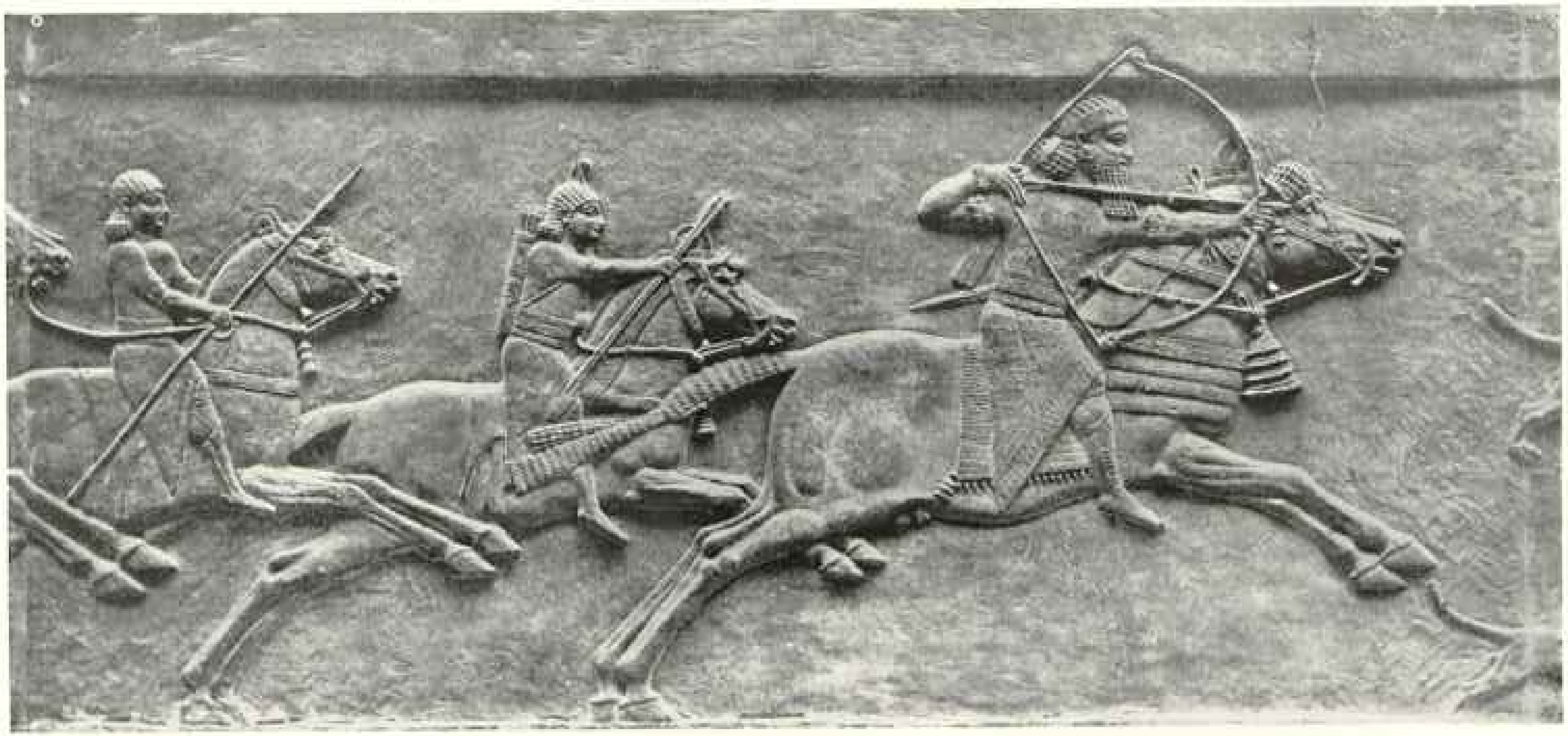
Sports and games ever were magic touchstones to geography and to those allied sciences which provide the surest clues to how peoples live, and work, and think.

In countless ways science has learned about climates, and products, and customs, and peoples of the past from toys, games, and sports. An entire new field of investigation was opened by the discovery that backgammon, as played in Burma, also was known to the pre-Columbian Mexicans.

A new light is shed on an ancient civilization when we learn that there was a law among the Persians by which all children were to be taught three things: horsemanship, shooting with the bow, and telling the truth.

Carthaginians and Phœnicians owed something of their maritime glory to a love of swimming, the sport by which they first mastered their fear of the sea. One wonders whether the more rapid strides made in England toward the political emancipation of women may not be traceable to the ardor of British women for outdoor exercise and sports.

Equally significant in the history of nations is the decline of their sports. While the Persians observed the rigid regimen of the chase, as prescribed by



BEFORE KINGS CLAIMED VOCATIONAL EXEMPTION

Assur-bani-pal was the William Hohenzollern of Assyria six centuries before Christ, and so mighty was his "kultur" that kings of hapless Belgiums of that time sacrificed their daughters to his harem as peace offerings. In his quest for more Assyrian room under the sun he drew his own bow and arrow, for "safety first" had not yet become the motto of war-breeding monarchs.

Cyrus, their armies were victorious. While Spartan youths followed the rigorous discipline of Lycurgus, their city was inviolate. Led by Alexander the Great in ways of abnegation and exercise, the Macedonians were invincible. The Romans extended their civilization so long as their gymnasia prepared youths to endure long marches and bear crushing burdens.

CLIMATE DETERMINES THE KIND OF GAMES WE PLAY

It is fairly obvious that coasting is a sport of the zone where snow falls, and reasonable that those peoples most generally proficient in swimming should be found in the equatorial islands, where limpid waters invite surcease from the scorching sun, but less well known, perhaps, that card and board games developed in southern Asia, where zest for play is just as keen, but temperature dampens the ardor for exertion.

The reactions of geography and sport are mutual. To the Netherlands are traced the stilt and the skate, which even yet have their work-a-day use in flooded and frozen areas, but are playthings for the rest of the world.

The Governor of Namur once made an oracular promise to Archduke Albert of Austria that he should see two troops of warriors who fought neither on foot nor horseback. The Archduke was so impressed with the giantlike soldiers on stilts that he exempted the city perpetually from duties on beer. Norway had a "regiment of skaters" and Holland's soldiers were taught to drill on ice.

THE CHILDREN'S CRUSADE

Sometimes sports spread beyond national boundary lines and express the common ideals of an age. Thus the tournaments of the middle ages were the normal symptoms of the adventurous spirit reflected in the quests for the Holy Grail. In that period, too, was a striking, if pathetic, illustration of the imitative spirit which translates the serious business of adults into sport for children.

In Franconia and Teutonia thousands of boys, some only six years old, hoisted banners bearing the Cross and started for Jerusalem. Some turned back at Mayence, some went as far as Rome, but of the multitude that went out on this play expedition few returned.

Games invariably adapt themselves to the individual need for a balanced life, mental and physical. This fact was illustrated by comments of civilian writers in the war zones, who told how Englishmen and Americans sought diversion in active play, while Frenchmen relaxed in more quiet fashion—smoking, reading, or day-dreaming by the side of a welcome fireplace. Many noted this as a contradiction, in view of the supposed sprightly temperament of our Gallic cousins.

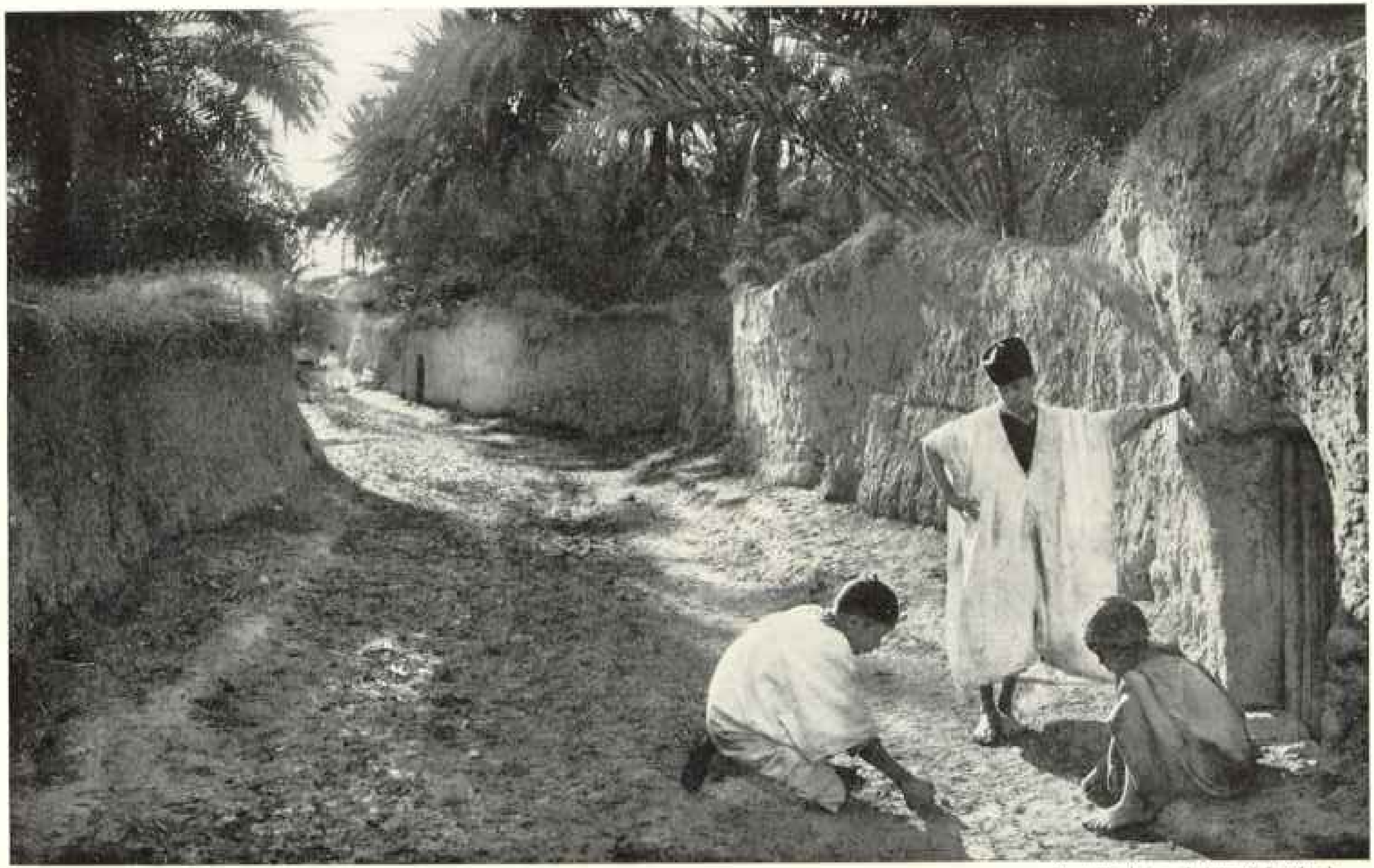
But a sporting writer, in an article printed years before the World War, relates how, "unlike his English counterpart, who seeks his relaxation by attending a football match and mauling the umpire when he does not approve of a decision, the workingman of France repairs to the comparative solitude of the 'jardin de l'arc' and there practices the peaceful sport of archery"; to which the writer appends this illuminating comment: "Probably this is typical of their different natures. The Englishman, phlegmatic during his work, seeks excitement as a relaxation, while the more animated Gaul needs quiet during his leisure."

IN THE AGE OF PERSONAL COMBAT

Just as the individual adopts games which meet his bodily need, so it seems that national pastimes are modified to foster and fortify the peoples who play them.

In the age of personal combat there were men like Milo of Crotona, a veritable Samson, reputed to have been able to break a cord wound about his head by swelling the muscles; or Polydamas of Thessalia, said to have slain an infuriated lion, and to have been able to hold a chariot in its place while horses tugged at it.

Those were the times when boxing and wrestling, most ancient of sports, were in their heyday, though they were not always gentlemen's diversions, reck-



Photograph from Lehnert & Landrock

PLAYING THE WORLD'S OLDEST GAME OF CHANCE: NORTH AFRICA

"Rolling the stones" is an expressive and historically correct bit of slang. Gambling on the turn of pebbles is prehistoric and made dice were ancient, if not always considered honorable, implements of play when Mark Antony gamed with them in Alexandria while he waited for Cleopatra to "be ready in just a minute," and when Caligula enlivened the playing by using the loaded kind. Only the scorching sun molests the "crap-shooter" of the desert lands, and this quiet street through an oasis affords shelter from such interference.

A BATTLE OF WITS: HOLLAND

The Chinese have a tradition that an emperor invented cards to amuse his concubines: but they generally are attributed to Egypt or India and are thought to have been suggested by chess, reckoned the oldest game in the world. Like the modern game of "authors," card games in medieval Europe were educational, and sets were made by monks for teaching geography, logic, and grammar.

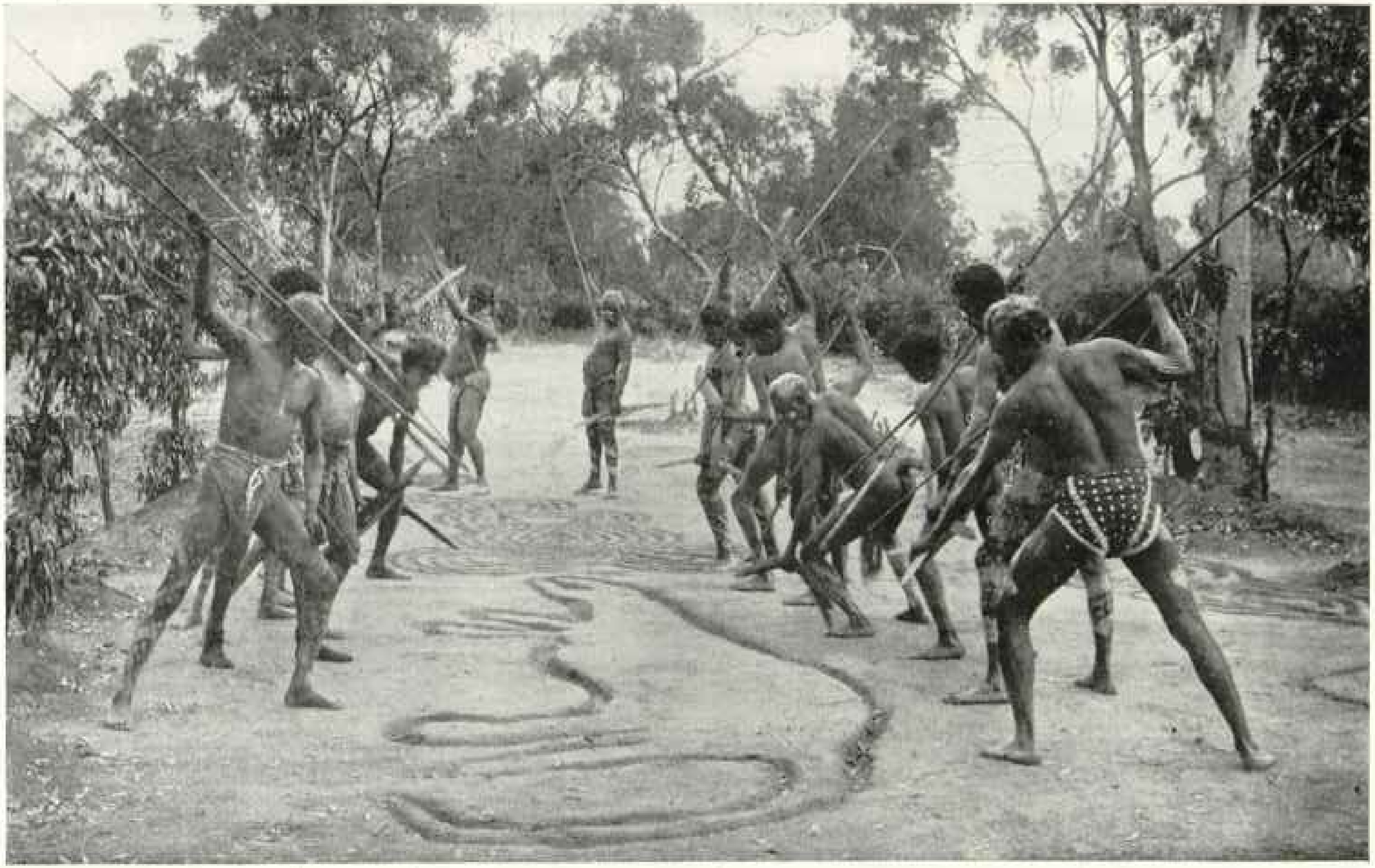
Photograph by J. Pérestrello

THE NATIONAL SPORT OF SPAIN, IN WHICH THE MATADOR SUPPLANTS THE GLADIATOR OF THE ANCIENT ROMAN ARENA

"Bread and butter," says the American, to express the ultimate necessaries; "pan y toros," says the Spaniard, meaning "bread and bulls." By edict of Carranza, bull fighting has been abolished in Mexico, and the magnificent stadium in Mexico City, seating 18,000, has been converted into an open-air opera house. Despite attacks like that in the novel of Ibanez, having a popular vogue here since its translation, the sport introduced by the Moors and perpetuated by Charles V and Philip IV, both amateur matadors, persists in Spain. More than 200 towns and cities have their plaza de toros, varying in size, but alike in two features, a hospital and a chapel, where matadors receive the sacrament before entering the ring. More than a thousand bulls of high breed are killed yearly; many others are injured or discarded.

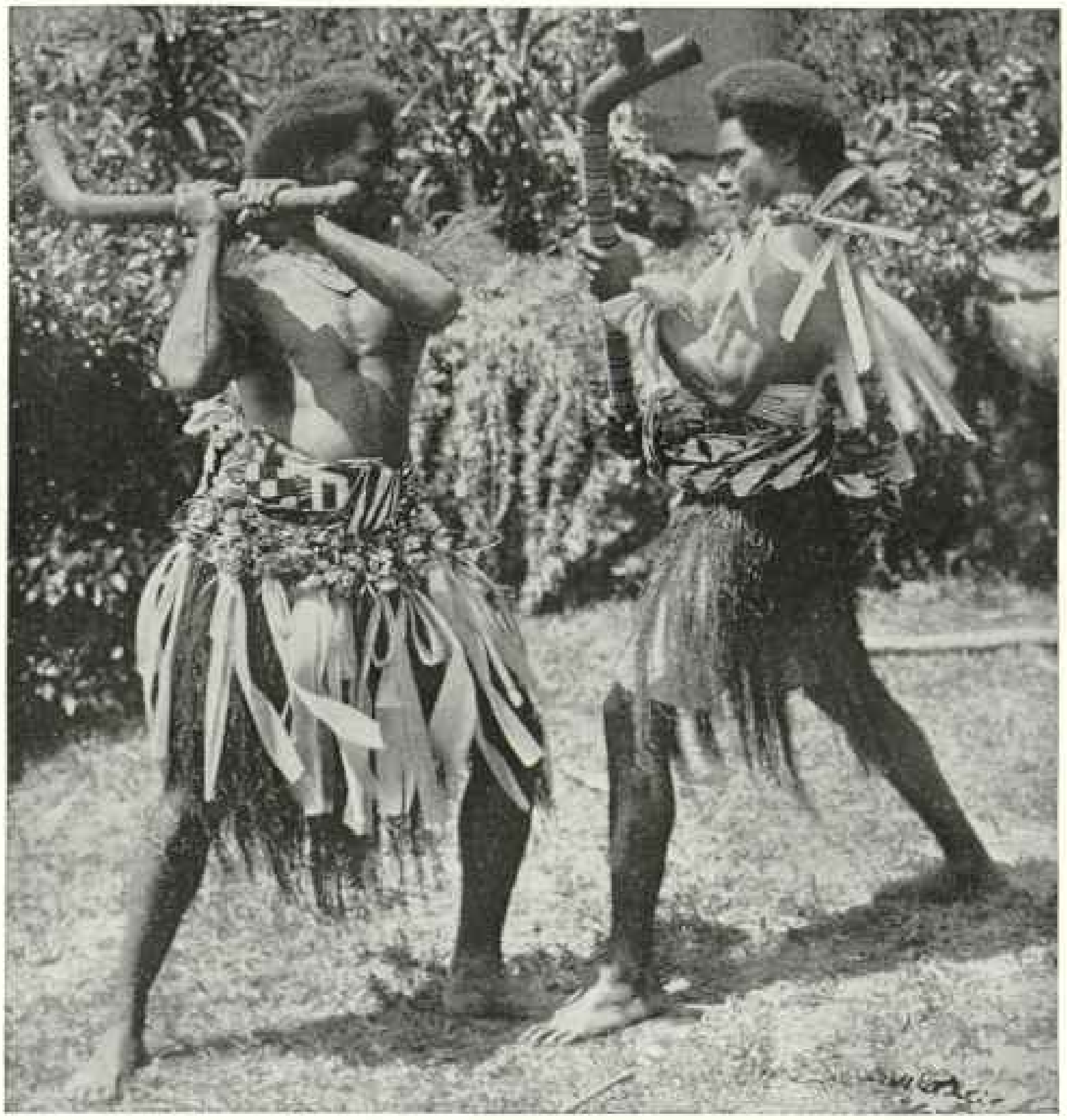
GYPSIES OF SPAIN: THE LAND WHERE FOLK ARE KNOWN BY THE DANCES THEY DO

The Italian must sing, the Englishman must hunt, the Spaniard must dance. Small wonder that one traveler observed that every Spanish girl is bitten by a tarantula. Surprising, though, that the vogue of Spanish dancing only recently captivated the New World. Every Spanish city has its own dances. The stately "La Muniera" is as characteristic of northern Spain as is the broad "a" of the American Yankee; the vivid, colorful "Sevillana" is ready identification of the Sevillian.



AN ABORIGINAL CEREMONY, "SPEARING THE ALLIGATOR": AUSTRALIA

"Hit the Neapolitan on the head and get a five-cent cigar," the circus barker's raucous invitation, is but a latter-day echo of this primitive sport. The pastime illustrates how savage tribes adapt their industry of the hunt to serve for play.



FIJIANS DOING A CLUB DANCE

In this land where wives were buried with their husbands before civilized restraints were imposed, and where cutting off a finger still is a common sign of mourning, these most cruel and barbarous of the South Pacific islanders show a human love for song, dance, and story-telling. Their famous club dance is a martial exercise, with a low comedy motif, and the costumes of the picture are supposed to be extremely clownish.

oned by modern standards. Homer described the set-to between Epeus and Euryalus, wherein the latter was carried away, insensible, "his legs hanging powerless, his head dropping on his shoulder, and dark blood flowing from his mouth."

Even that combat was mild compared to the fistic encounter of Kreugas of Epidamnus and Damoxene, an historic "heavy-weight slugger" of Syracuse. Kreugas landed a hammerlike left on his opponent's pate, but Damoxene countered with a mighty clout of his right to his adversary's stomach. His nails were long and his hand bound with thongs. It is recorded that the Damoxene terror's fist "sunk into the entrails, pulled them forth, and scattered them upon the arena, the poor wretch, of course, dying on the spot."

When missile-throwing became the technique of warfare the Italian city

RIDING THE SURF AT HONOLULU, HAWAII

Walking a tight rope stretched on top a speeding express train might afford some of the exhilaration of Hawaii's distinctive sport. Here, again, geography molded the national pastime; for the conformation of the ocean bed along the island coast creates the swells that make this sport popular. The picture illustrates only one position of the native rider, who lies prone, sits, and even stands on his head on his super-canoe.

Photograph by Perkins

TWO FISHERMEN AT KEALAKEKUA BAY, HAWAII, WHERE CAPT. JAMES COOK DISCOVERED THE ISLANDS IN 1778

Photograph by Harry F. Blanchard

KNUCKLES DOWN!

youth reduced stone-throwing to a fine art, and in winter made use of snowballs on fête days. In Perugia as many as 2,000 would engage in this game. Defensive armor was worn, but many fatalities resulted. Mothers and wives protested, it is safe to assume; but there, as in Sparta, heed to feminine counsels was held to be unmanly.

Old English statutes furnish evidence of the encouragement of archery, and the reason therefor may be found in the fact that the Battle of Hastings saw the Saxons panic-stricken at the effective use of the longbow by the Normans, although later, at Poitiers and Agincourt, Englishmen won lasting fame by their employment of that weapon.

Charlemagne sought to popularize archery; Edward III forbade all other sports on holidays and Sundays, thus making the pastime subserve universal military training.

BY THEIR PLAY YE SHALL KNOW THEM

It almost seems as if by a people's sports you shall know them. Taine thought literature was a sure criterion, but literature is not always precisely expressive, because it may become overselfconscious under the influence of a Dryden; or it may bend to winds of fashion, driving a Shaw to preach sociology in plays and a Browning to teach philosophy in verse; and nearly always it seeks out the exceptional, sometimes focusing a people all awry, as if heroic France were to be adjudged through some of her erotic fiction.

Play is more spontaneous. There is a wealth of suggestion in the fact that bullfighting in its most cruel form was an obsession in the years when the Council of Blood was making revolting sport of human life in the Netherlands. Charles V, by no means a robust monarch, felt called upon to celebrate the birth of his son, Philip II, by slaying a bull. It was that same son who sent the Duke of Alva upon his barbarous mission to the North Country.

One could all but write the history of classic Greece from a knowledge of its games, and tell something of its philosophy, too. Plato, in our time, while not engaged on a Chautauqua circuit, would be urging municipal playgrounds and swimming pools.

Photograph by R. R. Sallows

THIS SPORT WAS TOO BIG FOR ANY SMALL BOY TO RESIST

The prospective victim being the largest man in Goderich, Canada, who weighed 460 pounds.

"Every well-constituted republic," he said, "ought, by offering prizes to the conquerors, to encourage all such exercises as tend to increase the strength and agility of the body." He advocated State provision for teaching girls to dance and the use of arms for self-defense.

THE PLAY SPIRIT AS A PIONEER FOR PROGRESS

A Hawker sets out to fly across the Atlantic as a sporting proposition and helps chart the course that soon will be plied by air carriers of work-a-day commerce. Whirring motors churn about a banked speedway as thousands sense the zest of a breathless and death-defying game, but the play spirit which the contest arouses—the spirit that ever drove men to higher attainment—generates the stimulus for bringing nearer to perfection man's new-found servant, the automobile. Benjamin Franklin, employing a boy's familiar plaything, snatched from the clouds a secret that outdoes the pranks of a magic carpet.

Photograph by A. W. Cutler

MEET OF THE HOUNDS AT HIMBLETON, WORCESTERSHIRE, ENGLAND

This is one of the fox-hunting counties of Old England, where raising thoroughbreds was a gentleman's industry and where the hounds had pedigrees and histories that passed into the folk-lore of the countryside.

Invention of the rubber bladder made football popular, of the gutta-percha ball added immensely to golf, and of the encased sphere made tennis a keener sport; and so the story might continue to the mighty industries that provide the amusement to be had from motion-picture play or from phonograph record.

COLONEL ROOSEVELT'S INFLUENCE ON SPORTS

Theodore Roosevelt's influence is generally accounted in social, political, economic, and literary fields; yet time may show that one of the most profound lessons he impressed upon American people was a deeper regard for healthful, vigorous, strenuous outdoor sport.

The story of how the weakling Roosevelt went to the open places of the West and played at broncho-busting and cattle-herding, and later relaxed in African jungle from seven years in the hardest job in the world, is an oft-told tale. Such an uprooting of one's life, thanks to our national parks, is not necessary today. More and more is it the habit of young men and old to seek the health-giving recreations to be had in Uncle Sam's matchless play places.

Walking is one of the most healthful and invigorating of all pastimes and free to every one. Yet it is much neglected by Americans. Perhaps the automobile is to blame, in some degree; but the fact that walking is deliberate and lacking in that element so dear to the American heart, competition, also must be taken into account.

To the seasoned pedestrian "joy riding" cannot compare with "joy walking." The latter affords the devotee intellectual delights that neither speed nor rivalry can offer. To him walking is truly a royal road to learning—a matriculation in the God-given university of nature. To walk is to open the book of natural wonders—to see the flowers and the trees, to hear and know the birds and all the voices of the outdoors symphony.

Then, too, there is a walk for every mood and temper. Gladstone loved to walk in the rain; Browning delighted to stroll by night; Charles Lamb turned to the crowds of busy streets, while Wordsworth stole away to the silent places.

That protean sportsman, Theodore Roosevelt, counted walking among his favorite recreations, and found a plunge through untraveled woods, across streams, up and down the hills, strenuous enough for him. Former President Taft likes walking, but prefers the sights of the city streets.

Europeans have a higher regard for walking than most Americans. Viscount Bryce, when ambassador at Washington, by his daily tramps learned to know the environs of the National Capital as do few of the residents. He frequently covered 15 or 20 miles in an afternoon.

SPORTS BEHIND THE LINES HELPED TO WIN THE WORLD WAR

The World War has helped stress a higher claim for sport, more potent than the fact that plays and games register the habits and habitats of bygone peoples or that they stimulate mechanical invention; for it has proved that sport conditions the moral fiber of a people and tempers those mental qualities that advance civilization.

Right up to 1914 it was almost bromidic to laugh at the Englishman for putting his recreations in his "Who's Who," alongside of matters considered more weighty; for publishing massive tomes and cyclopedias of sport; for waging mighty word battles in print over the relative merits of the breech-loader and muzzle-loader for shooting grouse. Now the world knows that the Derby at Epsom, the cricket at Rugby, and the fox-hunts of Northamptonshire had everything to do with the bulldog determination with which he "carried on" one heartbreaking summer after another against vicious Hun onslaughts in Flanders.

It is significant that the wise men of Washington, London, and Paris made every effort in war time to maintain the amusements of the people. "Millions for morale," a familiar American slogan, was another way of saying "millions for play." At the government's behest, one welfare organization alone sent 25,000 baseballs and 15,000 baseball bats to France before half our men had arrived there.

Even the sport-loving Britons are said

Photograph by Paul Thompson

RAPID ACTION: INTERNATIONAL POLO

The exciting moment pictured here affords an extraordinary study of equine feet. The hind feet of the center horse are both off the ground and the pony in the foreground is giving a splendid demonstration of ankle action. In his sudden stop, two of his four fetlocks are touching the ground.

Photograph by National Photograph Co.

WHERE THE HORSE STILL HOLDS HIS OWN

Throughout the ages the horse has stood second only to the dog as man's best friend and playmate. Feats of horsemanship date back to the first "thoroughbreds" of Arabia, which, according to Moslem tradition, were descended from horses that Solomon bestowed upon the Arabs. Modern racing had its beginning with the charioteers of the Olympiad. Only in recent times has horse-racing in the western world been associated with gambling. In the Middle Ages tennis was played for heavy stakes, and a Puritan writer of Elizabeth's time, who excoriates most other sports, commends horse-racing as "yielding good exercise."

ONE REASON WHY FRENCH CHILDREN ADORED THE BOYS IN KHAKI

This was one of a series of "tank sports," which had no reference to the British tanks, though they were about as rough.

to have admired and wondered at the American dough-boy, whacking out three-baggers amid the booming of Big Berthas, issuing occasional rain-checks in mid-inning when the downpour of bursting shell became too distracting. In one cramped trench, so the story goes, was a quartet of Yanks who exhibited the same spirit in playing "five hundred;" in others it was poker or "rummy." A whizzing shell all but ripped off the thatched roof. Drawled a lank, prairie-bred Yank: "Gosh, if Fritz does that again, I'll trump my partner's ace."

Not that taking one's games to war is an American invention: the Yanks merely did it on a larger scale. Drake insisted on finishing a game of bowls before going out to encounter the Spanish Armada. Englishmen played cricket at Ladysmith while the enemy shells burst above them. When the sea was calm, Captain Cook, on his long voyages, made his men dance the hornpipe to keep in trim.

Qualities of initiative and courage and endurance implanted upon American gridiron and diamond shone with glorious luster at Cantigny, at Château-Thierry, and in the Argonne. That is why one of the most valuable by-products of this crucible of suffering will be a realization in this country that the sinews which won the war are just as needful for the rigorous, bloodless battles of peace.

AMERICA'S CONTRIBUTIONS TO THE WORLD'S PLAY

Back home, before the war, America had contributed two new things to sport: baseball and the city playground.

It has been noted that sports of a nation afford an almost invariable barometer of its progress in civilization. Baseball is one of the most complicated and highly organized pastimes known to any people. It is a veritable instrument of the most delicate precision in the world of sport. A South Sea islander no more could play it than he could

Photograph by M. Rosenfeld

A GOOD STIFF BREEZE IS NATURE'S SPEED LAW ON THE OCEAN HIGHWAY

Photograph by Central News

TAKING THE WATER JUMP IN THE JUNIOR RACE: ETON COLLEGE, ENGLAND

This is the way the English schoolboys played for generations in unconscious training for the obstacle race through Hun bayonet, barbed wire, and barrage in France. Note the Eton headgear of the gallery.

AQUAPLANING OFF ALTON BEACH: MIAMI, FLORIDA

This exciting sport of sea-sledding behind a motor-boat speedster at 30 miles an hour is a thing of joy and thrills to the onlooker as well as to the rider.

© G. R. Ballance

SKIING DE LUXE AT ST. MORITZ

Long the auto of Scandinavians, the ski, like the skate and the stilt, had a military use. Had there been a league of north European nations some centuries ago, its international army, passing in review, would have disclosed a Swedish ski regiment, a skating battalion from Norway, and Hollanders on stilts.

operate a linotype machine or deftly handle the paper money in a bank teller's cage.

Yet the instincts baseball satisfies—the zest of racing to a goal ahead of the ball, the deep satisfaction of diverting a swiftly moving object to serve his own ends, the mere impact of the speeding sphere against the instrument he controls, bagging the spheroid as it flies afield, the suspense of nine men as they await the batter's fate—each and all find their counterpart in play as old as animals that walk on two feet and have enough gray matter atop their spinal columns to control nature's laws for their human purposes.

The foot-race ever was the most popular of the twenty-four Olympian events. The Romans batted balls with the forearm swathed with bandages, and the Gilbert islanders wrap cocoanut shells with cord so they will rebound to a blow from the open palm; Homer's princess of Phæacia is represented in the Odyssey as jumping to catch a ball tossed by her maids of honor; and the Chinese had a game in which a suspended ball was kept hurtling to and fro by blows from the players. Perhaps there was more sport than economy in the old Dutch habit that Washington Irving tells about, of having a lump of sugar swinging above the dinner table from which various guests at a New Amsterdam banquet took successive nibbles.

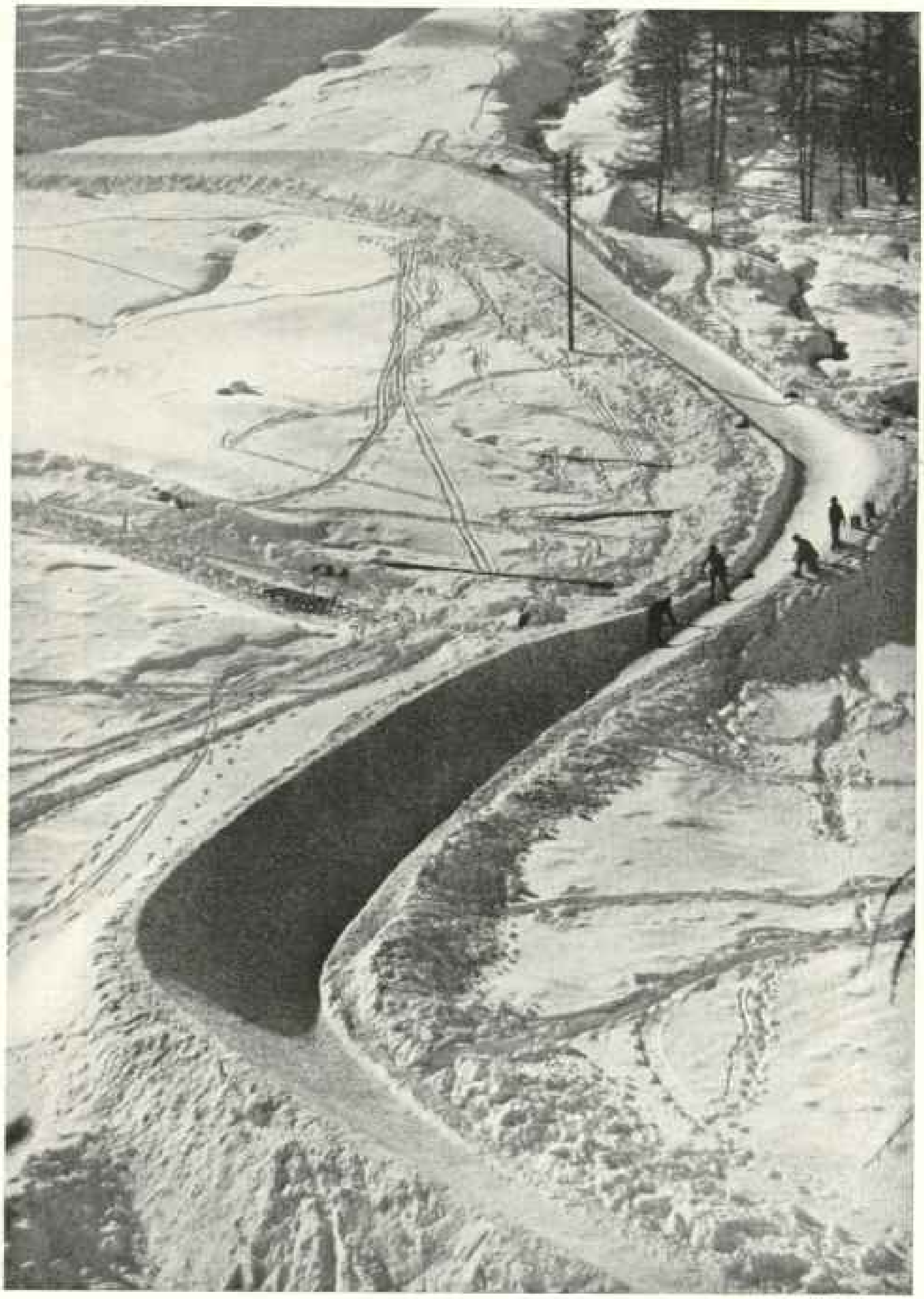
Some historians assert that the Greek games formed the foundation for the lucid thinking and the lofty art concepts that made her product classic. Yet the Olympian and the Pythian games at their best afforded no such spontaneous, and at the same time intricate, interplay of muscle and mind as baseball.

Throwing, catching, and running are as old as man; but it took the American genius for play, no less distinctive than the American genius for science, indus-

Photograph by Kenneth D. Smith

YOU CLIP THE CLOUDS AND SEEM TO GROW WINGS

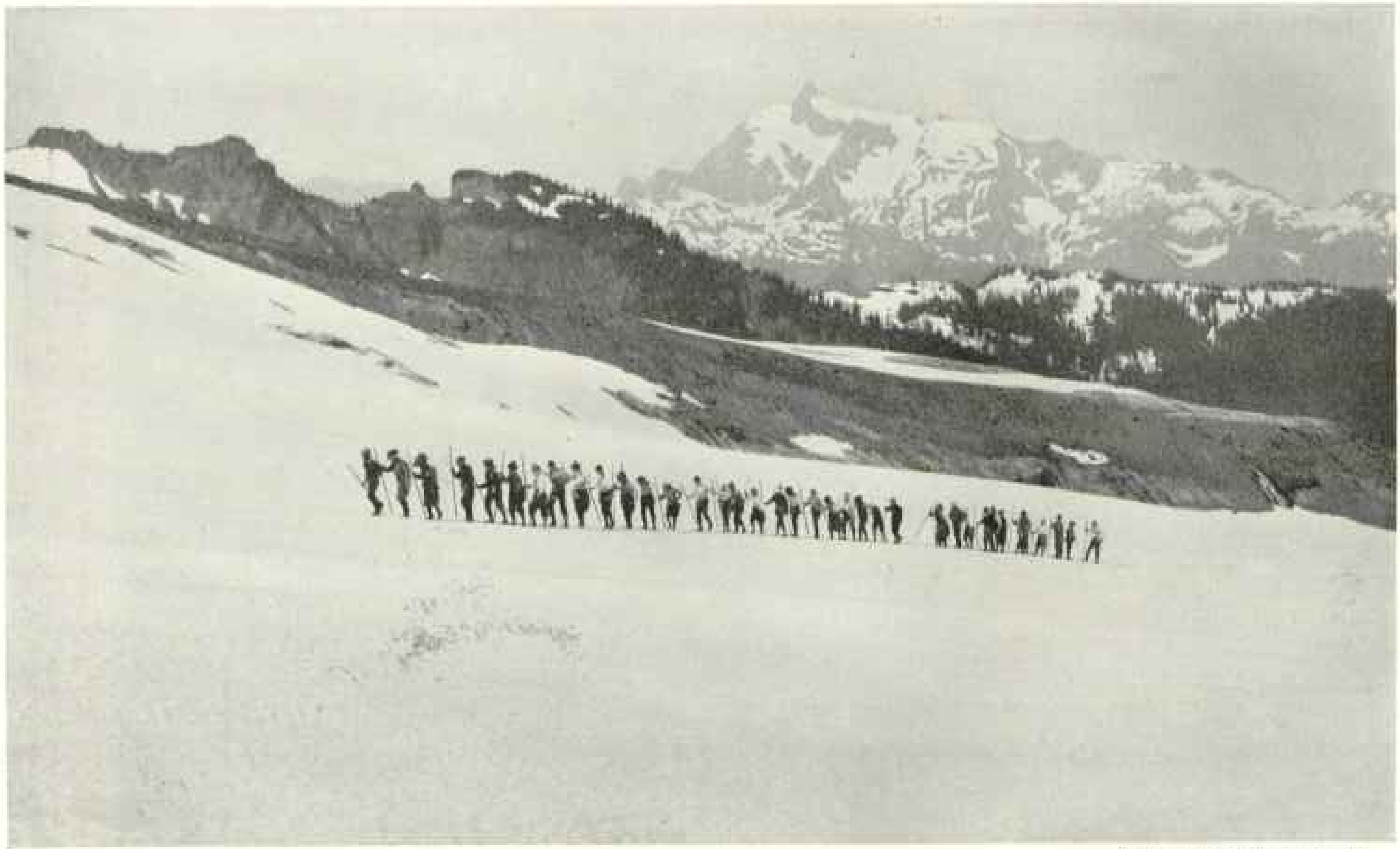
A Dartmouth College athlete making a ski jump of about 75 or 80 feet, in perfect form.



© C. R. Ballance

THE WORLD'S MOST FAMOUS TOBOGGAN SLIDE

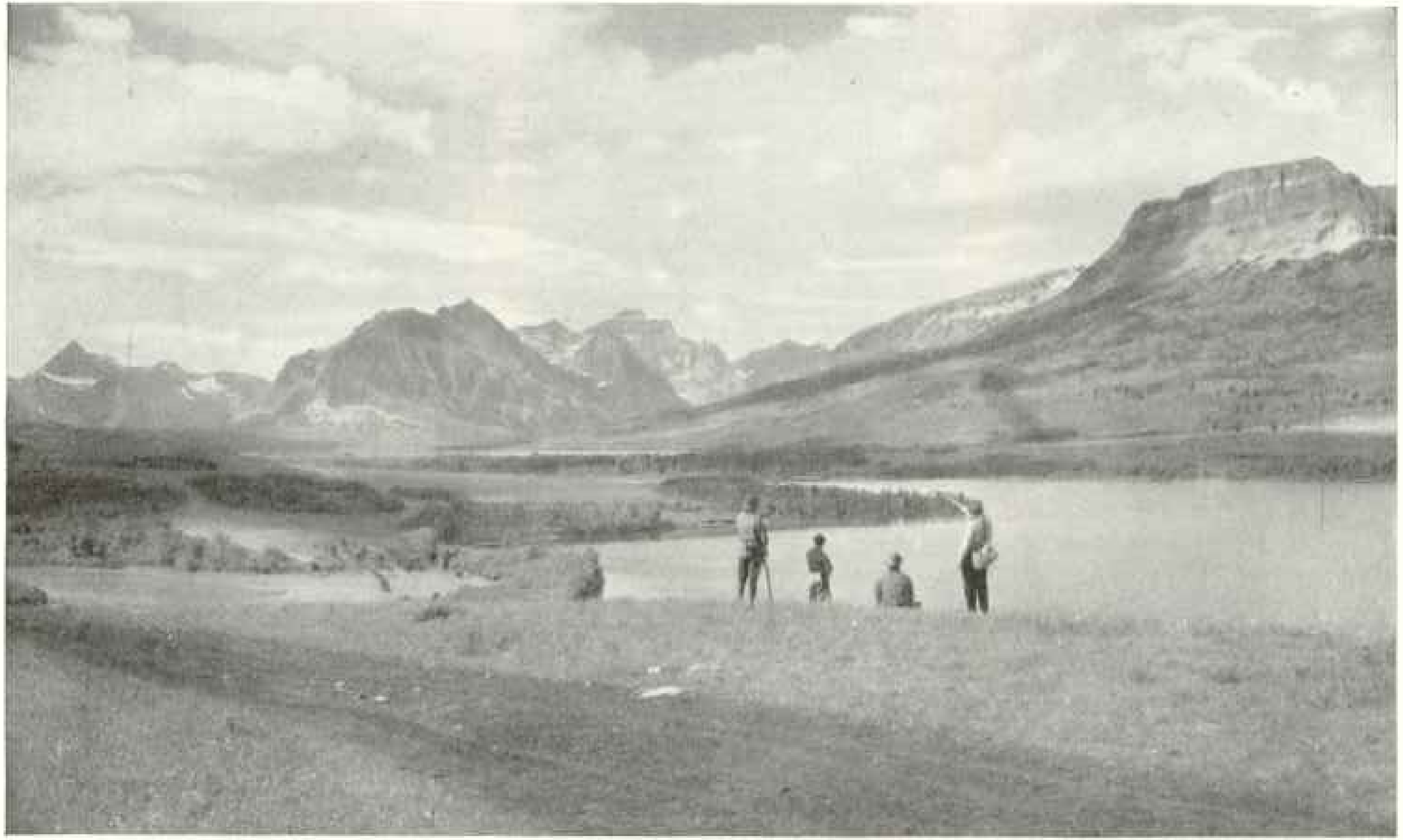
This is Cresta Run, at St. Moritz, Switzerland, known as "battledore and shuttlecock" because the coaster is tossed about by a series of corners, curves, and grades, no two of which are alike.



Photograph by Curtis and Miller

CLIMB AMERICA FIRST

This might well be the motto of those who feel the universal urge for climbing and repine because they cannot go to the Alps. This scene is on the slopes of Mt. Baker, Washington State.



Photograph by Haynes

HIKERS ON LOWER ST. MARY LAKE: GLACIER NATIONAL PARK

To visit Uncle Sam's National Parks is to do more than "See America First"; for they afford virtually an inland tour of the world. In them one may view the earth's biggest trees and pluck Alpine wild flowers; delve among Stone Age relics or track the "tame wild animals," from caribou to chipmunks; gaze upon the lofty peaks of Glacier Park, shown in the picture, or peep into the yawning depths of abysmal canyons, as in the Yellowstone, Yosemite, and Grand Canyon.

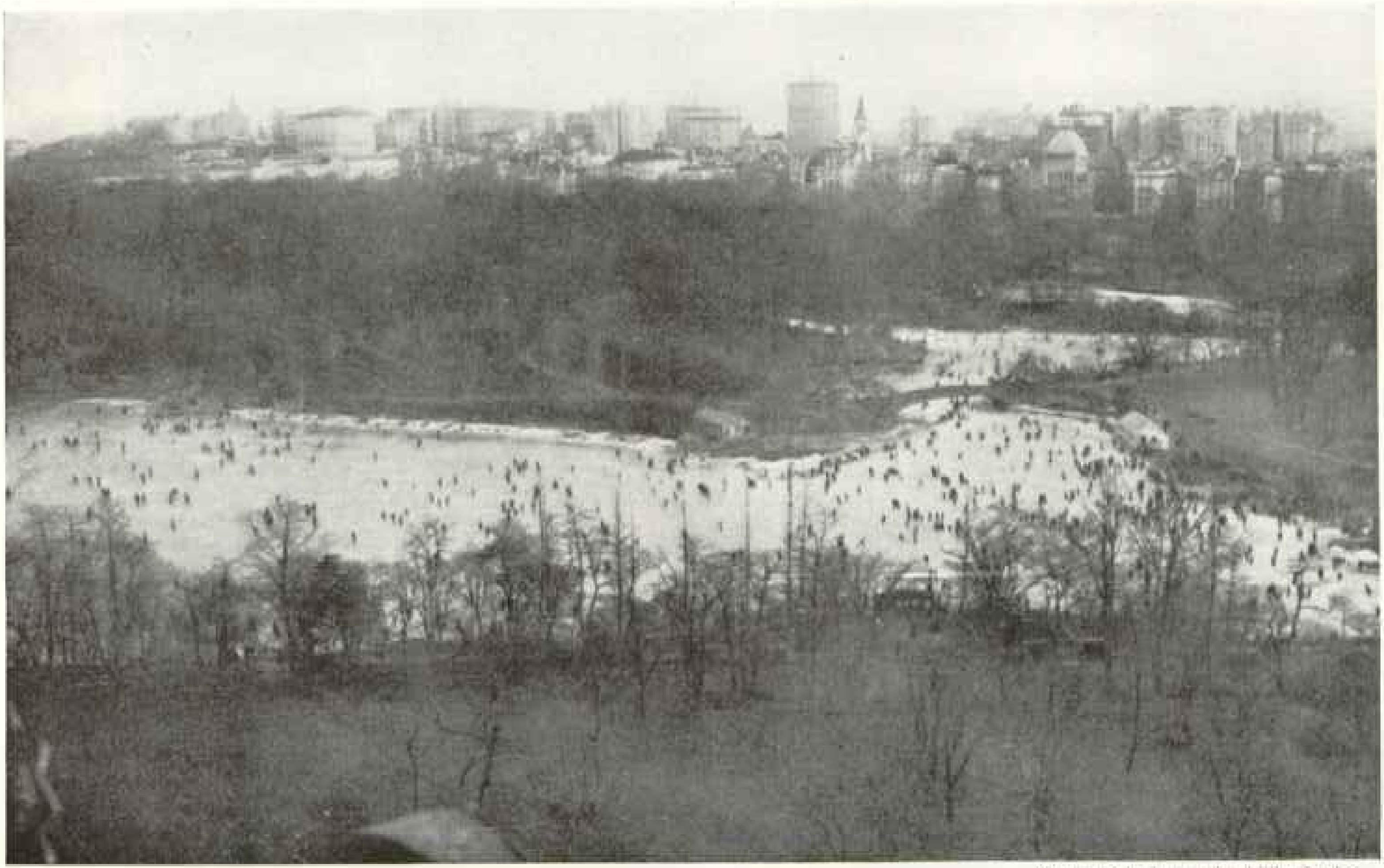
Photographs by W. R. Ross

THE "WANDERLUSTERS": WASHINGTON'S WALKING CLUB

Exercise need not be strenuous to be invigorating. These city folk are enjoying the world's oldest and most democratic sport, traversing a few of the beauty spots that abound in the environs of the National Capital (see also page 103).

Photograph by R. R. Sallows

THE BOYS' EXCUSE WAS, "SOMEBODY STOLE OUR CLOTHES!"



Photograph by International Film Service

SKATING IN CENTRAL PARK: NEW YORK CITY

With such a playground as this at his door, small wonder that the city child should show up as well in health statistics as his country cousin.

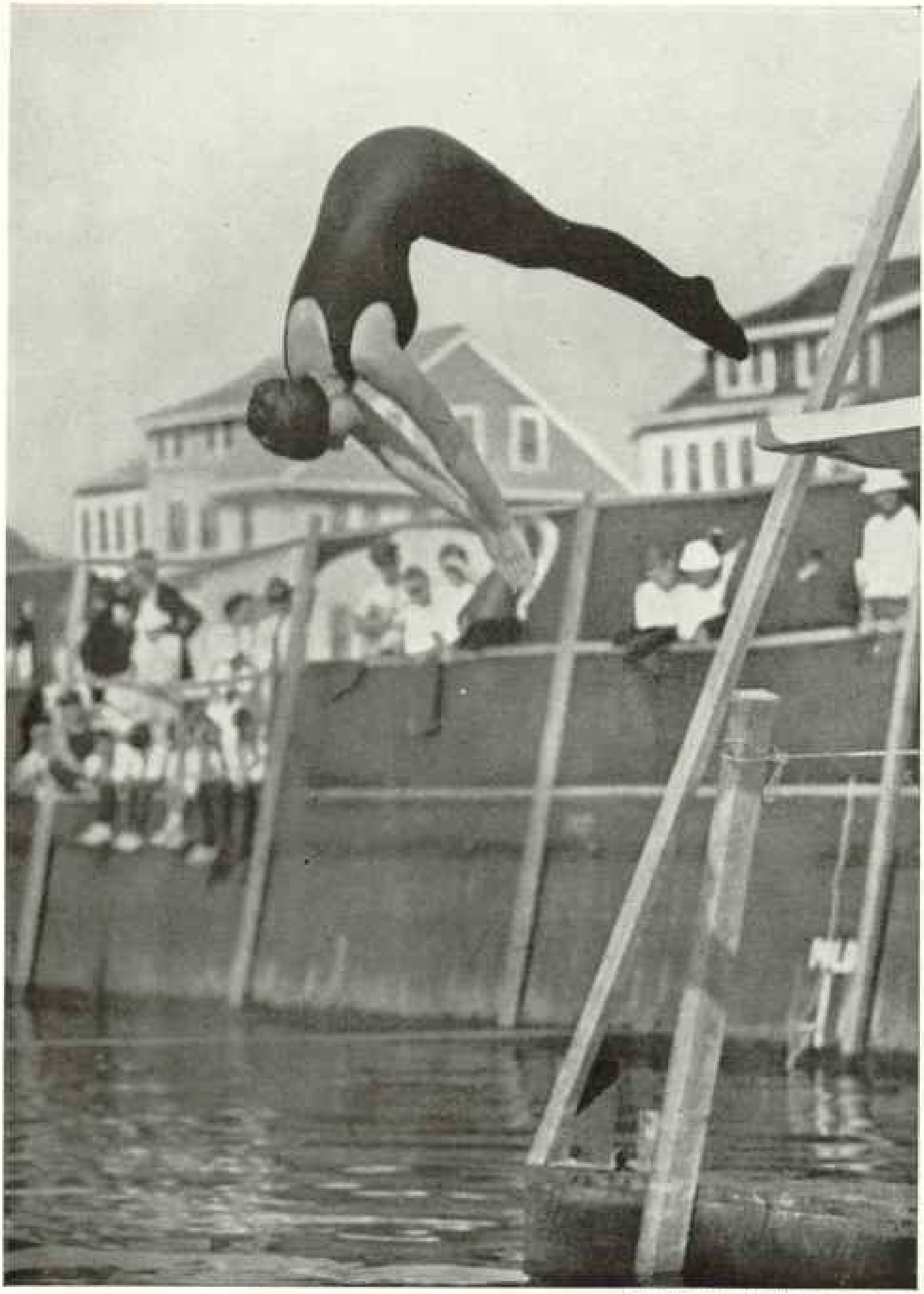
TOBOGGANNING IS A FEATURE OF THE OUTDOOR SPORTS CARNIVAL: ST. PAUL, MINNESOTA

Just as New Orleans, near the mouth of the Mississippi, employs that river, in part, for its historic mardi gras, so St. Paul, at its navigable head, utilizes its frozen waters for the city's more recent, but equally distinctive, winter sports carnival. St. Paul truly is a play city of the great Northwest, for its extensive parks, its public baths, and its State fair, most largely attended of the kind in the country, afford recreation for every season.

HOW ST. PAUL USES AN ICED STREET AS A MUNICIPAL PLAY PLACE: A HIGHLAND FLING ON SKATES

Photograph by C. A. Slade

TIMIDITY BORN OF COLD WATER RATHER THAN OF THE CAMERA'S RECORDING EYE



Photograph by Paul Thompson

THE SCISSORS DIVE

Every Roman girl was a Kellermann, from Martial's description of water games and fêtes, wherein maidens would "sport in a chariot like that of the fabled nereids and group themselves in the most varied designs"; and diving was an essential industry among the Syrians, who went out in fleets to dive for sponges, as do the old salts of Gloucester, Mass., to fish.

THE LAND AND WATER STEEPLECHASE

OFF FOR A 100-YARD RACE!

Swimming was included in a Roman woman's education. But of all swimmers perhaps the pre-Columbian Indians were the most proficient. One explorer reported, perhaps with some exaggeration, that the Brazilian and Peruvian natives would remain in the water eight days at a time. Photographs by Paul Thompson.

try, and commerce, to weld these motifs into a game that puts a premium on skill, yet admits of infinite variety; that rawest youth or trained athlete may play; and that Presidents and office boys steal away to watch.

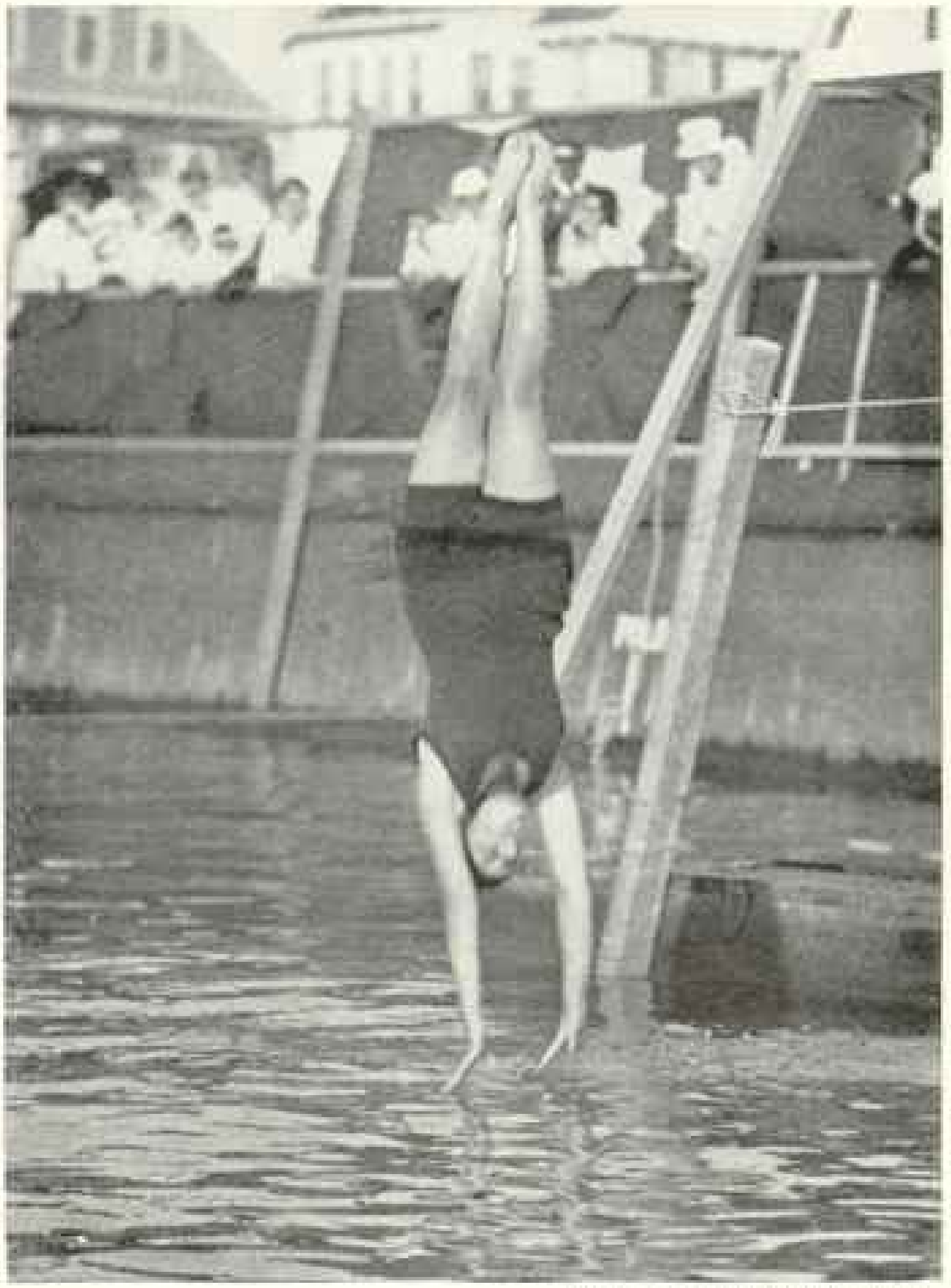
THE PLAYGROUND'S BIRTHPLACE

If the Greeks paved the way for classic art by teaching adults to play and Great Britain followed in her footsteps with a more spontaneous and democratic fervor, America now appears as the most forward-looking nation in her attention to children's playgrounds. In fact, the playgrounds for children may be considered the distinctive contribution of this country to the world's play.

To gather statistics of play is like counting the sands of the sea or the children of the nation; but it is significant of the awakening interest in play to note that in 1918 more than 400 cities maintained nearly 4,000 playgrounds, and the children who found relaxation on 340 of these playgrounds from which reports were had on any one day would have numbered scarcely less than the total population of Boston.

Moreover, this was but a fraction of the opportunities for normal play, for it does not take into account the thousands of boys' clubs and provisions for their special clientele which churches, parishes, private schools, and organizations like the Y. M. C. A., Boy Scouts, Knights of Columbus, and numerous others make. One of the most characteristic adjuncts of the American school, city, town, or country district is its playground; and few are the city parks where the old "Keep Off the Grass" signs have not been superseded by invitations to play, and special provisions for games.

There is nothing artificial about the games taught to children on American



Photograph by Paul Thompson

TAKING A HEADER AT A FANCY DIVING MEET

An officer of Captain Cook's crew tells how, on a trip to the South Sea Islands, he hurled some beads to a six-year-old youngster and they fell into the water. The child plunged from her canoe after them. Other trinkets were thrown into the water and the native men and women dived for them, showing such skill and staying under the water so long that the English "could scarcely help regarding them as amphibious."

Photograph by Paul Thompson

"ALL SET"

Despite our prowess in athletics, swimming is one field in which the palm must be conceded the ancients, if credence be given the marvelous tales of their aquatic feats. Plutarch tells how Antony engaged divers to attach fish to his hooks so he might impress his picnic companion, Cleopatra; but that shrewd lady engaged other divers the following day, and Antony found himself pulling in stale, salted fish amid peals of laughter from the Alexandria belle. Three of the world's speediest swimmers are shown set for a race, the one on the right being a Hawaiian champion.

playgrounds. They are products of a rich heritage of play tradition. Neither written history nor the faint traces of prehistoric times carry us back to a period when children did not play.

THE TESTIMONY OF TOMBS

Excavators in Central America found tiny rattles of bone and clay, as old as the pyramids of Egypt, in graves alongside baby skeletons. In Attica's tombs were uncovered dolls of pre-classic days, made of ivory and terra cotta. Little Hippodamia had a miniature bed, with slats, for his dolls. Roman children's toys were held in such high esteem by their elders that when the children grew too old for them they were offered to patron gods. Even today a similar association of religious ceremony and games is preserved, only it is with the acquisition of the toys, and not with their disposition, that Christmas and Easter are connected.

For one who would study the derivation of games, the average playground, no matter how crude, is a veritable museum of archæology. Tools and weapons of one age frequently become the playthings of the next; and centuries later, when adults have deserted the sport, children adopt it.

Many sports today are the survivals of obsolete industries. The canoe was the Indian's common carrier, and the Tierra del Fuego women who paddled their craft astern while their masters fished from the prows, and plunged into icy waters to anchor their barks, were pioneers of women in business and far from

Photograph by Kenneth Kerr

AN ESKIMO IDEA OF A GOOD TIME

No, the lady is not being punished for witchcraft; she merely is being crowned Queen of Love and Beauty by an Alaskan swain. The photograph was taken by a missionary at Point Barrow. There it is the custom for the Eskimo whaler making the biggest catch to be honored by the tossing of a woman in a blanket. Formerly this ceremony was observed after a victory in battle. The blanket is held taut by Eskimo boys and men. The more blasé belles always land on their feet; but a subdebutante is likely to have her head turned or her neck broken if this honor is too suddenly thrust upon her.

paddlers or divers for sport's sake. The Samoans who fashioned pearl shells to resemble small fish and attached tiny feathers for the fins may have been the precursors of fly fishers but their livelihood depended upon the catch.

THE DEVELOPMENT OF GAME-HUNTING

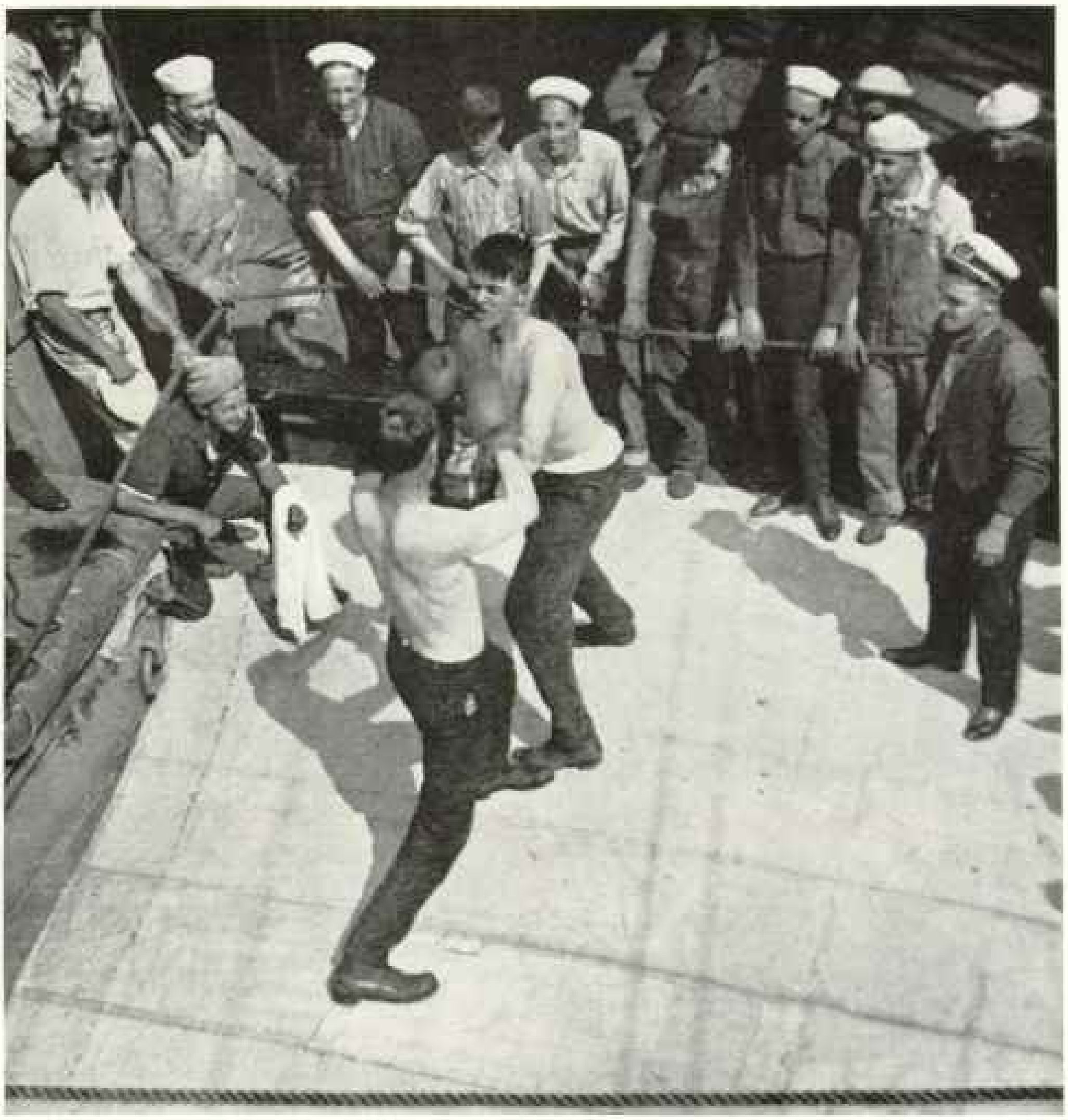
Game-hunting marked an important development in the life of primitive races. The Indian who stalked deer, the Semang black man who tracked snakes, the naked savage who hunted the rhinoceros, snared wild birds at their drinking places, and trapped the tiger were not out for a summer's sport.

Methods of hunting were exceedingly primitive at first, but some tribes early developed an amazing technique. The Eskimo would wrap himself in skins and lie by the hour alongside an ice-hole to harpoon a seal. The Tarahmares of Mexico felled trees by the score to get squirrels occasionally caught as the trees fell.

More ingenious were the Tasmanians, who would clear a forest oasis by burning, wait for the grasses to grow and attract animals, and then would set fire to a barricade of brush they arranged in the meantime, with exits near which they would take their stand and spear the frightened animals as they sought to escape.

Malay wild men killed elephants by lying in wait until an animal descended a hill, and then they would drive a poisoned bamboo splinter into its heel.

Some African tribesmen camouflaged their spear-heads with bird feathers.



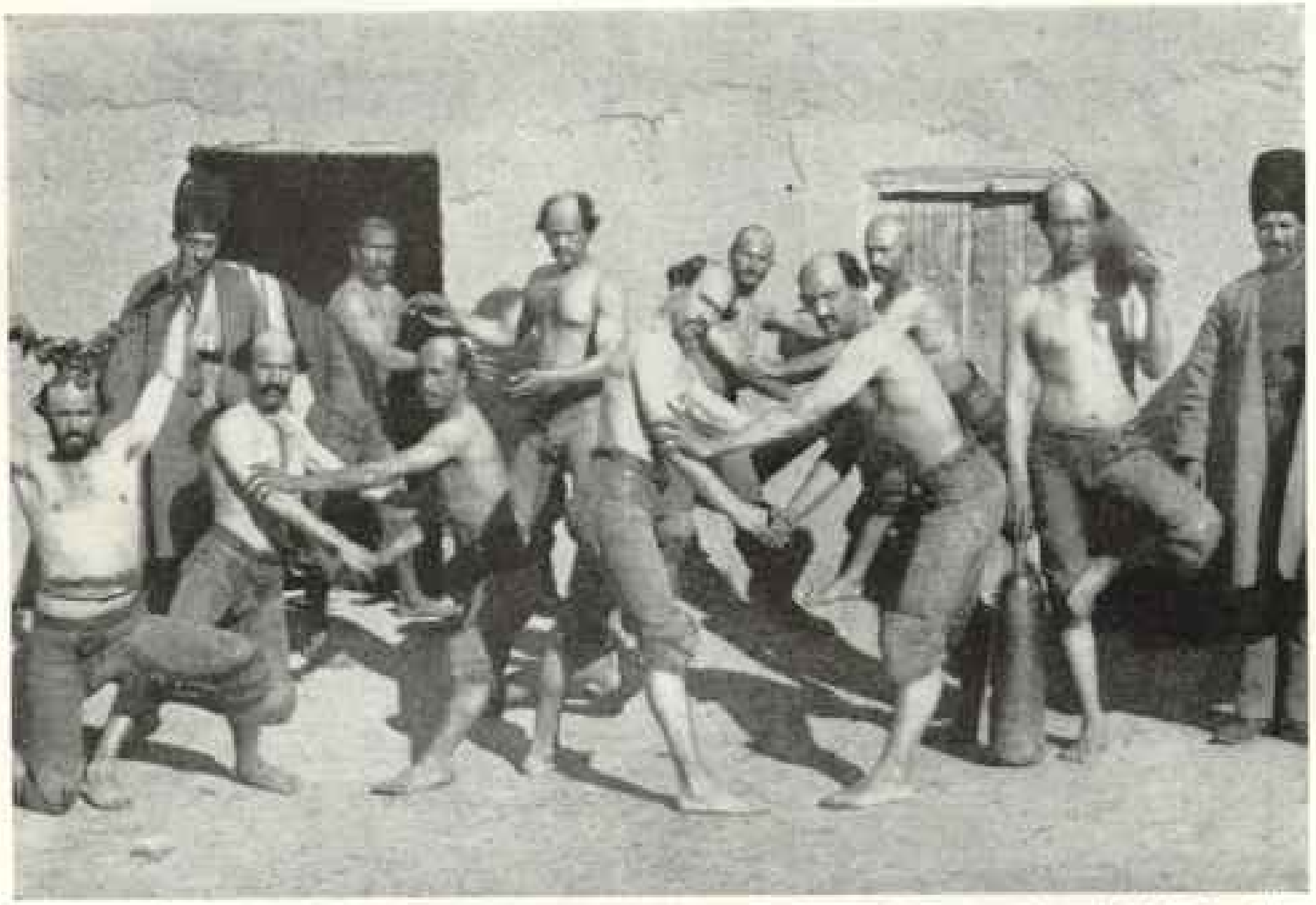
A BOXING BOUT ON A U. S. TRAINING SHIP

Fuegians attained a low visibility by daubing themselves with mud and clay. Florida Indians donned skin and horns of deer to enable them to approach their prey.

Ways of setting traps for animals and of poisoning spears were known thousands of years before Christ. The sportsmanlike Greeks shrank from use of poisoned darts in warfare for the same reason that they regarded archery as a savage practice in combat. Even in war they declined to use instruments which would give one side an unfair advantage.

It was long before the horse, ridden so skilfully by the Arab and the Moor, became either a beast of burden or man's plaything at the races. And whatever the civilized opinion of bull-fighting, that sport is a far cry from either the combat to death of human beings or the lack-sport diversion of watching two animals tear each other to pieces. The Spaniard will defend his national pastime by citing that the matador runs a far greater risk than the hunter of the biggest game, with the advantage of his firearms.

Horse-racing is another sport that



Photograph from Mabel D. Merrill

PERSIAN WRESTLERS

From the Nilesian country, where tombs bear pictures of ancient wrestling, this patriarch of sports spread to many lands, and varies in its style and rules from the jiu-jitsu of Japan to the "catch-as-catch-can" mode, as reported by that veteran sporting writer, Homer, when he wrote, "He lifts Ulysses, who, having now recourse to his extraordinary skill, kicks Ajax in the hamstring and makes him bend the knee. Ajax falls upon his back, dragging with him his adversary."

dates back to remote antiquity. Probably the French were the pioneers in turf sport as practiced in modern times, but it was natural that the English, with their love of outdoors and of animals, should have cultivated the horse for the race as they did the dog for the hunt. James I seems to have been the first royal patron of racing and Queen Anne further encouraged it.

Even the austere Cromwell could not part with his brood mares. One of them was concealed in a vault by the court master of the stud at the time of the Restoration, when diligent search was made to confiscate the Protector's personal property. Thus the animal became known in tradition and picture as the "coffin mare."

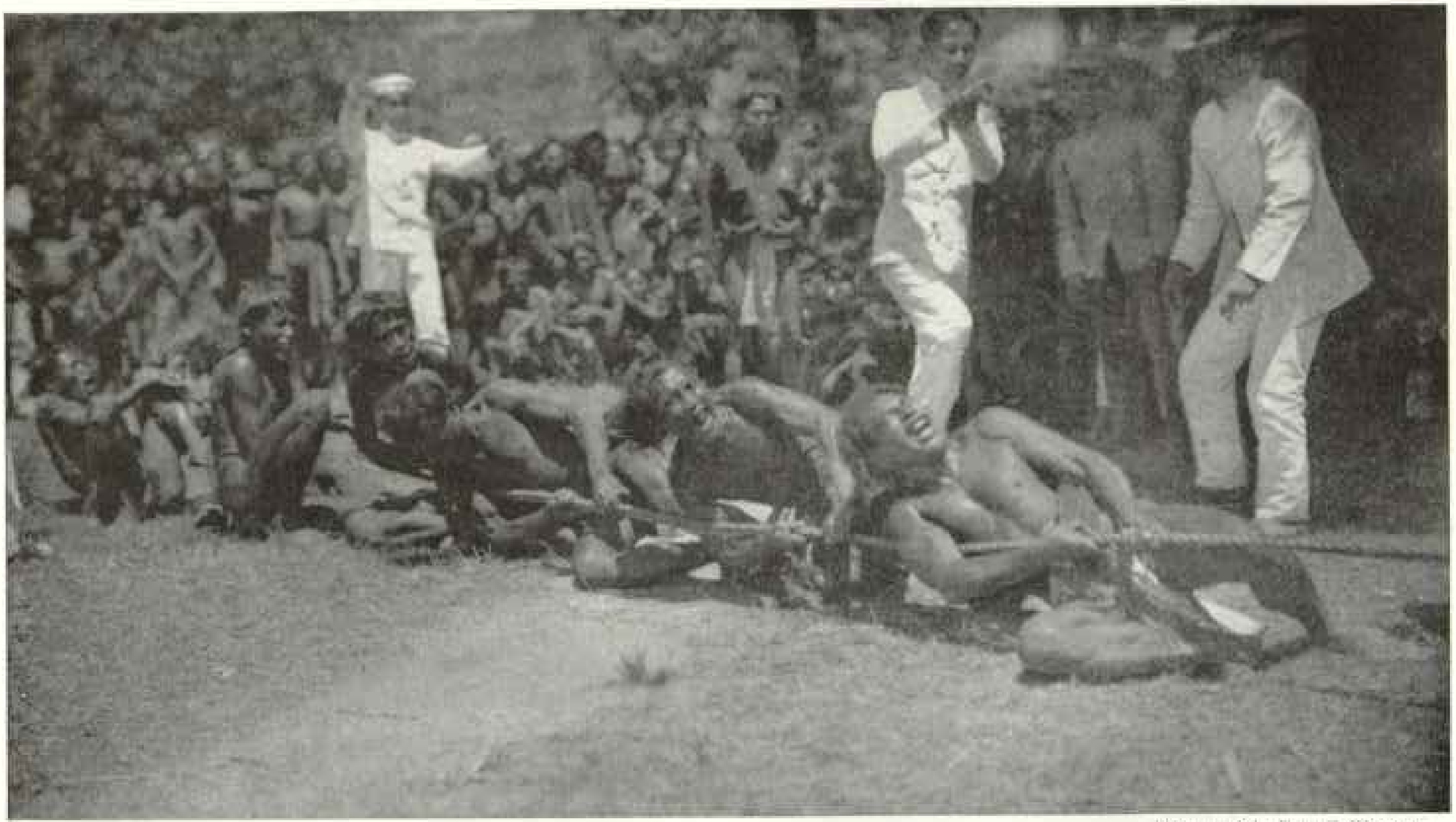
Boxing and wrestling are the more humanized forms of individual contests of strength. Naturally the programs of the Olympic games, veritable encyclopedias of ancient sports, included boxing and wrestling. Moreover the Greeks had one game, the pancrace, which combined both.

Wrestling, at least, is much older than Greece, as indicated by the bouts pictured on tombs along the Nile.

In Greece, boxing fell into disfavor in Sparta for an unusual reason. The Greeks had developed sportsmanlike rules for the game, eliminating kicking, biting, and ear-pulling, and the bout closed when one boxer admitted his defeat. Lycurgus held it improper for any Spartan to acknowledge defeat, even in a game!

The Japanese have been devoted to both sports for ages. Sukune, Hackenschmidt of Nippon, in the days when John was foretelling the coming of Christ, was deified, and from wrestling jiu-jitsu evolved. Boxing today is extremely popular throughout the empire.

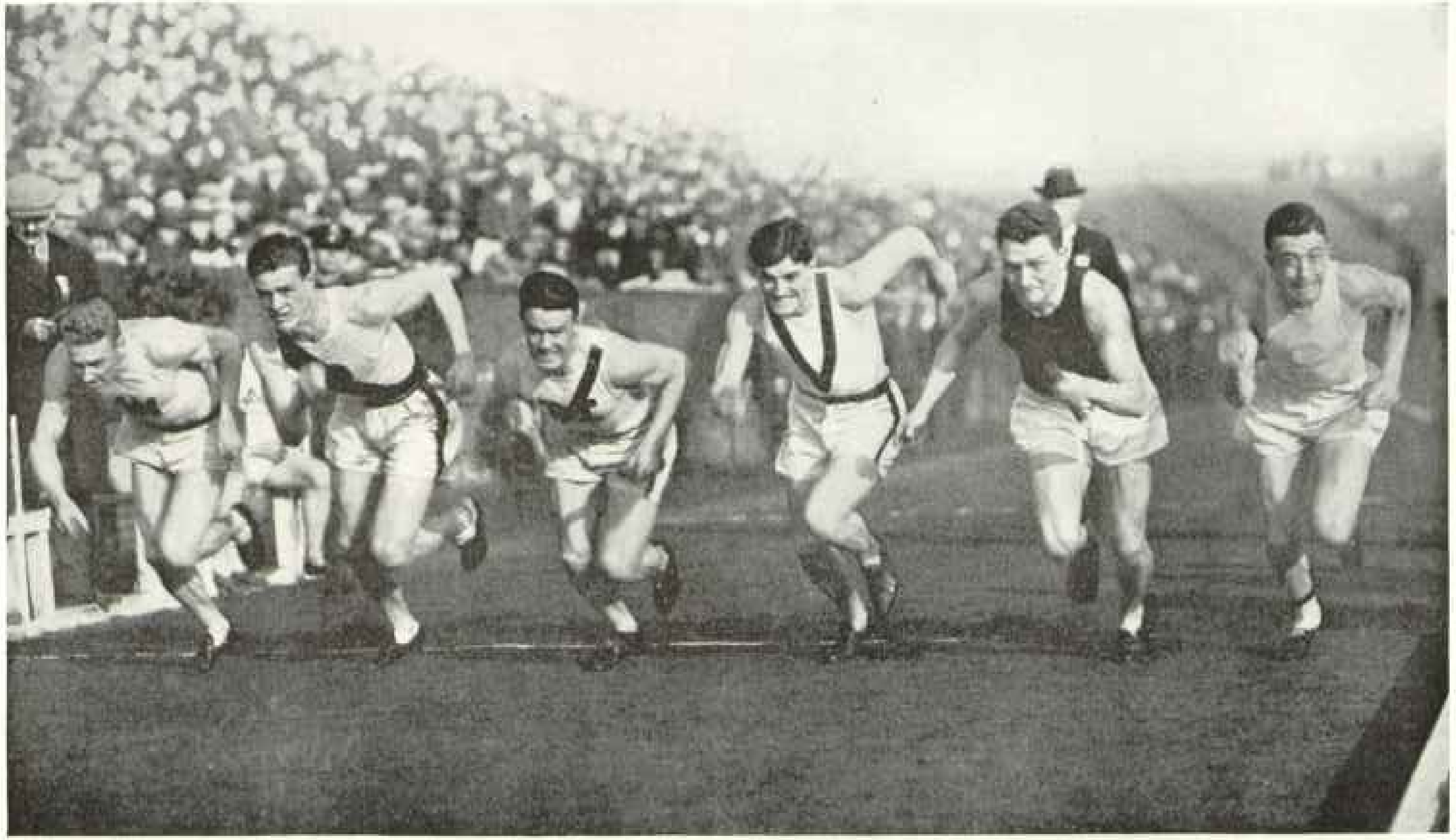
Jack Broughton, English "father of



Photograph by Dean C. Worcester

UNDER AMERICAN INFLUENCE, THE TUG-OF-WAR HAS SUPPLANTED HEAD-HUNTING AS THE FAVORITE PASTIME OF THE NATIVES OF NORTHERN LUZON: PHILIPPINES

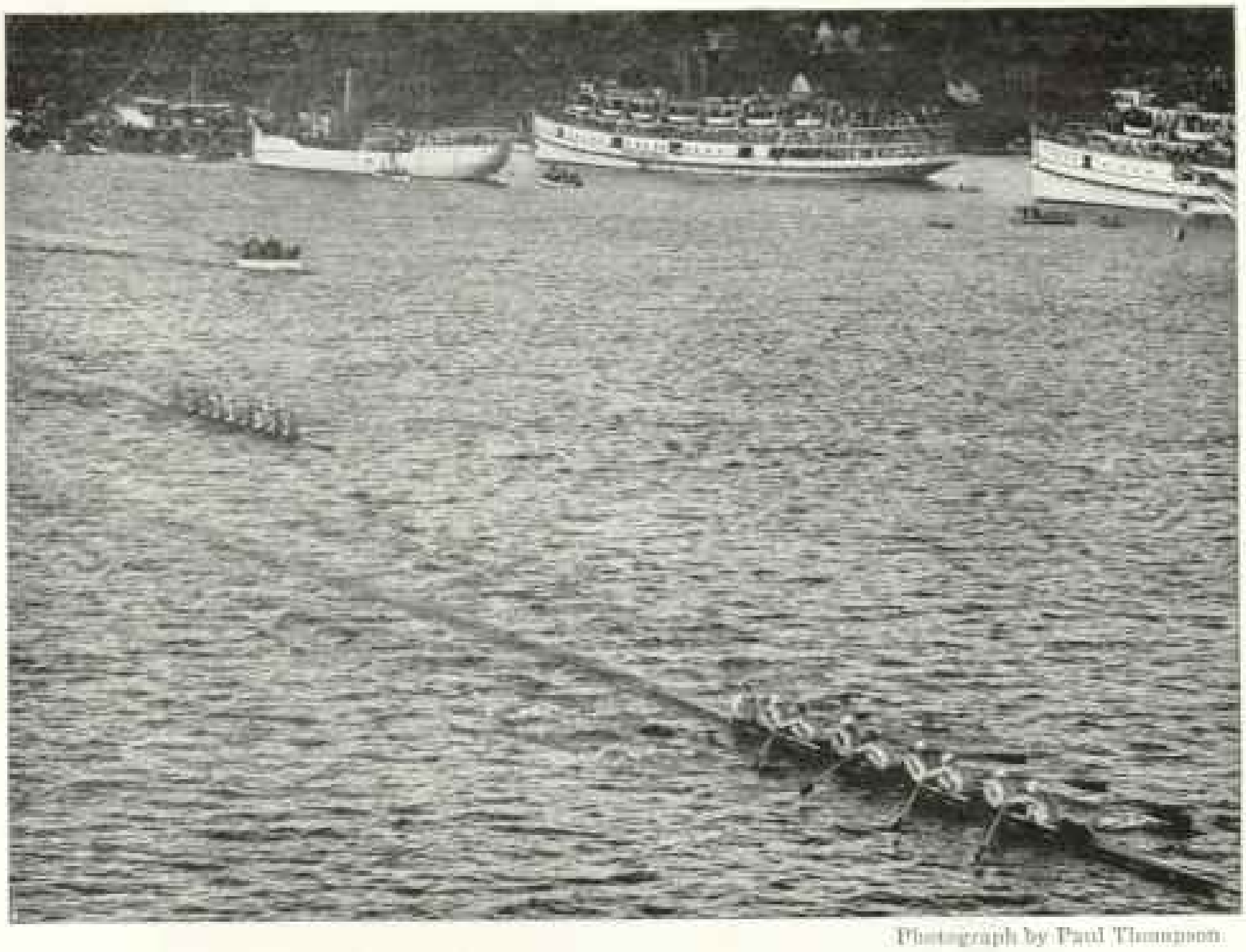
The photograph depicts the moment of triumph of a team of twelve men of Samoqui over their ancient enemies of Talubin.



Photograph by Paul Thompson

A STUDY IN FACIAL EXPRESSION

This is the start of a relay race, a survival of the pre-railroad means of carrying mail. Basque runners were so swift that their speed became a by-word. Barefooted Turkish runners had their feet shod with iron, like horses, and the early English messengers wore tinkling bells that served as the postman's knock.



Photograph by Paul Thompson

THE FINISH OF A YALE-HARVARD BOAT RACE AT NEW LONDON

Rowing is one of the oldest known means of transportation and the newest form of racing. Trials of speed on the water were not common until a little more than a century ago, and to that fact is ascribed the slight advance of vessels of that day over those of ancient times. But as soon as boat and oar making were touched by the magic wand of sporting competition, radical improvements resulted.

boxing" as it is practiced today, is believed to have invented the modern boxing glove and the division into rounds, but he scorned to train in order to meet a butcher named Slack, who belied his name, with a blow like a cleaver, and put the idol of British sportdom in the ex-champion class.

Slack's "punch" recalls the story of the mighty swing of Glaucus, a Greek farmer boy, whose father, after he saw him use his bare hand to pound his plowshare into place, thought him fit material for Mount Olympus. Matched with an adversary skilled in the fine technique of Greek boxing, Glaucus waxed decidedly "groggy" until, so the story goes, his father shouted "Strike, my son, as you did on the plow;" whereat the lad from the farm lulled his opponent to a swift sleep with a hammerlike blow.

Avoidance of brutality in even the most grueling of the early Greek contests is indicated by the heavy penalty a contestant was compelled to pay if he inflicted death upon his opponent, and again in a peculiar style of boxing, which consisted almost wholly in defensive tactics. There is a legend concerning Hippomaches, who defeated three opponents successively by sheer attrition and left the field without having inflicted a single blow.

FOOTBALL WAS A ROUGH GAME EVEN IN ELIZABETH'S DAY

Running, throwing, hitting, and kicking are the fundamental muscular operations of America's characteristic sports — baseball, football, tennis, and golf. The peoples of antiquity manifested all these instincts in cruder form.

Luzon hillmen, the Polynesians, and the Eskimo and Sumatra islanders had

Photograph by Paul Thompson

THESE LATTER-DAY APOLLOS ARE FIT SUBJECTS FOR THE CHISEL OF A RODIN

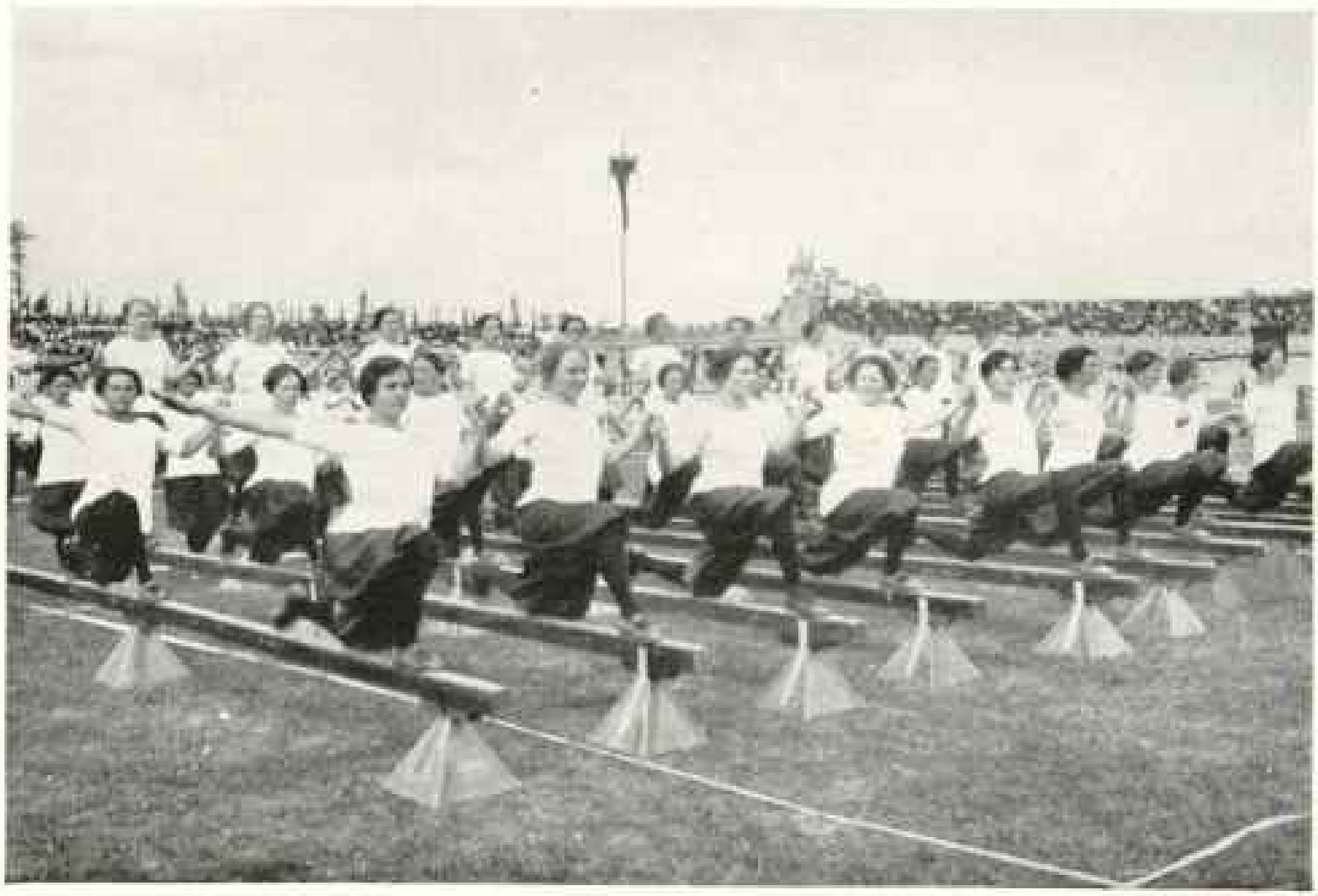
games played by kicking a ball. Greeks played it, and the Roman game, harpastum, derived its name from the Greek "I seize," which is evidence that carrying the ball was practiced then. With shoes of hide, the medieval Italians played a game which seems the direct ancestor of the Anglo-Saxon college sport. Gaelic scholars point to a football game in Ireland before the time of Christ, and until comparatively recent times Shrove Tuesday was distinctively an occasion for football as is our Thanksgiving today.

In old England football was even rougher than most sports of those hardy times. James I thought it was "meeter for lameing than making able the users thereof." Henry VIII and Elizabeth ruled against it. Edward II frowned upon it for its interference with archery and also because of the commotion it aroused. In those times it was played in the city streets. A writer of the sixteenth century called it a "devilish pastime" and charged it with inciting "envy and sometimes brawling, murther, and homicide."

Nevertheless, by the time of Charles II football had become firmly established at Cambridge. It was ever held in high

CHAMPION HIGH JUMPER OF AFRICA

The East African native here shown is jumping from a small termite heap a foot high. The best jumpers of his region attain astounding heights of 8 feet 5 inches



HOW EUROPEAN GIRLS "GO IN" FOR ATHLETICS

Photographs by Paul Thompson

CALISTHENIC DRILL OF 17,000 TURNERS IN LEIPSIC

Photograph by Edwin Levick

A PHENOMENAL SERVICE STROKE

A former United States national tennis champion in action.

esteem in Ireland. There, when all other sports were prohibited for archery's sake, "onely the great footballe" was exempt. Women joined with the men in playing it on Shrove Tuesdays. So many participated that few knew the whereabouts of the ball. An expedient, which not so long ago aroused a furore in the American sporting world, was adopted by a player, who shook out the shavings with which the balls of those days were stuffed and carried it under his shirt to the goal.

Abandoned as a general pastime because of its roughness, it was retained in colleges until, within the past half century, it sprang into renewed popularity in greatly modified form.

The British carried football into Jerusalem when they recovered the sacred city. Missionaries have taught it to heathen tribes.

The reason why it has become a handmaiden of civilization and is so popular among college men of America was summarized by Howard S. Bliss, writing about the Syrian Protestant college at Beirut, of which he was president, in an article for the NATIONAL GEOGRAPHIC MAGAZINE:

"You will find the son of a prince playing football under the captaincy of a peasant or the son of a cook. We believe in football there and we have 17 or 18 different football teams in college. The game develops the ability to receive a hard blow without showing the white feather or drawing a dagger. This means that when the men get out of college they will stand upon their feet as men."

THE ANCESTRY OF TENNIS

Likewise one must go back to the Greeks and Romans for the origin of tennis, which descended to England by way of France. In the twelfth century a game with ball and plaited gut but was played on horseback. Then came "La boude," in which the horses were abandoned. This was a "royal game," at least from the time that Louis X died after excessive playing had induced chills. Chaucer wrote: "But canstow playen racket to and fro," while the church found it necessary to prohibit priests on the continent from spending too much time upon it.

Margot was the Molla Bjurstedt of the twelfth century, famed especially for her back handstroke. Henry VIII of England was a youthful devotee, while Louis

Photograph by Edwin Levick

THE GAME WHERE EVERY MUSCLE COUNTS

Few sports call into play so many muscles or combine mental and muscular activity to such a degree as tennis. Evidence that Romans soon forsook the Greek ideal of a sound mind in a sound body is found in the fact that Horace and Virgil could not join their patron, Maecenas, at tennis because of weak eyes and poor digestions. It was a truly royal game when kings of France and England played it; and it typified the democracy of the New World when ambassadors, generals, politicians, and cowboys joined Roosevelt's famous "tennis cabinet" back of the White House executive offices.

XIV's heavy expense accounts show salaries paid to caretakers of his courts. Complaint was heard at one time that there were "more tennis players in Paris than drunkards in England." In Shakespeare's Henry V are these lines:

"When we have match'd our rackets to these balls
We will, in France, by God's grace play a set
Shall strike his father's crown into the hazard."

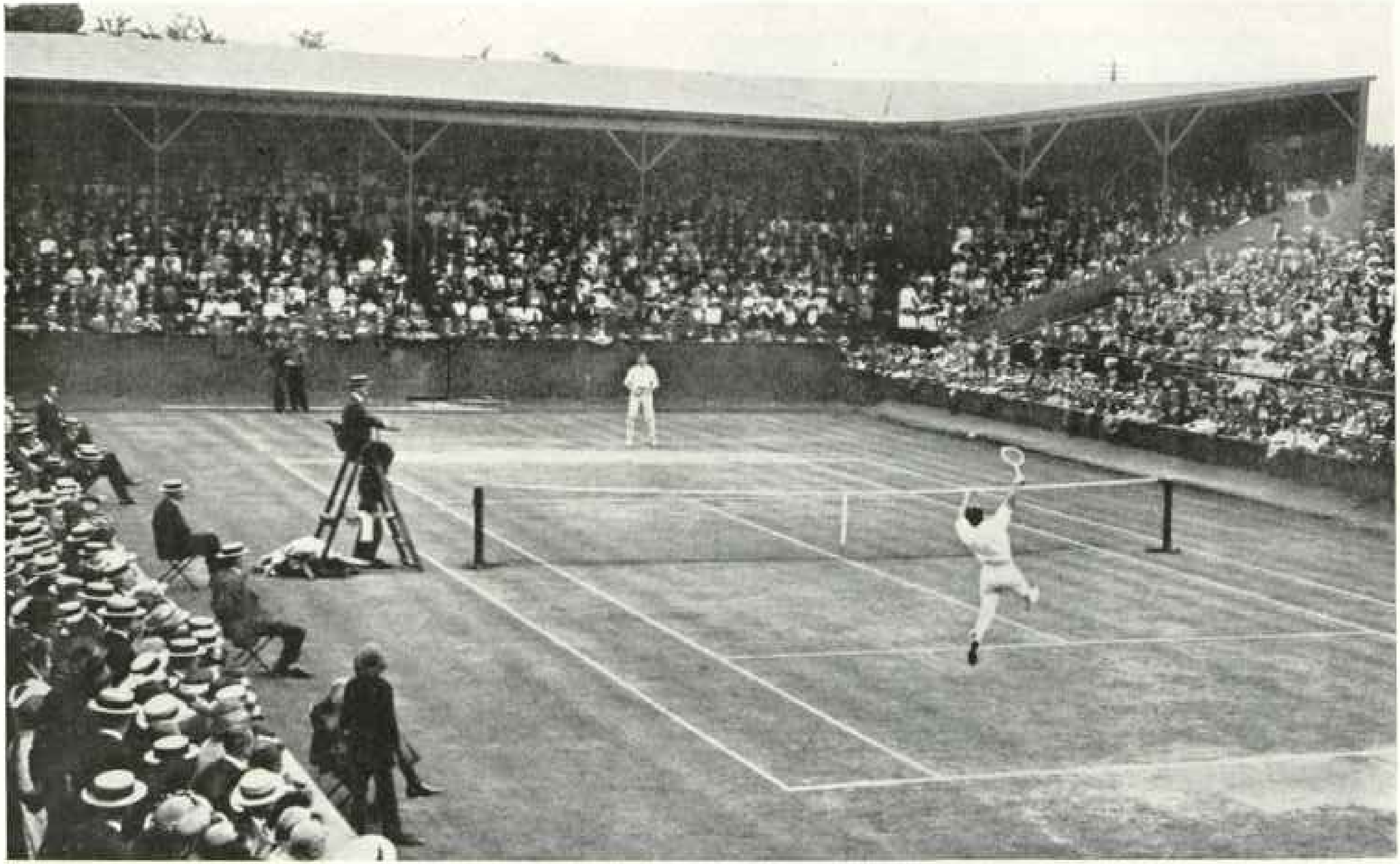
Manufacture of the accessories of the game became so flourishing an industry in England in the sixteenth century that appeal was made for a protective tariff against imported balls.

Until that century the hand continued to be used for batting, but soon the racket came into general use. A match, probably played on a Windsor Castle court, is recorded in which the King of Castile gave his opponent "fifteen" because the latter used his hand.

Even tennis, like all medieval sport, was not free from the taint of gambling and charlatanism. It was charged that "certayne craftie persons arranged for crack Lombard players to meet Henry VIII." The monarch was induced to make wagers with these players until, losing large sums, he became suspicious and played only with amateurs. In one famous match the Emperor Maximilian was his partner, the two playing against the Prince of Orange and the Marquis of Brandenborow.

GOLF HAD ITS BEGINNING ON ICE

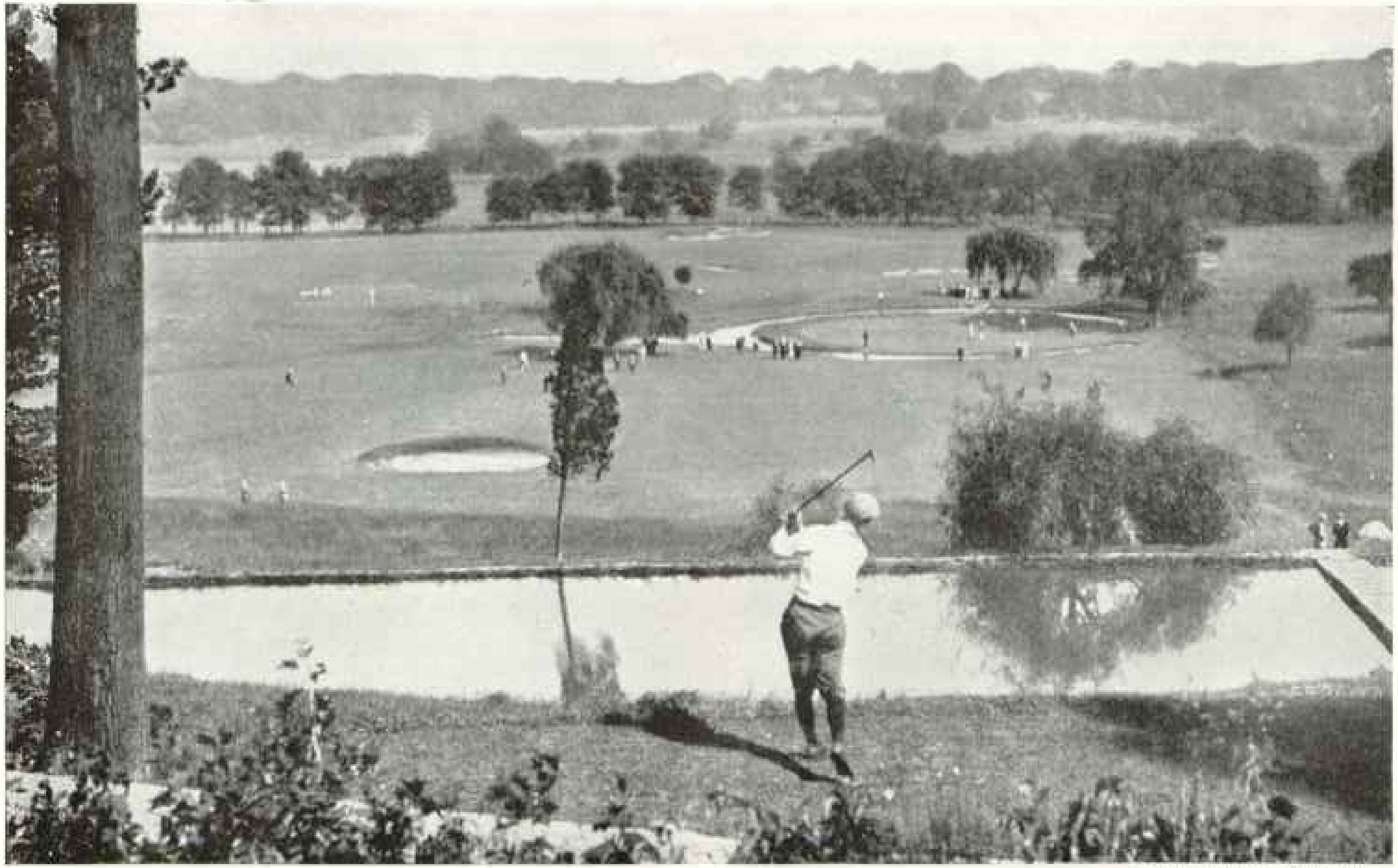
If tennis has a royal lineage, golf, which was later regarded as a rich man's



Photograph by Paul Thompson

AMERICA INHERITED TENNIS FROM FRANCE, WHOSE LOUIS X DIED AS A RESULT OF EXCESSIVE INDULGENCE IN THE SPORT

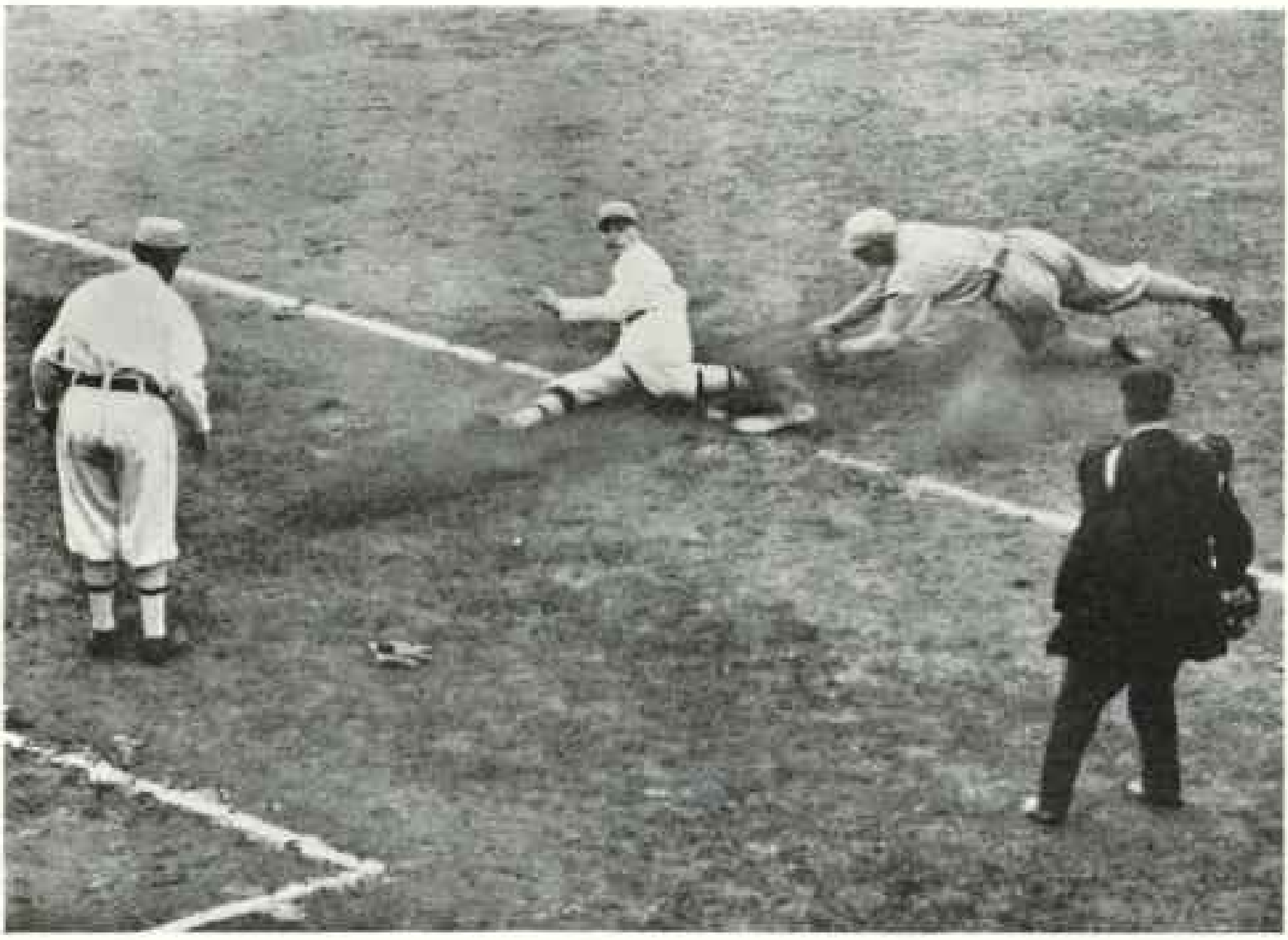
In Spain it would take a bull fight, in Mexico a cock fight, in England a cricket match, and in most American cities a baseball game to attract this number of spectators.



Photograph by Edwin Levick

ON THE FAMOUS 10TH AT BALTUSROL

While tennis boasts of royal lineage, golf originated in plebeian surroundings. Contrary to general belief, it had not its beginning among the Scotch Highlands, but in the Low Countries of northern Europe. By the fifteenth century, however, its popularity in the land of heather and bagpipes threatened the ascendancy of archery.



SAFE!

Photographs by Paul Thompson

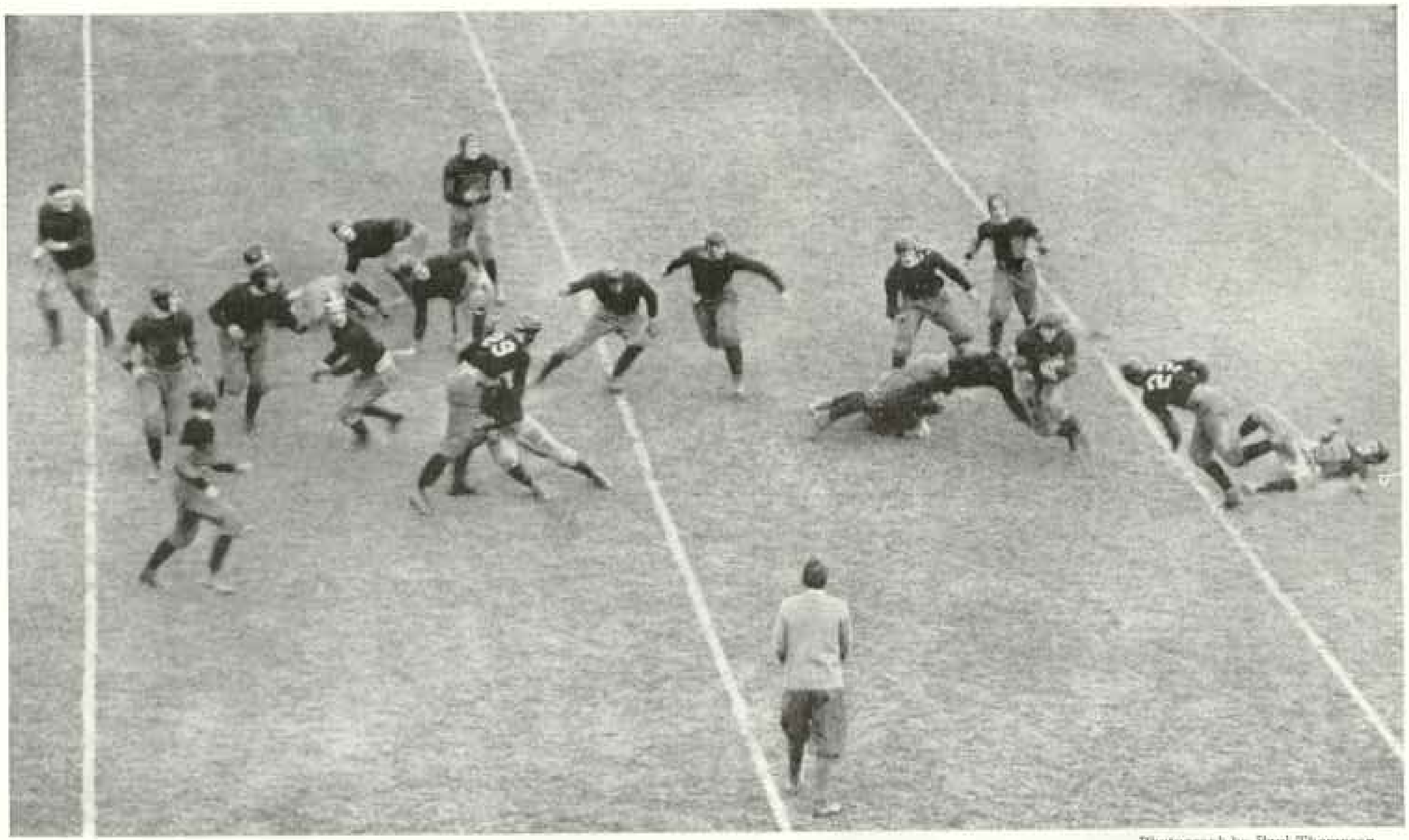
SLIDING HOME

Photograph by Edwin Levick

A BUNKER SHOT

NAVY TRYING FOR A FIELD GOAL PLACE KICK

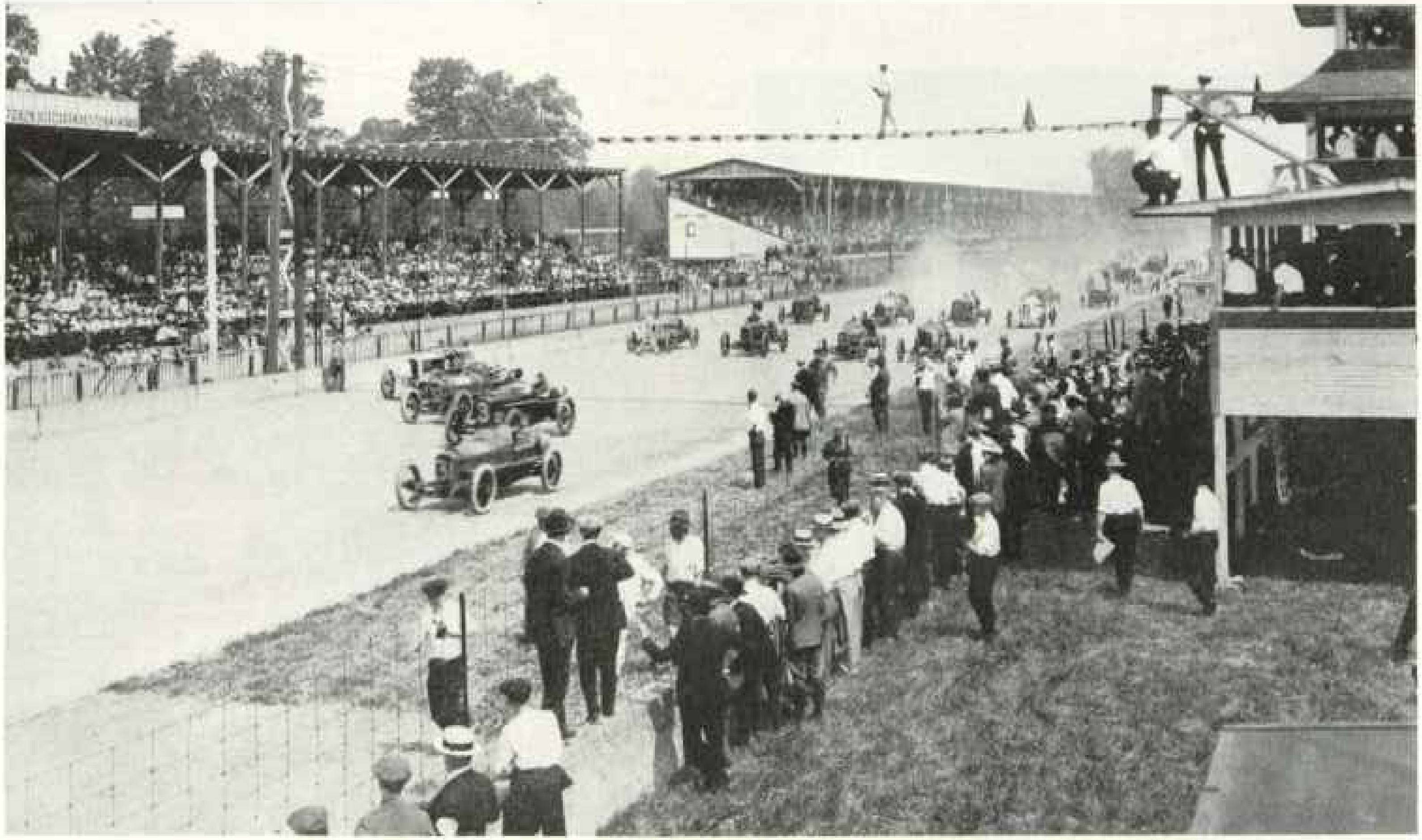
King James found football "meeter for lameing than making able the users thereof," and another writer charged the game with inciting "brawling, murther, and homicide." Small wonder, for entire towns engaged in it, and the whereabouts of the ball was of minor consequence. It remained for American colleges to put the ball back into football and take enough of the "kick" out to make it a red-blooded and humane sport (see page 120).



Photograph by Paul Thompson

TRYING FOR AN END RUSH: NOTE THE EXTRAORDINARY ATTITUDES IN WHICH THE CAMERA HAS CAUGHT MANY OF THE PLAYERS

This picture might well be called "The Spirit of Football," for every player is in action, and alertness and agility are the prime requisites of the game.



THE DEVELOPMENT OF THE AIRPLANE ENGINE WAS LARGELY DUE TO AUTOMOBILE RACING

Of the hundred thousand people who witness automobile races such as the Indianapolis Speedway Classic, pictured above, how many realize that the airplane substantially owes its development to the keen rivalry which exists between the builders of automobile engines? Such competition on the track resulted in the improvement of the gasoline engine to the point where its adaptation for aircraft use was quickly possible and eminently successful. These great speed and endurance tests have been directly responsible for saving many lives, for weak spots and faulty construction are inevitably exposed during the long grind of the race, and as rapidly as these defects are detected they are eliminated from all types of cars by automotive engineers. Thus touring accidents, caused by the breaking of steering knuckles, tie rods, axles, etc., are minimized and tragedies of the highway caused by mechanical shortcomings are constantly becoming less frequent.

Photograph by Dean C. Worcester

THE BONTOC IGOROT SLAPPING GAME OF THE PHILIPPINES

There are two contestants in this remarkable pastime. One man sits on a bench with the thigh exposed to his opponent, who administers a blow with the flat of his hand with all the strength he can muster. After the stroke, judges examine the thigh of the man who has been struck. If the blow has been sufficiently hard to cause the blood to show beneath the skin, the striker has won the game, but if not then the opponents change places. The first contestant who causes the blood to show beneath the other's skin is declared the winner. Note the knots of muscle that spring out on the striker's arm, back, and legs as he strikes.

game, had most plebeian beginnings. Contrary to a widespread belief, it seems not to have originated in Scotland, but in northern Europe. Apparently it was first played on ice, being one of the winter sports adapted to the physical geography of the Low Countries. Even in the north, though, it evolved to a *terra firma* stage, as indicated by a sketch in a book illuminated at Bruges, which shows three players, each with a ball and one club, playing on turf.

By the fifteenth century golf had attained such vogue in Scotland that it threatened the cherished archery, and it is classed with "fute-ball" and other "unprofitabll sportis" by James IV. That monarch, however, seems to have disregarded his own edict, as did enough other Scotchmen to keep the game alive.

Like tennis, golf was played by both sexes. Critics of Mary Stuart cited in evidence that her husband's fate weighed so lightly upon her heart that she was seen playing the game in the fields near Seton.

To the Romans also is ascribed a game that suggests modern golf. It was played with a feather-stuffed ball, and called "paganica," because the common people played it—another evidence of the game's lowly origin.

THE BOND OF PLAY

America's love of play is a distinctive part of her Anglo-Saxon heritage. Where two or more English-speaking people get together, be it in Bagdad or Buenos Aires, their common tongue makes the point of contact, but it generally is their love of active play that forms the tie that binds their comradeship.

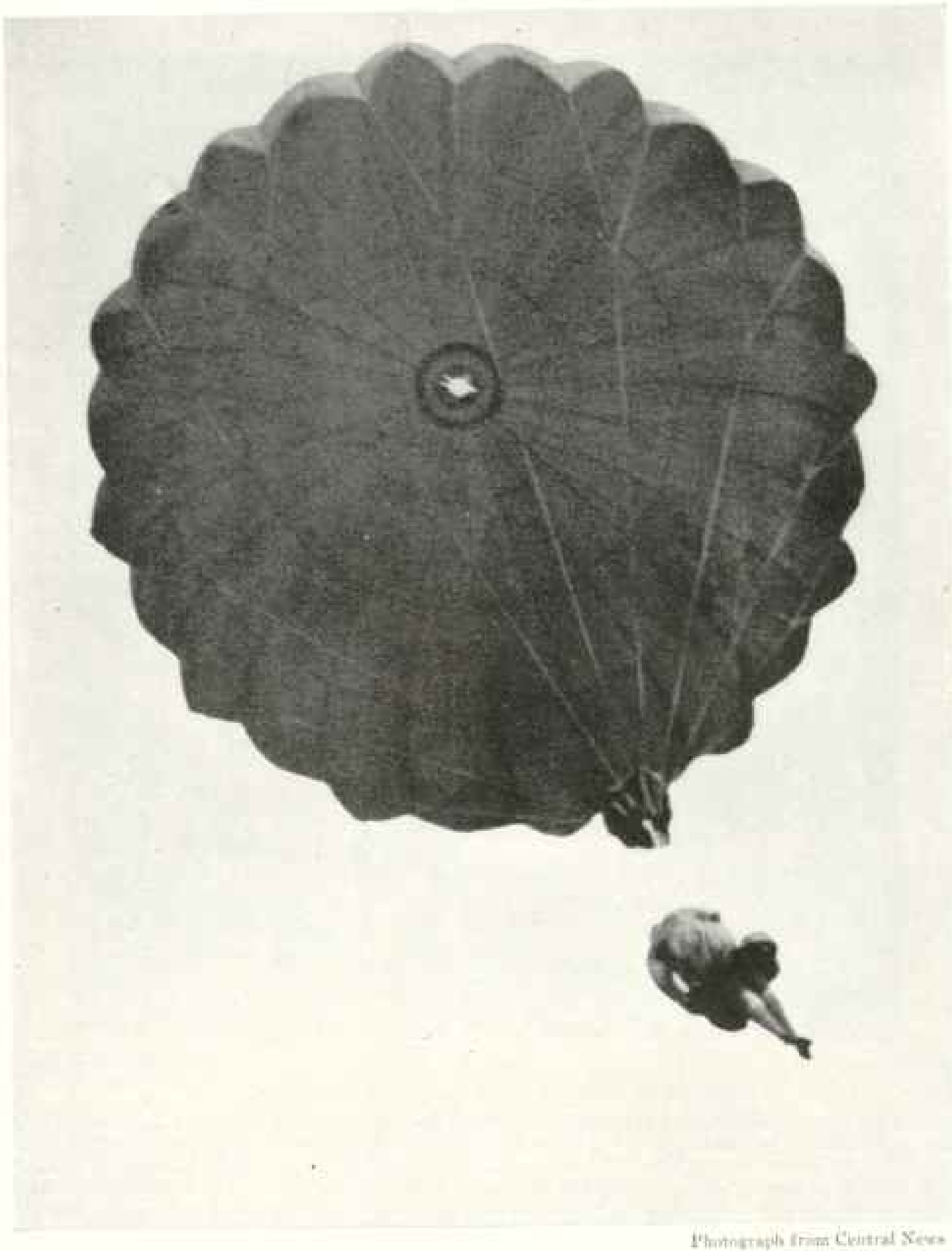
Photograph by G. N. Collins

LIBERIAN NATIVE SPINNING THE GYROSCOPIC TOP

Two of the inexplicable facts of science are that the primitive tribes of Liberia should have discovered the principle of the gyroscope long before it was known to civilized peoples, and that the Australian natives, who have not even advanced to the agricultural stage, should wield the boomerang, involving another principle of advanced physics, in a manner that white men cannot equal. The Liberian keeps his top spinning in the air for any desired time by repeated strokes with the small whip in his right hand.

Certain oriental dignitaries visited London some years ago and were deeply impressed by their lavish entertainment. One thing puzzled them. Inquired one, when his curiosity got the better of his restraint, "Why make the women of your own families dance and why play so many games yourselves? We can get dancing girls and minstrels to entertain us?" Nearer neighbors than that never can understand why Englishmen and Americans play so hard.

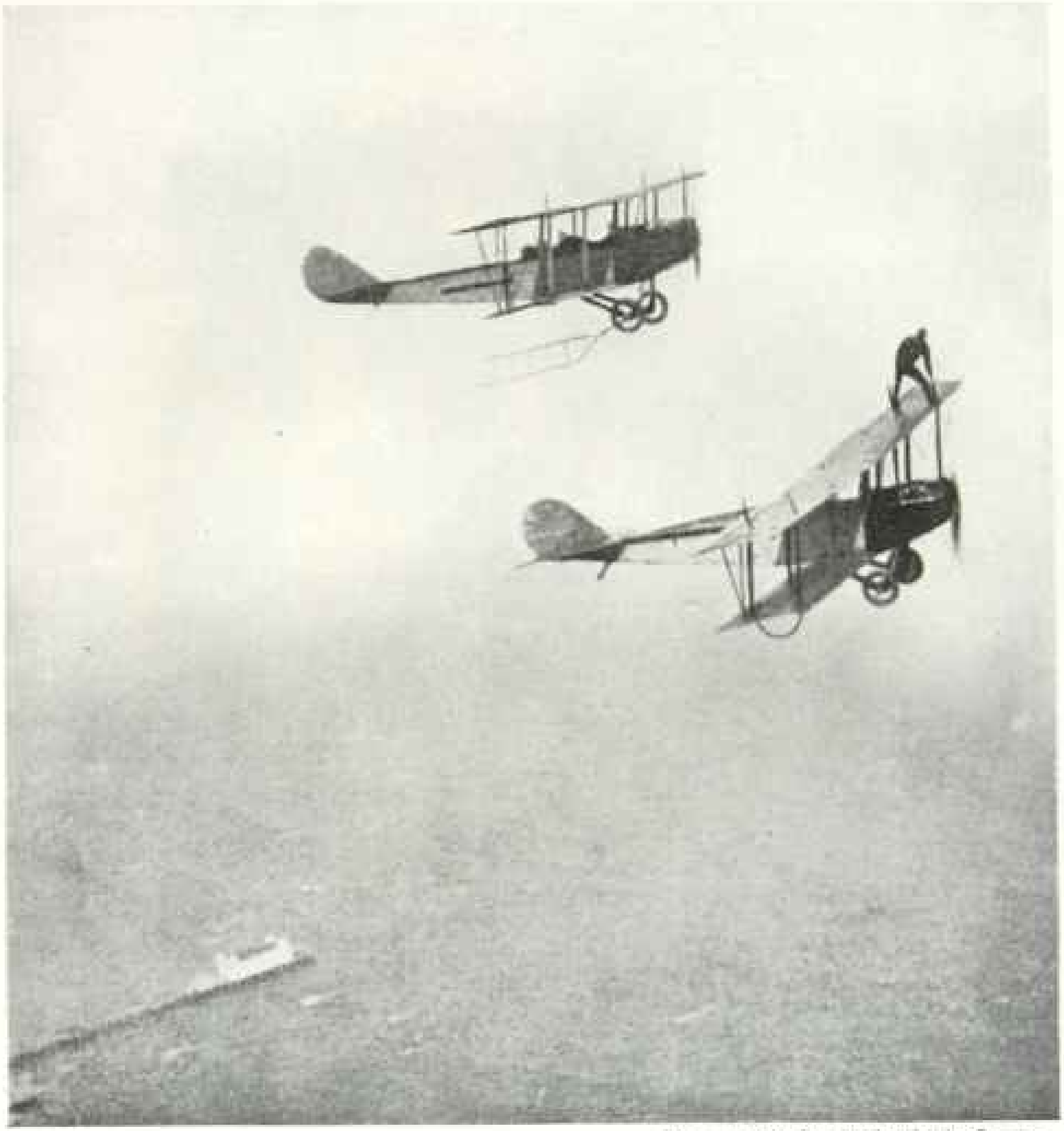
No explaining is needed among Anglo-Saxons for mountain-climbing, baseball, walking, or other active exercise. Colonial Americans brought the sports of England with them. George Washington's diaries attest his love of hunting



Photograph from Central News

PARACHUTING FROM AN AIRPLANE, WOMAN'S LATEST SPORT

Descent by parachute from the old-fashioned hot-air balloon used to inspire awesome "Ahs!" from the assembled thousands at county fairs and on circus grounds, but floating to earth after "cutting loose" from a gently swaying bag provided a far less exciting sensation than the sudden drop from a swift-flying airplane, such as this daring aviatrix is experiencing. The parachute of modern aviation is the aerial navigator's life-belt. When the great British dirigible R-34 made its epochal transatlantic flight a few weeks ago, every officer and member of the crew was provided with one of these emergency devices, and by this means one of the officers descended from a height of 2,000 feet to superintend the anchoring of the craft at Mineola, Long Island. It is not improbable that the airship inspection service of the future will be rigorous in its insistence that every passenger on a transoceanic aerial express shall be provided with a parachute, just as today ocean-going vessels are required to provide a life-preserver and seating place in a lifeboat for each person on board.



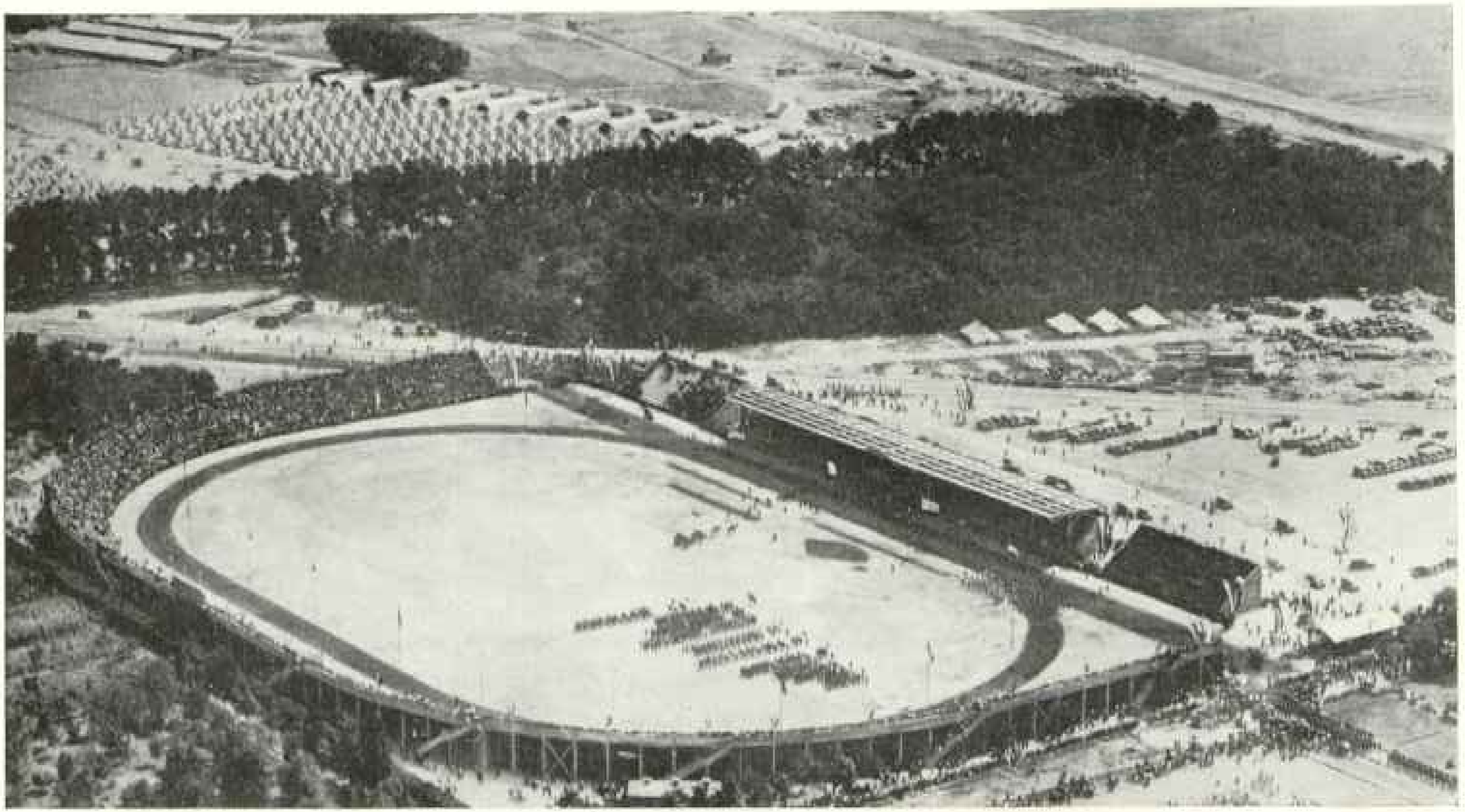
Photograph by International Film Service

THE NEWEST SPORT: AËRIAL ACROBATICS

Standing on the top plane of one "ship," a very military aviator is seen here waiting to grasp the rope ladder suspended from another machine—a feat which he successfully accomplished recently after several attempts. Transferring from one airplane to another while both are speeding a hundred miles an hour should furnish "the thrill that comes once in a lifetime."

and he, like Grover Cleveland, enjoyed fishing.

Most great Americans have played. Benjamin Franklin, who prized his minutes and his pennies, was as enthusiastic a sportsman as that other versatile American, Theodore Roosevelt. Franklin was an expert swimmer, as well as a pioneer fresh-air advocate, and once seriously considered an offer to become a swimming instructor. Lincoln has been widely acclaimed for burning the midnight pine knots; but he has received too scant credit for his daily practice of wrestling and running which developed his marvelous endurance and capacity for work.



PERSHING STADIUM, SCENE OF INTER-ALLIED GAMES, PHOTOGRAPHED FROM THE AIR

This is the sign and seal of America's new play alliance with France, duly ratified by millions of doughboys and poilus. Not only did the "Yanks" take their games to France, but they taught baseball to some twenty-four nationalities behind the Allied lines. This stadium, after its dedication by General Pershing, was presented to France as a lasting memorial of the new *entente cordiale* in sport. The stadium is at Joinville, near Paris. It was built at a cost of $100,000 by American army engineers with money contributed by the American people through the Y. M. C. A.

A GIRL OF THE HARDANGER REGION, NORWAY

The people of this part of Scandinavia have to a large extent retained their medieval style of dress. The women wear a black skirt with a long white, deeply embroidered apron and a white waist with a short velvet jacket embroidered in intricate design with brightly colored beads. Married women wear a white cap which almost entirely conceals the hair, and bridal crowns are passed from mother to daughter. These women excel in embroidery and weaving.

THE DISTAFF OF THE SPINSTER IN THE DOURO DISTRICT, NORTHERN PORTUGAL

The spindle and the distaff are still employed here for producing the best linen thread used in the beautiful laces for which Portugal is famed. Woolen yarn for the family clothing is also spun by this primitive method. Rustic life in Portugal is not a dull, dreary grind, for each epoch of the farming year is celebrated with a *festa*, and of fairs and such gatherings there is no end.

WEAVING THE MULTI-HUED NAVAJO BLANKET: SOUTHWEST UNITED STATES

Such a primitive loom as this is said by ethnologists to have originated with the Chilkat Indians of Alaska. This tribe still produces some wonderful blankets, but those of the Navajos of the Southwest are better known to the world at large. The warp is hung over a long pole, as shown in the picture, and mythological figures are woven into the piece in brilliant colors.

OUTDOOR WEAVING IN SUNNY MEXICO

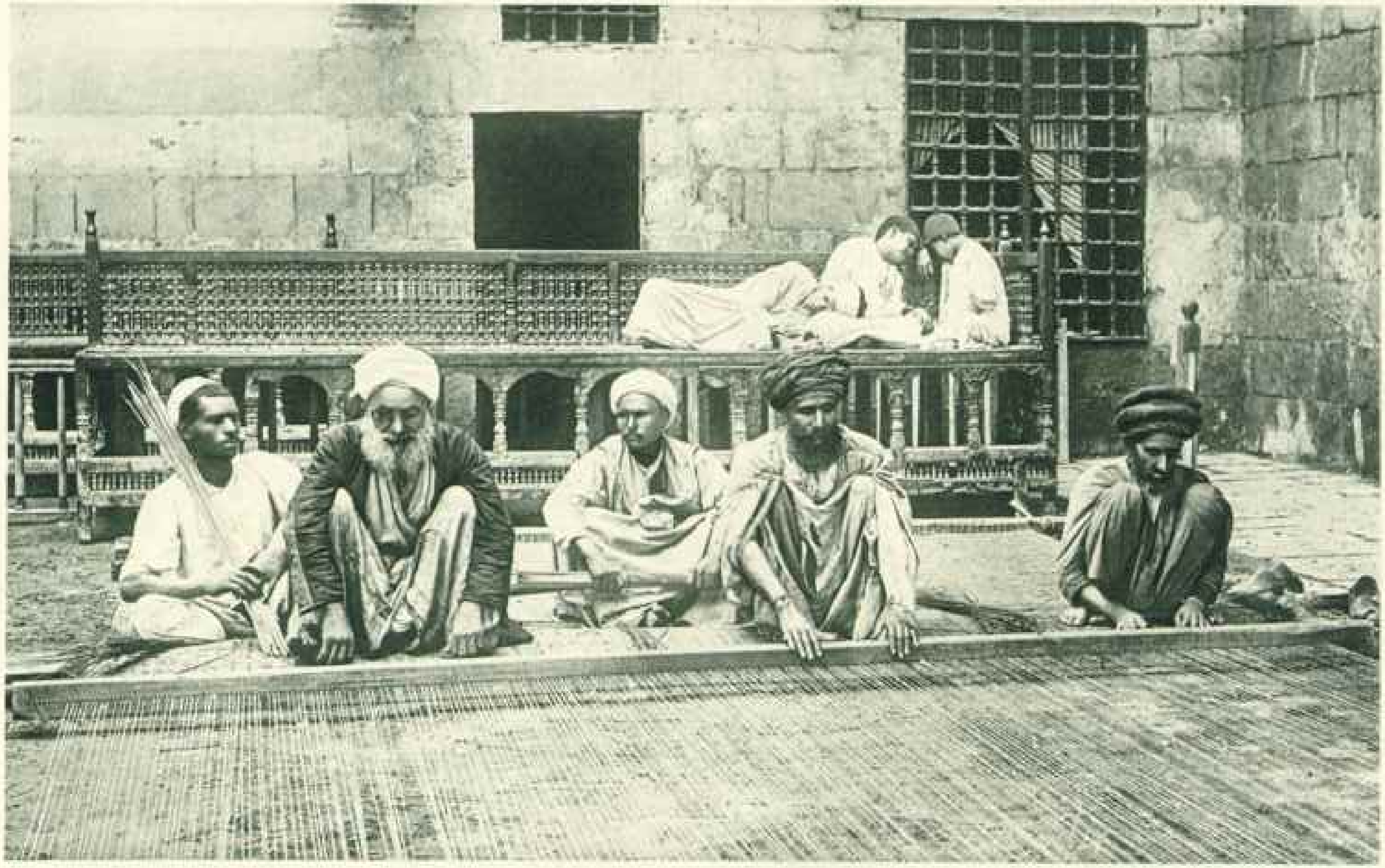
Like everything else in Mexico, textiles range in quality from the crudest to the best. In the North the poms weave coarse net work and lace of twine, but in the South they produce beautiful fabrics of intricate design and wonderful texture.

WEAVING HOMESPUN LINEN: SERBIA

Both the men and women of this little war-torn country wear linen smocks spun, woven and made into garments at home. Over this garment the men wear gayly colored waistcoats and the women short velvet jackets decorated with much embroidery. Another feature of the feminine dress is the two gaudy aprons worn tied over the white linen skirt. This little old lady, who has stopped her labors for a moment and smiles up from before her crude loom, is creating the family's supply of white cloth.

A WEAVER OF SANTA CRUZ, LA PEROUSE ISLANDS, SOUTH PACIFIC OCEAN

The mats and "dilly," bags made by these men of cannibalistic forebears are among the most beautiful articles produced in the South Sea Islands. The patterns and designs reflect much ingenuity and are woven into the piece with a flax which has the lustre of black silk.



MANUFACTURING A FLOOR COVERING OF REEDS: EGYPT

The three weavers of great, greater and greatest degree have in hand the actual work of intertwining the reeds among the threads of the warp while they are waited upon by assistants who are probably apprentices and may at some future time succeed their present masters. The three sleeping urchins in the background may eventually bring more reeds, after their nap.

KOREAN WOMEN SPINNING AND WEAVING

Korea, now called Chosen, had an important part in the extension of the silk industry, according to a story in an ancient Japanese book. About 300 A. D. a party of Koreans was sent from Japan into China, where the secrets of the wonderful silk manufacture were closely guarded. Upon their return the Koreans brought back four Chinese girls who instructed the Japanese in the art of weaving

EXPLORING THE GLORIES OF THE FIRMAMENT

By William Joseph Showalter

Author of "Chicago Today and Tomorrow," "New York, the Metropolis of Mankind," "Steel, Industry's Greatest Asset," "How the World is Fed," etc.

DEALING with distances in the endless reaches of space where a million miles are but as an inch in terrestrial measurements; studying worlds that are as much larger than ours as a mountain is bigger than an ant-hill; gauging the velocities of celestial travelers that outfly the speediest Spad that ever chased a Hun as an express train outruns a snail; reckoning with forces that make the tremendous eruptions of a Katmai seem weaker than the bursting of a mustard seed, the astronomer is an explorer of realms that overpower the layman's comprehension and overwhelm his imagination.

But luckily this layman can check up the celestial geographer in a way at once dramatic and convincing. The grapes brought back by Joshua when he was sent to spy out the Promised Land were not half as sure a corroboration of his story as are the fulfilled prophecies the astronomer brings back from his incursions into the depths of space.

He tells of stars that are trillions—aye, sextillions—of miles away; of suns that are hundreds, and even thousands, of times as bright as the orb of our day; of forces that are thousands, and even millions, of times as great as the power with which the earth sweeps round the sun.

THE ASTRONOMER AT THE BAR

Does he know what he is talking about? Let us put him on trial and see. Our witnesses shall be heavenly bodies and forces themselves. The first one we shall call, out of the thousands who could testify, is a comet—Halley's. Here is its evidence:

"Yes, I'm a comet. For countless generations I had been swinging through space. When I approached the earth men believed me a messenger of evil. They knew precious little about me or my kind. In 1682 I appeared on one of my excursions into realms bounded by the earth's orbit. A little before that Sir Isaac Newton had worked out the fundamental principle of celestial mechanics, namely, the law of gravitation.

"He had a friend by the name of Halley. This man undertook to see whether or not I was subject to that law, and whether, indeed, Newton's interpretation of it was correct. Looking back over the twenty-four comets that had been recorded as invading the precincts of space set aside for the earth, he found that three of them had traveled a similar path and all the others diverse paths.

"Applying Isaac Newton's law to me, he said that I was traveling thirty-four miles a second when I was nearest the sun, and that I had turned round and was headed for the regions whence I had come. He said I would travel out into space some three billion miles, my gait slowing down as I journeyed, and that when I got ready to make the turn to come back I would be loafing along at the celestial snail's pace of a mile a second.

PREDICTED 75 YEARS AHEAD

"Furthermore, he figured out my mass and many other details about me. Then he said that if he was right I would come back in about seventy-six years, the exact month of my coming depending on how much influence Jupiter and other planets would have upon me, which he had not had time to calculate.

"I knew that he had fathomed my mystery and solved my secret. But the people of the earth did not. They said: 'Oh, yes, Halley is a cheap-John notoriety-seeker. He is trying to get fame by a prediction that will attract attention, but he postpones the date of the comet's reappearance to a time when he is dead and his forecast forgotten!'

"But Halley 'stood pat' and called on an impartial posterity to witness that it

Photograph from Yerkes Observatory

A COMET WHICH LOST ITS TAIL AS IT FLEW AWAY—A SORT OF TADPOLE OF THE HEAVENS

Before the time of Halley the visitations of comets were looked forward to with dread. So ephemeral are most of them, however, that Barnard has observed a central passage of one of them over a star of the ninth magnitude, yet the star remained distinct and seemed to be floating through the comet instead of the latter's passing before it.

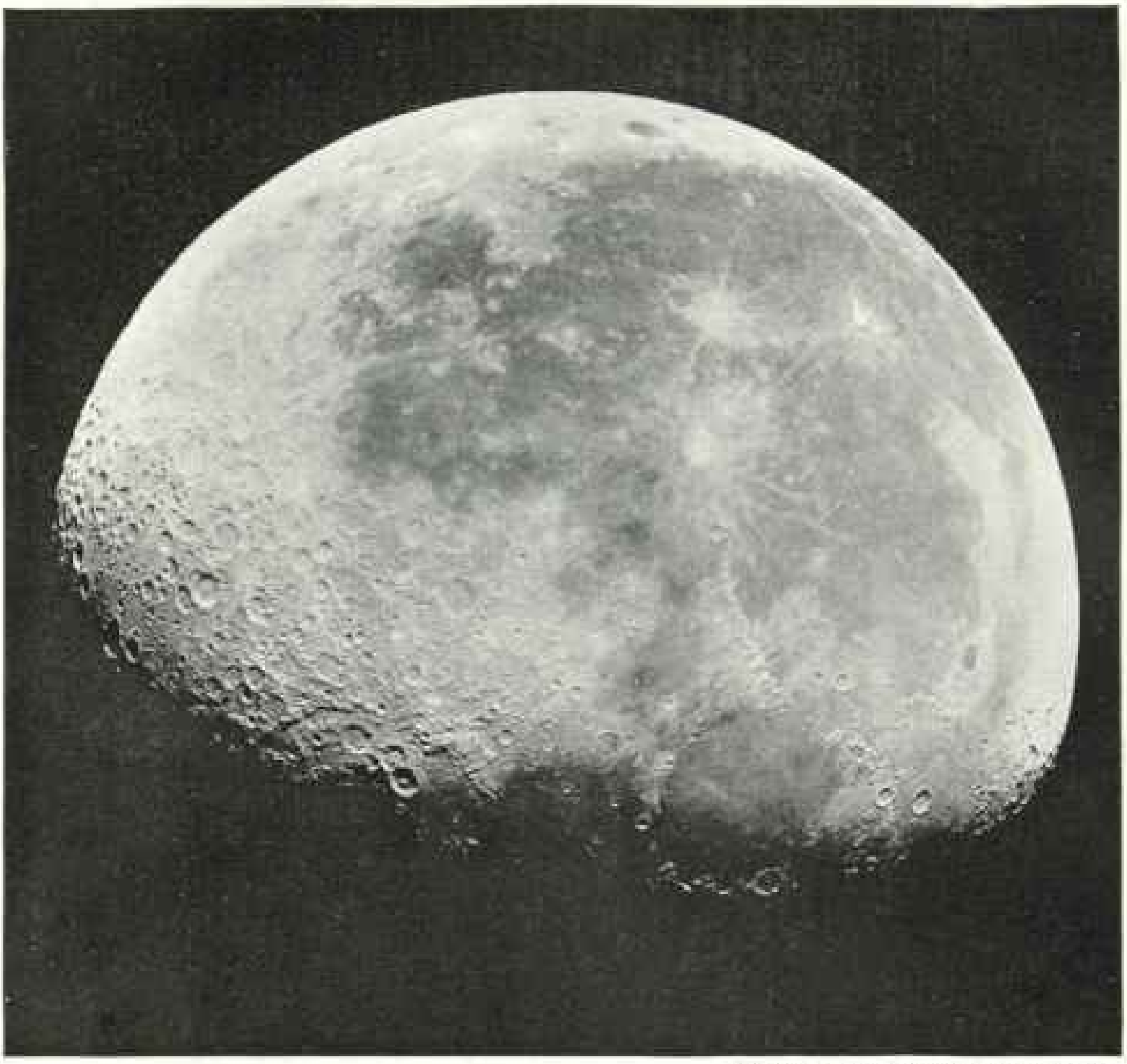
was an Englishman who had first predicted the return of a comet. Sure enough, in the language of the street, 'he had my number.' With less proportionate departure from his schedule than the Congressional Limited makes in its Washington-New York run, I reappeared, having traveled some seven billion miles in the interim. So I have to admit that Halley must have known what he was talking about."

SIRIUS, KING OF THE STARRY EMPIRE, TESTIFIES

The next witness is a star—Sirius by name. His evidence may be somewhat self-incriminating, but perhaps it is even more valuable therefor. It makes the seven billion miles that Halley's comet travels between its earthly visits seem only a morning constitutional. Here's his testimony:

"For untold centuries I had been shining down upon the sons of men with my bluish-white light. I was the king of kings of the starry empire, ruling my own constellation, *Canis Major*, and at the same time excelling all of the other stars in the heavens for brightness. I am third among fixed stars—that is, those outside the solar system—in nearness to the earth, but I was to men only a star and nothing more. They called me the 'Dog Star' and said my constellation was one of the hounds of Orion.

"But one day that man they call Edmund Halley got to studying my habits. He made a series of notations in the year 1718 to the effect that I was not behaving as fixed stars are supposed to deport themselves, drawing attention to the fact that I frequently changed my position on the path I was traveling. He hinted that it might be that I was departing from the straight and narrow



Photograph from Yerkes Observatory

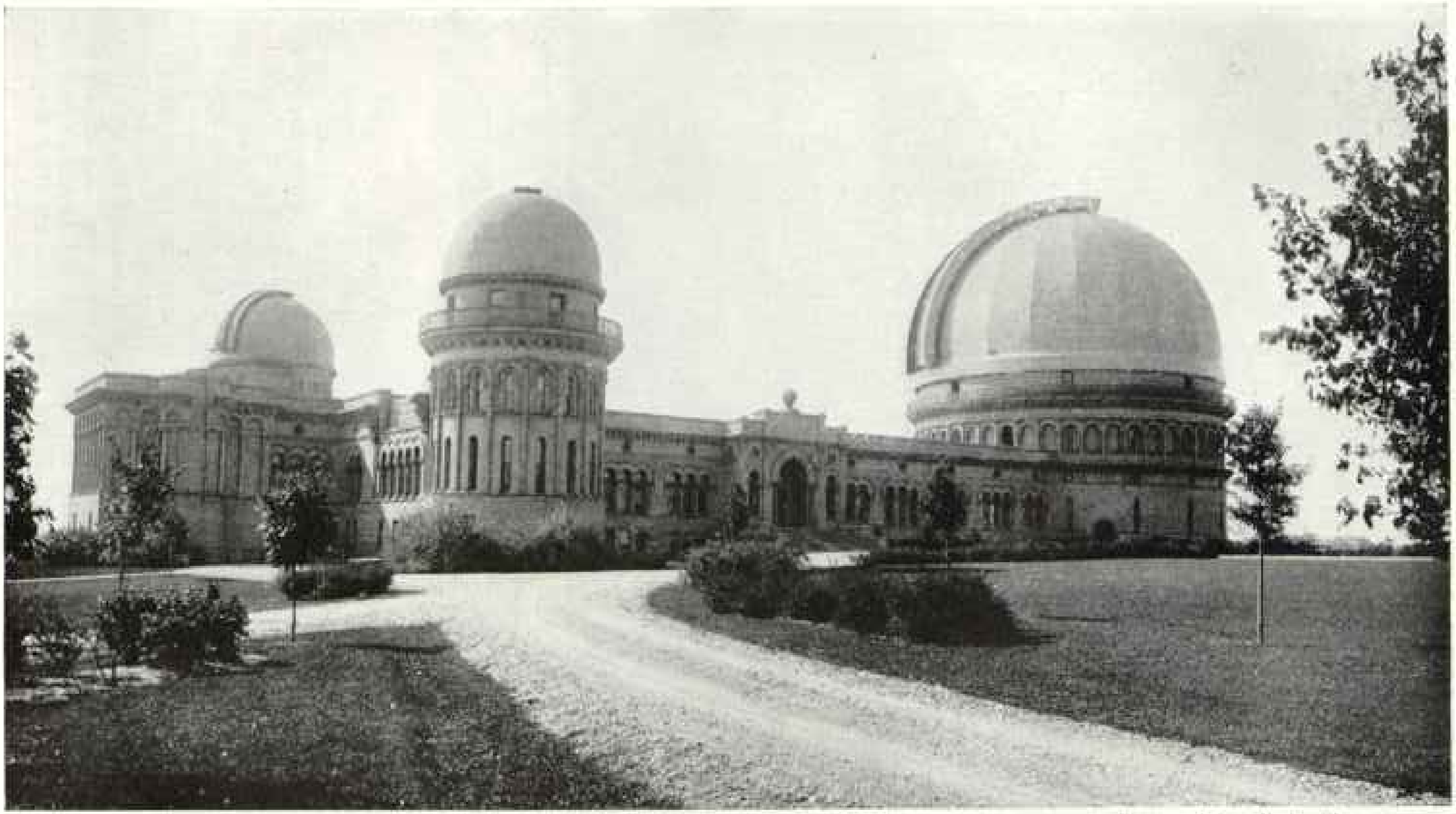
THE MOON AT EIGHTEEN DAYS OLD

By measuring the length of their shadows, astronomers have been able to determine the height of the mountains of the moon. Mount Newton is 24,000 feet high, and there are twenty-eight that are more than three miles high. There are volcanoes on the moon with diameters of 125 miles.

way, though he made no charges that such was the case.

"More than a century later another astronomer came along—Bessel was his name—and he undertook to interpret my behavior. Although I was forty-seven trillion miles away from him, he and his pupil, Peters, pronounced me a 'gay dog,' with an affinity they could not see, though only because they lacked telescopes powerful enough. They said my affinity and I were coming in the sun's direction, overtaking that luminary at the rate of nearly six miles a second, and that we traveled around a common center of gravity once every 48.8 years.

"Another half century passed, and meanwhile telescopes were undergoing improvement. The circumstantial evidence against me was mighty strong, but still no one had yet seen my affinity, and I felt pretty safe. Then came along that gifted optician, Alvan G. Clark. He was adjusting what is now the Dearborn Observatory telescope. When he trained that instrument on me, I saw that the jig was up with my secret. My affinity herself was seen, and I have to admit that Bessel and Peters knew what they were talking about."



Photograph from Yerkes Observatory

THE HOME OF THE WORLD'S GREATEST REFRACTING TELESCOPE

The Yerkes Observatory, at Williams Bay, Wisconsin, is one of the finest in the world. It houses the big refracting telescope shown on page 161 and many other heavens-searching instruments. The big dome at the right is constructed so that it can be revolved, thus bringing the shutter opening over the skyward end of the telescope, whatever the position. The floor of the dome can be raised and lowered, so that the observer can always get to the eye-piece without difficulty (see text, pages 160 and 162).

The next witness is a planet, Neptune (see pages 167 and 168).

NEPTUNE TELLS HIS STORY

"If you please, sir, I long flattered myself with the thought that I was an uncle that you Earth-ites never knew you had. I am an elder brother of Mother Earth, though for ages and ages she and her children never suspected my existence.

"But back in the 'forties' of the nineteenth century my brother Uranus overtook me in our Marathon around the sun. Though our track is a billion miles wide and he has the rail, yet whenever he passes me I fret him so much that he gets a case of 'nerves.'

"Two astronomers, Adams of England and Leverrier of France, each working without knowing that the other was engaged on the same problem, undertook to diagnose my brother's case of nerves and to explain his perturbations. Each finally reached the conclusion that the trouble was caused by me, as yet an undiscovered planet.

"They figured that I, though undiscovered, must be nearly a billion miles farther out in space than Uranus; that I must be eighty-five times as big and sixteen times as heavy as the earth. They also calculated that I must have a year twice as long as that of Uranus and 165 times as long as the earth's.

"They said that the perturbations of Uranus were due to the fact that every now and then he got between the sun and this hypothetical me, and that the rival pulls of the sun and myself upon him were responsible for his nervousness. And then they, in effect, made a most audacious prophecy. They said that if they were right about it I would put in my appearance at a certain hour, on a certain day, in a certain spot of the heavens, to answer whether their conclusions were right or not.

"And, sure enough, I was right there, Johnny-on-the-spot, exactly on schedule time and in my assigned position. I am quite ready to testify, therefore, that a man who can project his mind nearly three billion miles into space and recognize my unseen presence by the effect I have on my brother comes pretty near to knowing what he is talking about."

Our next witness as to the credibility of astronomers is a ray of light. We will hear its story:

"Yes, I am a ray of light. Once men thought I was instantaneous. They tried by various devices and expedients to ascertain whether I was or not. But by no experiment they could make were they able to discover that it required any interval of time for me to pass from one place to another.

"However, a man by the name of Roemer finally found that an eclipse of Jupiter's moons seemed to occur about sixteen minutes later when the earth was on the side of the sun away from Jupiter than when on the side nearest that planet.

"He concluded that this was not because the moons were behind time, but because it took me sixteen minutes longer to come to the earth when crossing its orbit than when not having this extra distance to travel. Here was evidence that I was not instantaneous and indications that I travel at the rate of about eleven million miles a minute.

"But these astronomers were not satisfied with that deduction or the tests that followed. Finally Dr. Simon Newcomb and his associate, the talented Professor Michelson, decided to put me to a test I could not dodge.

DEVISING SPEEDOMETER FOR LIGHT

"They erected a great revolving mirror in the grounds at Fort Myer, overlooking the Washington Monument, 2¼ miles away. At the latter's base they set up a stationary mirror. Then they turned the revolving mirror at the rate of 250 revolutions a second, which sent me hurtling through space toward the fixed reflector. It caught me and hurled me back as though it were a tennis player and I the ball. If on returning I should reach the identical spot on the revolving mirror from which I had departed, they would know that I was instantaneous.

"On the other hand, if I did not come back to that identical spot, they could conclude that it took me some time to make the trip—the time represented by

the interval required for the revolving mirror to move the distance between the spot of my departure and that of my return. They found, by noting the direction I was hurled after returning, that the mirror had turned 2¼ degrees between my going and coming, which, at 250 revolutions per second, amounted to 1/40000th of a second. I had traveled 4½ miles in that time. So they knew that my velocity is 186,330 miles per second — seven times around the world before you can say 'Jack Robinson'! Thus was Roemer's deduction conclusively sustained.

"Then other men invented a wonderful instrument called the spectroscope which forces me to write my life story on a photographic plate (see page 162). By this means they can tell whether I originated in an incandescent gas or from a solid body; whether or not I came through a cool gas in leaving the star that started me; and, if so, whether that gas was under pressure or free.

"Now every message I bring, whether from the nearest planet, the farthest star, or the remotest nebula, can be decoded and read.

"In the words of Abbot, the message may be faint and hard to read, but it tells of the materials of which the stars are made, their temperature, their velocity, their brightness, their distance, etc."

A WIRELESS WAVE WITNESS

The last witness to the credibility of the astronomer is the electromagnetic wave. It deposes as follows:

"Yes, I take my hat off to these astronomers. After that canny Roemer proved that light is not instantaneous, another eminent scientist undertook to find out what it really consists of. By purely mathematical processes, this Mr. Clerk-Maxwell came to the conclusion that light is a matter of waves, some of them inappreciably short and others tremendously long; many too short to be seen and some too long.

"I knew he was getting close to my secret, for I am a long wave, sometimes many miles long, whereas the X-rays are often less than the billionth of an inch in length. Then came another man, Hertz by name. He placed a great sheet of metal against the wall of a room and sent me toward it. I was reflected like sound by a sounding-board. There were two points in the room where the spark would not jump the gap. They were half a wave-length distant from one another. He was thus not only able to detect me, but to measure my length and my velocity.

"Then Branley found how to make an extremely sensitive detector which would catch me. Sir Oliver Lodge developed this into a coherer and employed it in signaling. Wireless telegraphy followed apace, and every boy who has a wireless set toes me because these astronomers, mathematicians, and physicists calculated, detected, and harnessed me."

Thus endeth the testimony, which could be added to, corroborated, and reinforced a thousandfold.

A PENETRATING EYE

A visit to an astronomical observatory and a study there of two or three of the instruments with which the astronomer works gives some clue to the secret of the vastness of his power, as compared with the layman's, in penetrating the mysteries of space.

Of course, the first thing that claims our attention is the big equatorial telescope, which multiplies the power of the astronomer's eye as much, perhaps, as a locomotive throttle multiplies the power of an engineer's arm. It is a far cry from the lens fashioned from a block of ice, with which Metius concentrated the rays of the sun and set fire to a piece of wood, to the great 100-inch reflecting mirror of the new Mount Wilson telescope (see pages 164 and 165).

The pupil of the human eye is about one-fifth of an inch in diameter. It brings to a focus on the retina only so many rays of light as fall within such an area. If it were one inch in diameter and could bring to a focus all the rays entering it, our vision would be twenty-five times as strong; if six inches, and the rays entering could be centered on the retina, we could see an object nine hundred times as faint as those visible with the unaided eye.

We cannot regulate the size of the pupils of our eyes at will, but we can

Photograph from Lick Observatory

HOW THE MOON LOOKS THROUGH A 36-INCH TELESCOPE

A day on the moon is four of our weeks long. If our mountains were as high in proportion to the size of the earth as those on the moon, they would be fifteen miles high; a man there would weigh only as much as a five-year-old boy here. Note the size of the sphere in the telescope by extending the arc in the upper left-hand corner into a circle (see page 165).

build an artificial pupil that serves the same purpose. Men call such artificial pupils telescopes. Imagine trying to fill a narrow-necked bottle by catching raindrops as they fall. Rain falls all around, but only a few drops go into the bottle. Put a wide-mouthed funnel into the neck of the bottle and see how much more water you catch. The telescope is merely a light funnel, wide-mouthed enough to catch many rays of light and to bring them so close together that they can all enter the pupil of the human eye.

Many of these huge instruments have tubes of greater diameter and length than the dimensions of the most powerful gun ever built. They have grown larger and stronger in a way that is startling. In 1861 the 18-inch Dearborn telescope was the biggest in existence. It was when adjusting that instrument that Alvan G. Clark discovered the elusive companion of gay Sirius (see pages 154 and 155).

THE BIG YERKES INSTRUMENT

Typical of the big refracting telescopes is the 40-inch equatorial at the Yerkes Observatory. The outstanding impression one gets when studying the surpassing delicacy of its mechanical manipulation is that our knowledge of the infinitely large comes from our mastery of the infinitely small (see page 161).

The big lens of this instrument weighs a thousand pounds and is carried in the upper end of the six-ton, 62-foot tube, which is 52 inches in diameter at the center. To train this big spyglass on a

DIAGRAM SHOWING THE USUAL METHOD OF MOUNTING A BIG TELESCOPE

The big telescopes are so mounted that the principal axis is on the meridian and parallel to the axis of the earth. Then, as the earth moves from west to east, a clock movement carries the barrel of the telescope in the opposite direction, so that it always points at the same spot in the sky as long as an observation is being made. The other—or declination axis—is at right angles to that of the earth, and is used to train the instrument on the path of the star under observation.

star and keep it there requires that it be mounted on two bearings, one at right angle to the other.

To understand the function of these two bearings, imagine yourself on a merry-go-round, looking through a spyglass at a house away off in the distance. In order to keep the house in the field of vision, you would have to move the big end of the glass backward as you traveled forward. The earth is the merry-go-round and the star is the house in the distance.

So there has to be one bearing that will permit the line of vision in the telescope to move backward just as fast as the earth moves forward. Our terrestrial merry-go-round is rotating at the rate of about 1,040 miles an hour at the Equator, but the sun and the stars are so distant that we seem to pass them very slowly, though their speed as well as their brightness is magnified in the telescope.

To keep the telescope moving backward as the earth flies forward is at once a very big and extremely delicate task. Imagine swinging a huge instrument 64 feet long and weighing, with its movable parts, 22 tons, through the air with such nicety of poise that the spider thread in the eyepiece, which is 1/6000 of an inch in diameter, is kept constantly cutting in two a star image that is 1/2500 inch in diameter.

Yet that is what is done at the Yerkes Observatory with the big telescope. In the case of the Mount Wilson 100-inch reflector, the parts to be moved weigh 100 tons. In all the instruments the movement is made by a huge clockwork that carries the big barrel as steadily as ever an hour-hand of a full-jeweled watch was driven by its mechanism.

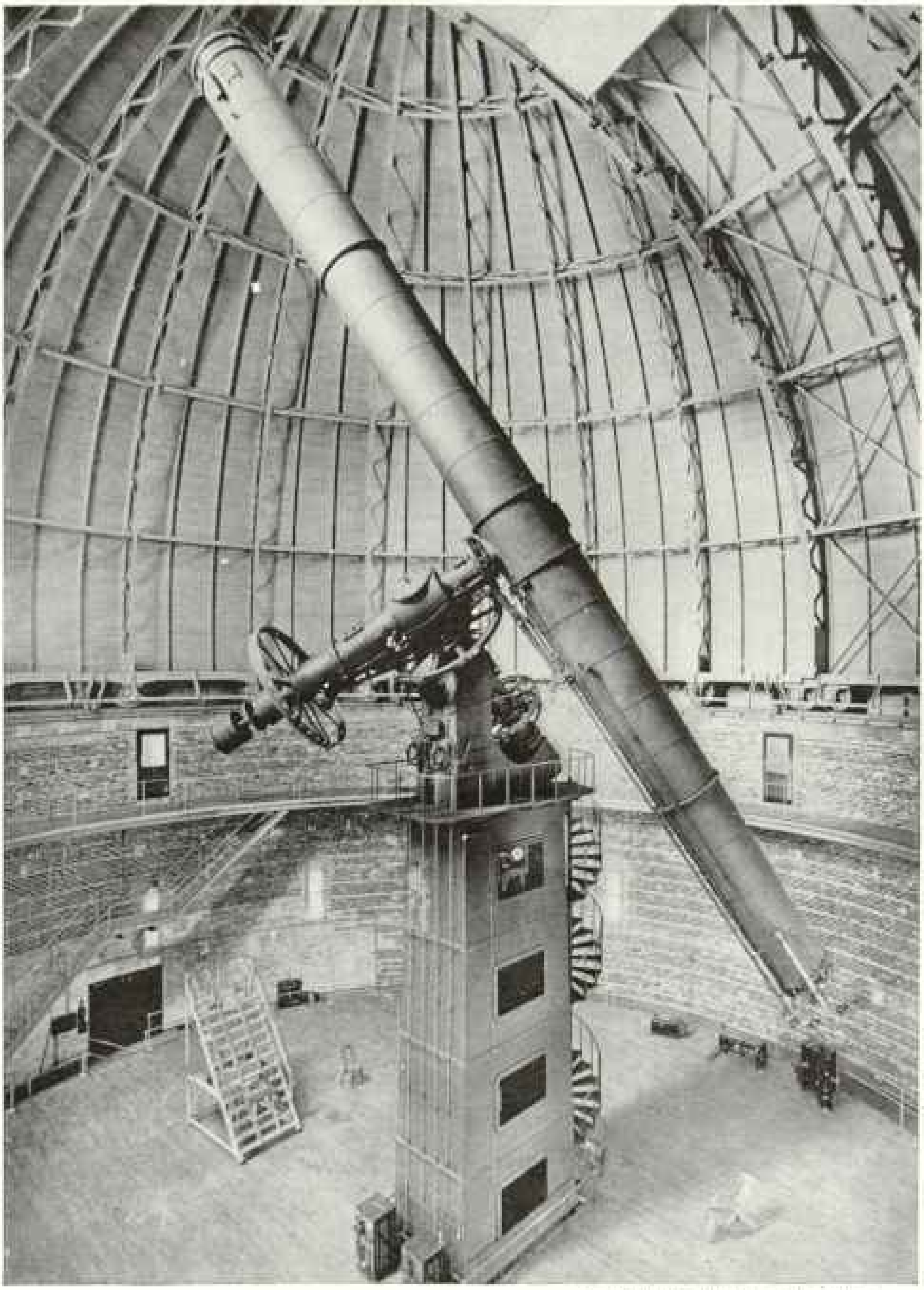
"SHOOTING" THE STARS

But if we imagine ourselves in the merry-go-round and looking at the house in the distance through a spyglass, we not only have to turn it backward as we move forward in order to keep the house in view, but we cannot see it at all if the glass be pointed too high or too low. However, when we get our spyglass at the proper elevation we do not have to raise or lower it thereafter.

So also with the big telescope. The astronomer has to put it in the nightly path of the star across the sky before he can follow it in its journey. To do this requires a second bearing, or axle.

The observer consults his star tables to see exactly how far above the Pole the star's path is. He then moves the lever of an electric motor, and the great tube begins to rise until it is trained on that path. A big graduated circle, distinctly marked and numbered, tells the approximate position. For the exact position, it is adjusted with a slow motion, the adjustment being determined by a very fine circle, the marks on which are read through microscopes.

The astronomer now consults his star tables again and finds the star's position



Photograph from Yerkes Observatory

THE LARGEST REFRACTING INSTRUMENT IN THE WORLD: THE YERKES 40-INCH TELESCOPE

This "big gun" of the astronomical world is a Brobdingnagian eye, 40,000 times as powerful as the human optic. A human eye to be as powerful as it is would have to be 25 feet in diameter, and the man who could possess such an eye would have to be 1,300 feet high (see also page 138).

in its apparent nightly path at that moment. He pulls a switch, and the big instrument sweeps along the star's well-beaten track until its approximate position is reached. The slow motion is brought into play, and the big barrel swings directly on the star, which the clockwork, in turn, causes the telescope to follow as it journeys across the heavens.

Suppose that with your merry-go-round spyglass you should have two spider threads crossing one another at right angles, and that the house you were looking at was a mile away; and then suppose that the glass was so powerful that you could see the head of a nail at that distance; and then further suppose that you kept the intersection of the two spider threads trained on that nail-head. Then you have a fair measure of the delicacy of the adjustments of the Naval Observatory, Yerkes, and Mount Wilson telescopes.

Formerly the floor of the observatory was stationary, on a level so low that when the instrument was pointed at the zenith a man sitting in an ordinary chair could look into the eyepiece; but when looking at a star nearer the horizon the observer had to climb up a glorified step-ladder twenty or thirty feet high and observe his star from such an unstable perch.

Now, however, the floors of modern observatories can be raised and lowered like an elevator. The domes are made to revolve, so as to bring the shutter-opening over the object end of the telescope (see page 161).

TAKING PICTURES OF DISTANT WORLDS

Many of the star observations are not made with the eye. A majority of them are made with a photographic attachment. Often a photographic plate on the big telescope will record in minutes what would require days to work out with eye observations. At the Mount Wilson Observatory some photographs are taken that have to be exposed for four nights.

Think of the wonderful perfection of a driving clock that makes possible four all-night exposures of a given group of stars, no adjustment being required for speed, but the photographer having to keep a constant watch for such changes as the quality of the air, so as to adjust the instrument to meet them!

Powerful as the big telescopes are, they have their limitations. An instrument that magnifies six thousand diameters might be employed, theoretically, in low-altitude work. Such a telescope would bring the moon to a distance of only forty miles.

ATMOSPHERE LIMITS THE TELESCOPE

But the power that would bring the moon so close, except on high mountains, would also magnify greatly the tendency of the air to obstruct our sight; and, as the late Dr. Simon Newcomb once said, the moon might be brought that close, but our view of it would be as though we were looking at it through a tiny pinhole and several yards of running water. Under such a view the whole atmosphere would look like the air over a hot automobile engine or above a stove—full of heat waves. It is those waves that cause the fixed stars to twinkle.

The observatories on mountains and high plains get rid of so many atmospheric difficulties that it is possible to magnify one hundred diameters for each inch of diameter of the mirrors. The big 100-inch reflector on Mount Wilson therefore has a magnifying power of ten thousand diameters. In other words, an object two miles distant would appear as big as if it were only 12½ inches in front of the unaided eye. The big mirror will gather in a quarter of a million times as many rays as the pupil of the eye receives unaided.

But next to the big equatorial telescope in an observatory the spectroscope claims chief interest. A wonderfully versatile instrument it is in applying the third degree to light. Light is composed of waves of an infinite variety of lengths. The shortest wave-length the eye can see is 1/70000 of an inch long and the longest is 1/40000; yet the Annapolis Wireless Station makes use of wireless waves more than ten miles long, and the Bureau of Standards employs X-rays a billionth of an inch short (see also page 158).

Photograph from the Mount Wilson Observatory

TERRIFIC EXPLOSIONS ON THE SUN

Think of eruptions so powerful that they hurl streams of gas farther from the sun than the moon is from the earth, with a velocity frequently of a hundred miles a second and sometimes of two hundred. They leap up in great jets and flames, often changing their appearance greatly in a quarter of an hour. The highest "prominence" here depicted reaches about ninety thousand miles into space (see page 164).

The spectroscope takes the visible rays and their closest neighbors above and below—the ultra-violet and the infra-red—tears them into shreds, and assorts them according to their wave-lengths with as much certainty as a banker assorts the different denominations of his money.

It not only analyzes the light that comes from the sun and the stars, but lights that come from all the earthly elements. It tells with equal fidelity whether a red particle is dried blood or colored paste, or whether a ray of light came from iron or from soda. It once revealed new lines in an European mineral water. Forty tons of the water had to be evaporated to get two teaspoonfuls of the element, but the spectroscope had detected its presence.

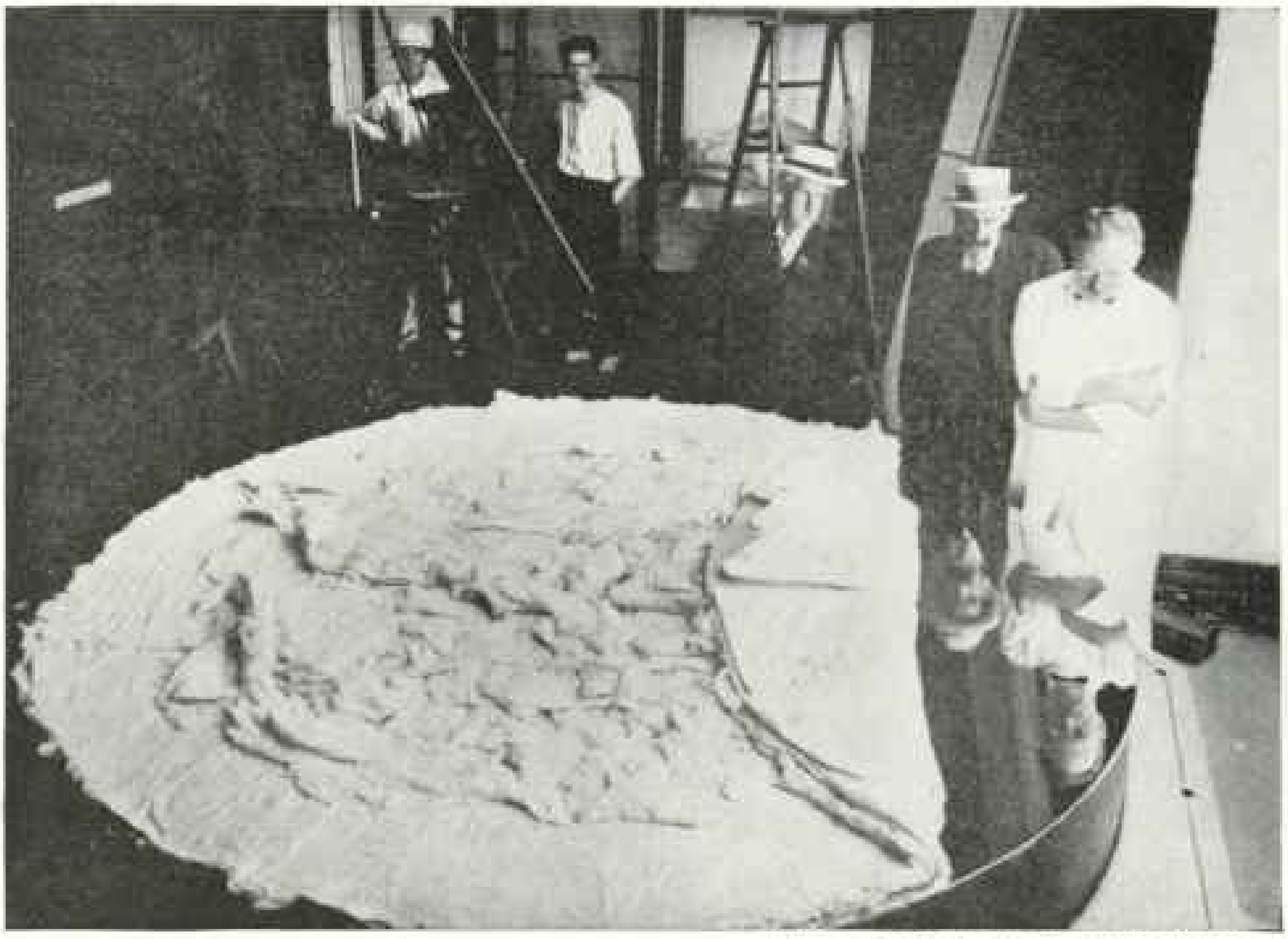
In our childhood days we all recited the stanza, "Twinkle, twinkle, little star"; but we no longer need to "wonder what you are"; for now, as one authority tells us, "Unto the midnight sky we the spectroscope apply."

A photograph of the sun through some of the more powerful spectroscopes shows several million of the telltale lines. Sodium has only two, calcium has seventy-five, and iron has more than two thousand. Thirty-nine of the common elements in the earth show lines that have perfect matches in position, arrangement, and character in the sun.

HOW LIGHT IS TORN APART

There are three classes of spectroscopes: In the one type the light is broken up by being passed through prisms; in the second class the light ray is torn apart by the lines of a diffraction grating through the same process that gives the opal its color; in the third kind the light is separated by being passed through a "stairsteps" of optical glass.

The telescope has proved that the same laws of mathematics and mechanics that govern the fall of an apple, the dropping of a tear, or the rise of steam from a tea-



Photograph from Press Illustration Service

"THE SUPREME COURT OF THE HEAVENS"

This hundred-inch mirror, which has just been installed at Mount Wilson Observatory, California, will bring a hundred million new stars into the ken of man. Are the nebulæ masses of gas or are they other universes in the great sea of infinity? Are the dark spots known as "coal sacks" holes in the heavens through which astronomers can peer into starless space, or are they black masses of gas curtaining off from our view worlds beyond them? Scores of such questions have arisen and are to be submitted to this wonderful mirror for answer.

kettle apply as well to the sun of the day and to the stars of the night. But the spectroscope proves that the chemistry of coal-stove and test-tube is also the chemistry of sun and star. With it man went 93,000,000 miles away to find the helium that is in the very air we breathe and that soon will give buoyancy to the dirigible airships of our navy.*

FIERY FLAMES LEAPING INTO SPACE

It is thirty years since solar prominences, those fiery flames that shoot out from the sun to distances greater than that from the earth to the moon, were first discovered. Formerly they could be observed only during the few minutes of total eclipses of the sun, and it was possible to study them for only fifteen minutes in a quarter of a century. Then Professor Huggins found that by screening off the disk of the sun and widening the slit of the spectroscope we may see these prominences at any time.

With the spectroheliograph it is possible to get pictures of the sun and these prominences in the light of a single substance, so that the astronomer is now able to study them any bright day. Think of explosions so powerful that they hurl material three hundred thousand miles into space with a velocity of two hundred miles a second! (see page 163).

Not only does the spectroscope tell us of the materials of which the sun and the stars are composed, but it also tells us whether a star is headed toward us or

*See "Helium—the New Balloon Gas," in the NATIONAL GEOGRAPHIC MAGAZINE for May, 1919.

TRANSPORTING THE PRICELESS HUNDRED-INCH MIRROR FROM PASADENA TO MOUNT WILSON (SEE PAGE 164)

The motor truck carrying this treasure of the astronomical world up the great mountain was geared down to four miles an hour.

away from us, is coming or going, and how fast.

Did you ever notice, in traveling, when meeting a train on a double-tracked railroad, how much higher the pitch of the bell is as it comes toward you than when going from you? More sound-waves reach your ears as the train comes toward you than as it goes from you. The same is true with the light-waves in the spectroscope. If the star is coming toward us, the lines shift toward the violet or higher pitch; if receding, toward the red. And these shifts are always proportional to the speed of the star; so that not only the coming and the going are recorded, but the velocity as well.

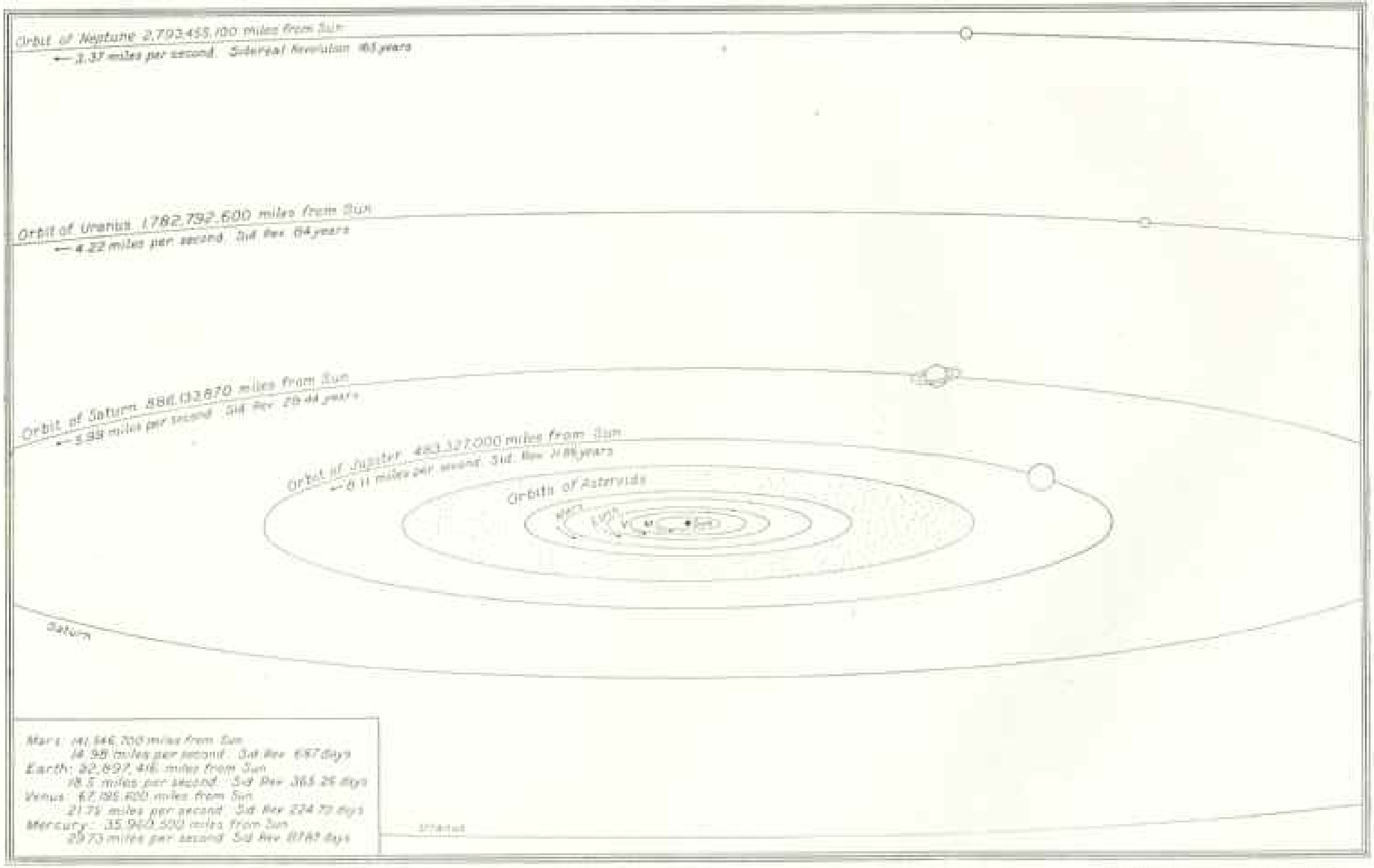
THE PATIENCE OF ASTRONOMERS

The patience with which astronomers make their studies in their unrelenting pursuit after truth is unsurpassed in any field of human inquiry. At the Naval Observatory in Washington computations based on a single series of observations have been in progress for a period of nineteen years, but are not yet completed. The results of the various expeditions that observed one of the transits of Venus were for half a century under calculation and comparison.

A single investigation of the inequalities of the changes of the moon required 9,000 hours of hard calculations by a trained mathematician. There were 13,000 multiplications of series, containing some 400,000 separate products. The whole computation required the writing of nearly five million digits and plus and minus signs. And even then the author felt that much remained to be done before he could construct the tables he had undertaken to make.

OUR STUPENDOUS INSIGNIFICANCE

Before starting out to explore the heavens and to make a biographical survey of its more prominent folk, one here might well revert to that old, old question: "What is the good of it all?" Are



Drawn by Albert H. Bumstead

AN ILLUSTRATION OF THE PATHS, OR ORBITS, OF THE EARTH, MOON, AND PLANETS AROUND THE SUN

The orbits of the planets are shown in their relative sizes. While these orbits are elliptical, the ellipses are so little elongated as hardly to be distinguishable from circles in a drawing. The planets are here drawn much exaggerated in size (see page 180). Indeed, if we reduced them to the scale we have used for their orbits they would disappear entirely. It is amazing to think that there may be millions of other solar systems as large or larger than our own (see page 109).

the fruits of astronomy worth all the labor and thought expended on it? The thoughtful man, realizing how vastly it enlarges his appreciation of the great First Cause, how wonderfully it teaches us the stupendous smallness of our place in the universe, finds it both good and profitable.

But even to the man who looks for direct physical benefits and every-day good, its worth will appear. Parallels of latitude and meridians of longitude depend upon it, time signals are born of it, safe navigation at sea were impossible without it. State and national boundaries are often fixed by it.

Yet the indirect benefits excel, if that may be, the direct ones. When Roemer discovered the velocity of light, little did he suppose that the interpretation of his discovery would lead to wireless communication.

It is interesting to have a look at our own earth in its relation to the worlds that people the sky. When a mighty storm sweeps over the ocean, when a great war devastates a continent, when a Katmai blows off her head, when an earthquake destroys a populous city, men stand overwhelmed and awed at the spectacle!

But how little and insignificant are such forces, measured by the majestic might of the earth as it sweeps on its course around the sun!

An eminent physicist has estimated that the power developed by a million Niagaras in a million years would not equal the energy expended by the earth in a single second as it circles round the sun.

And yet so perfect is the mechanism that, flying around its axis at an equatorial speed of more than a thousand miles an hour, and around its orbit at more than eleven hundred miles a minute, all the mundane influences of which astronomers know could not change the length of its day as much as a second in a hundred thousand years.

WHERE THE EARTH BECOMES A DROP IN A RESERVOIR

But as soon as one looks out into space with the eye of the astronomer, there comes the discovery that in all its seeming greatness the earth is so small that even a telescope ten thousand times as powerful as the strongest instrument now in existence would not reveal it to an astronomer on any fixed star.

Compared even with the sun, our planet's insignificance becomes evident. More than 1,300,000 spheres like ours would be needed to make a bulk equal to that of a single sun (see pages 166, 180).

Perhaps our most graphic picture of the solar system is given by Herschel. Imagine a circular field two and a half miles in diameter; place a library globe two feet in diameter in the very center; eighty-two feet away put a mustard seed. The globe will represent the sun and the mustard seed Mercury.

At a distance of 142 feet place a pea, and another at 215 feet. These will represent Venus and the earth, both as to size and distance. A rather large pinhead at a distance of 327 feet will speak for Mars, and a fair-sized tangerine a quarter of a mile distant will stand for Jupiter. A small lemon at two-fifths of a mile will play the rôle of Saturn, a large cherry three-fourths of a mile will answer for Uranus, and a fair-sized plum at the very edge of the field will proclaim Neptune (see pages 157, 180).

SIGHT-SEEING THE SOLAR SYSTEM

In our celestial tour there is time for only a passing reference to the moon and the planets. Eighty moons would be required to make one earth. A player there could throw a ball six times as far as it can be thrown on American diamonds. A man weighing 150 pounds there would weigh 990 on the earth. The earth receives as much light and heat from the sun in thirteen seconds as it gets from the moon in a whole year.

Mercury is almost the "unseen planet." Being very close to the sun, it is nearly always engulfed in the rays of the dawn or overwhelmed in the haze of twilight, and thus rarely gets a chance to shine out. At some stages of its journeyings Mercury almost breaks the solar system's speed limit, dashing wildly along at a pace of more than two thousand miles a minute.

Venus was an unusually interesting object in the sky during July of this year. Not again until February, 1921, will it appear as bright and fair in the evening sky. It has phases like the moon, and these can be seen even through a good field-glass. Its day is believed to be the same length as its year, which is 224 of our days.

WILL A STAR FORETELL OUR WEATHER?

Mars always challenges interest. Its day is about the same length as ours, but its year is nearly twice as long. Although astronomers generally take less interest than laymen in the surmise as to whether other planets and stars are inhabited, since they, more than laymen, realize that this is a problem that must in all human probability remain unsolved, the question is more often asked about Mars than any other planet.

It is quite generally believed that Mars has ice-capped poles. The telescope reveals white spots at the poles that have every appearance of being like our ocean Polar region. They advance toward the Equator in winter and retreat in summer. In the summer of 1916, Pickering, who, with Lowell, has led the school of astronomers who believe they can see canals on Mars, said that he found the white caps stretching farther down toward the Equator than he had ever seen them before.

He said that if there was any connection between the weather of Mars and that of the earth, the winter of 1916-17 would be the coldest in many years. And it was. May it yet be possible to do long-range weather forecasting on the earth by studying the waxing and the waning of the ice-cap on the South Pole of Mars?

Swinging around the sun at a distance five times as remote as that which separates the earth from the source of its light, having a year nearly twelve times as long as ours and a day less than half as long, Jupiter is as much bigger than the earth as a tangerine is larger than a pea. He has nine satellites, seven of them revolving around him in one direction, the other two pursuing an opposite course. Saturn, with its wonderful rings, is one of the finest objects in all the skies through a telescope of even moderate size. Uranus is barely visible to the naked eye, while Neptune (see page 157) can be seen only with a telescope.

Whether studied as the head of the planetary family to which the earth belongs, or whether as an average member of the great household of suns that dwell in the distant skies, Old Sol has many thrills for the student.

To the inhabitants of the earth the fact that he shines is the most important physical consideration in life. From him we derive warmth, light, and power; without him the oceans and even the air itself would freeze; and, of course, under such conditions, life would be impossible.

TIES THAT BIND

With what firm ties he holds his family together well-nigh defies the imagination.

Prof. Charles G. Abbot estimates that a steel column five hundred miles thick would be required to keep Neptune in its path around the sun if the force of gravity were removed. Sir Oliver Lodge has estimated that the pull between the components of the double star Beta Aurigæ is twenty million times as great as the force that keeps the earth in its path.

Prof. F. R. Moulton says that the heat that reaches us from the sun amounts to more than two trillion horsepower, in spite of the fact that two billion horsepower goes off into space for every single horsepower that comes to the earth itself.

While the stars appear to us about as much like the sun as the fireflies of a summer night, yet the patient investigations of astronomers show not only that the sun is a star, but that it is by no means either the largest or the brightest of the celestial family.

Assured that it is a star and knowing that the next nearest one is three hundred thousand times as far away, astronomers addressed themselves to the task of learning about the other stars by studying our own. They found that there are some like it, giving out the same kind of light, though most of them send us, through the spectroscope, messages that tell quite different stories.

With the fundamental facts about the sun in hand, most astronomers are now engaged on star studies. A photographic

Photograph from Mount Wilson Observatory

THE NEBULA IN COMA BERENCIS

A little poleward from a line drawn between Regulus and Arcturus is the constellation Coma Berencis (see the chart on page 170). The nebula shown here is a part of it, and is thought to be so far away that a light ray leaving it today will not arrive on the earth for thirty thousand years. It is the fastest-moving object yet discovered in the heavens. Traveling at the speed it is going in its headlong flight through space, we could go around the earth in one minute.

chart of the whole sky is being prepared by the observatories of the world. This chart requires the taking of 22,000 photographs, each covering four square degrees of sky (see page 178).

MAPPING A UNIVERSE

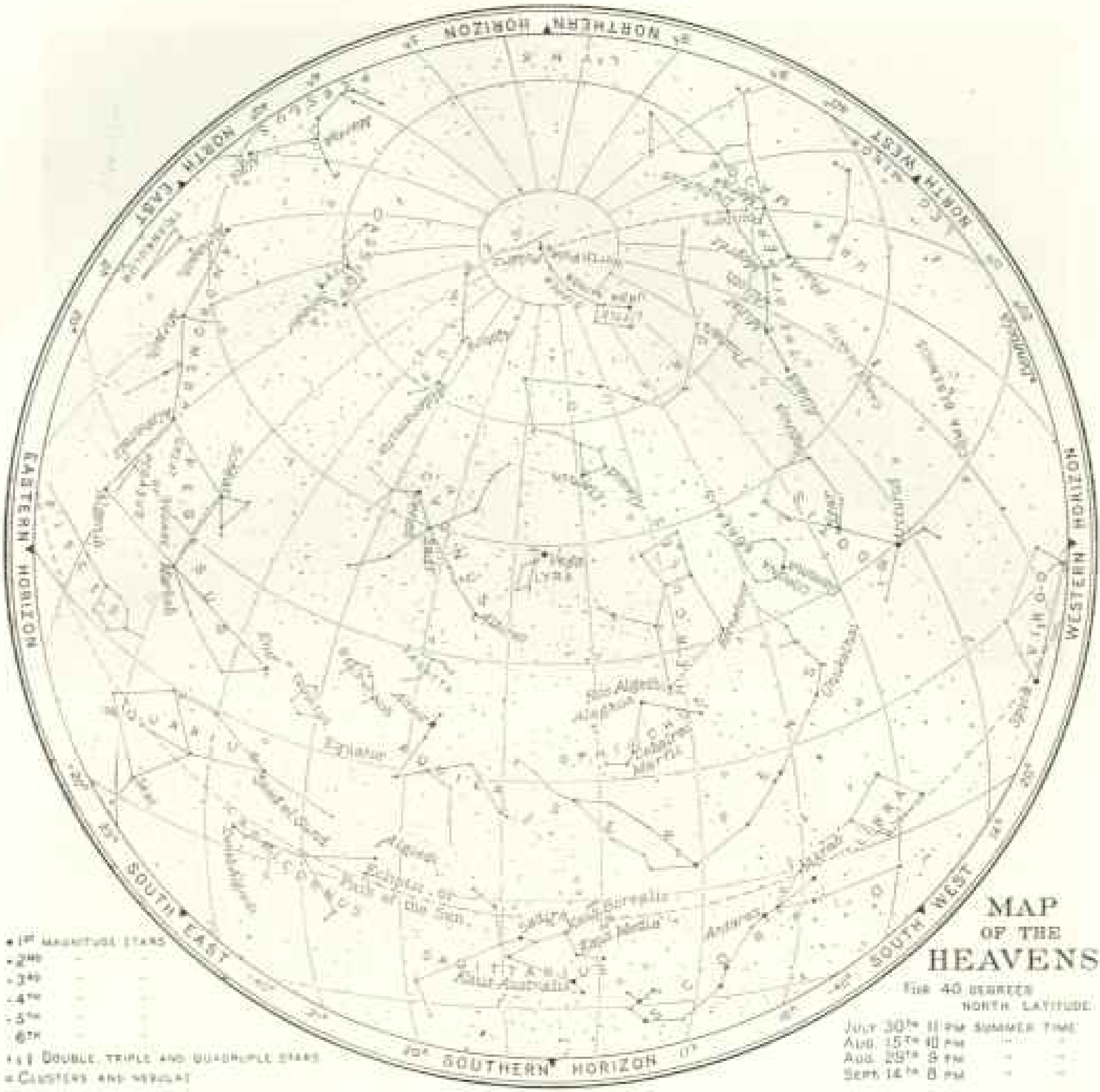
Each photograph has in it several stars whose positions have been fixed by direct observation. From them the position of every other star shown on the plate can be fixed by measuring, with a machine employing high-power microscopes, their exact places in the photograph. The completion of this work will record the position of at least eight million stars.

When we consider the solar system—with its great sun, its eight planets and their twenty-seven moons, and its eight hundred asteroids—as occupying an area whose diameter is nearly six billion miles (some six million times as far as from New York to Chicago), it is amazing to think that there may be millions of other solar systems as large or larger than our own, comparatively close to us as star distances go, though so remote that their planets could not be seen by the astronomers of the earth, even with telescopes as much more powerful than the biggest ones now in use are stronger than the naked eye.

THE ACME OF ISOLATION

So careful an astronomer as Agnes M. Clerke tells us that a skiff in a vast, unfurrowed ocean could not be more utterly alone than is our solar system in its little corner of the universe. She continues:

"Yet the sun is no isolated body. To each individual of the unnumbered stars strewing the firmament, down to the faintest speck of light, . . . it stands in some kind of relationship. Together they master its destiny and control its movements. Independent so far as its domestic affairs are concerned, it is



Drawn by Albert H. Bumstead, © National Geographic Society

A CHART OF THE HEAVENS AS THEY WILL APPEAR TO RESIDENTS OF THE UNITED STATES AND SOUTHERN CANADA AUGUST 15 AT 10 P. M., AUGUST 22 AT 9.30 P. M., AUGUST 29 AT 9 P. M., AND SEPTEMBER 5 AT 8.30 P. M.

The lines on this chart corresponding to meridians are separated from each other by the distance the stars appear to move across the sky in one hour. The lines corresponding to parallels show the direction of the stars' paths from the time they rise to the time they set.

By remembering that the stars within the space bounded by two meridian lines sink into the western horizon every hour, and that a corresponding stretch of new sky arises out of the eastern sky in the same time, the major portion of the chart will be usable hours after the time named. This, of course, does not apply to stars near the North Pole, like the Great Dipper. They never set—the daylight merely puts them to sleep.

Do you belong to that innumerable throng who have never made personal friends of the stars? If so, you are missing one of the easiest and most delightful diversions of evenings in the open. The first formality is to meet the Great Dipper, which might be called the supreme announcer. Its pointers, Merak and Dubuhue, will then escort you over to Polaris, king of celestial directions. All the roads of heaven lead to his throne and all the highways of earth are oriented with reference to his position (see pages 173-179).

Drawn by Albert H. Rungstad, © National Geographic Society

A PICTURE MAP OF THE HEAVENS, CORRESPONDING TO THE CHART OF THE STARS PRINTED ON THE OPPOSITE PAGE

The center of this map, with the bright star Vega outstanding, represents the part of the sky directly overhead, and the circumference represents the horizon. On account of the absorption of light by the atmosphere, the stars near the horizon are rately visible, and then only the brightest ones. The map, however, is complete down to the horizon. The map is made for latitude 40, but is approximately correct in other latitudes within the United States and southern Canada.

To locate a star or a constellation in the heavens, first find it by name on the chart on the opposite page. You can then easily transfer your eye to the same spot on this page.

After forming a mental picture, face that section of the horizon which is nearest the object and hold the map, so that the corresponding section of it is at the bottom. Then run your eye up from the horizon until you find the star or group that corresponds to the picture.

Vega will interest you greatly. Old Sol is carrying us, and indeed his whole family, in a headlong flight toward her, at a gait of more than 700 miles a minute (see page 172).

The stars that mark the handle of the Great Dipper will take you on their sweeping curve to Arcturus, a sun so bright that it outshines ours, as a flashlight outshines a lightning-bug, yet so distant that it seems only a point of light to us. From constellation to constellation you can go, making acquaintances that will give you the friendship of the royal hosts of heaven all through the years (see page 176).

Photograph from Yerkes Observatory

ONE OF THE SPIRAL NEBULÆ

This wonderful mass of whirling matter is at about the center of a circle that would be made by the continuation of the arc which forms the curve of the handle of the Big Dipper. One of the same type—the great Andromeda Nebula—is said to be approaching the earth at the wonderful speed of 12,000 miles a minute. Astronomers generally hold that of such whirling masses as these are worlds created (see page 177).

bound up, as a star, to the other stars by influences reaching across the unimaginable void that separates them."

A TERRIFYING PACE

Spectroscopic studies and sky observation alike tell us that our sun and his family are all headed in a great migration across the sky toward a point between the constellations of Hercules and Lyra (see picture, page 177).

The speed with which we are traveling in that direction is twelve miles a second. The velocity of an artillery shell is around 3,000 feet a second; that of the sun 63,000 feet. An artillery shell with the velocity of the solar system through space would, according to Kip-

Photograph from Yerkes Observatory

A VIEW OF A NEBULA IN THE CONSTELLATION 'TRIANGULUM

There are cradles and tombs in the heavens, with mewling infancy, gay youth, settled middle age, mellow advanced years, and lightless death as stages of the journey between them (see text, page 181).

pax, penetrate a sheet of steel four city blocks thick.

Think how far we travel every year and how complex our journey! In the first place, those of us who live near the Equator cover upward of nine million miles in our flight around the earth's axis. In the second place, in our journey around the sun we travel nearly six hundred million miles. While we are doing all this we are also being carried off into new and untried regions of space at the rate of four hundred million miles a year.

Is our great family journey through space along a straight road, or is it revolving around some greater body, even as the earth revolves around the sun and the moon around the earth? The astronomer tells us frankly that if the sun has an orbit its curve as yet defies detection.

Photograph from Yerkes Observatory

A YERKES PHOTOGRAPH OF SOME OF THE NEBULÆ IN THE PLEIADES

Imagine a drop of water expanded into a sort of supersteam so attenuated that it would fill a globe sixty-two miles in diameter. It is believed that some of the nebulæ may be composed of gases as rare as that.

Referring to the picture of the heavens on page 171, and to the map accompanying it, let us survey the sky as it will appear at the hours and on the dates given therewith.

Of course, the Great Dipper will first claim our attention, as it is the principal "landmark" of the heavens. It will be seen westward from the Pole Star, with its Pointers guiding the eye to Polaris and its handle sweeping in a broad curve toward Arcturus and Spica.

THE GREAT DIPPER

The star at the bend of the handle of the Great Dipper is known as Mizar. Insignificant though it looks in its smallness, it radiates more than a hundred times as much light as the sun, and is nearly five million times as far away. Its light has to travel three-quarters of a century to reach the earth. It is a great triple luminary. The combined mass of two of its members is many times as great as that of our sun; they swing around their common center of gravity every twenty days.

Following the line of the Pointers eastward, one's eye picks up Polaris, the only bright star in its neighborhood.

Shining down upon us from a point almost midway between the zenith and the northern horizon in the latitude of Washington, this humble star of the second magnitude tells little of its glory. Yet it is so distant that the light-waves entering the eye as one looks at it today left it forty-five years ago and have been traveling at the rate of more than eleven million miles a minute to reach us.

Photograph from Yerkes Observatory

A VIEW OF THE GREAT NEBULA IN ORION (SEE PAGES 180-181)

"The central portion of the Huyghenian region in the nebula of Orion is the opening of a colossal cavern in the primordial stellar floor. The nebula is no longer a flat surface. One peers within cosmic deeps; one looks into a chasm before which all powers of imagination are submerged, and feasts the eye with supernal splendors. It is like looking in at a door and to the rear of a cave, deep within glittering nebulosity. The chasm is the most beautiful object visible to human sight. Pillars, columns, walls, façades, bulwarks, stalactites, and stalagmites are within deeps of deeps. They glow and shine superbly with pearly light."

Not one star, indeed, but three—a triple sun—is Polaris. Until recently it was supposed to be a double star, but the newer high-power telescopes reveal that the brighter of the two companions has a closer companion of its own.

VEGA AND ITS COMPANIONS

In the zenith is Vega, the bluish-white star of the first magnitude that shines down with beautiful brilliancy from the constellation Lyra, the Harp. Any doubt in identifying Vega, otherwise Alpha Lyræ, can be dispelled by observing the close equilateral triangle formed by it and its companions, Epsilon and Zeta Lyræ, this being the only triangle of its kind in the whole heavens.

If with the unaided eye we viewed the sun from the distance of Vega, it would appear as one of the dimmest stars. Vega is said to be eight million times as far from us as we are from the sun.

Epsilon Lyræ is a double star. Neither Persian, Arab, Greek, nor, indeed, any primitive people, seems to have discovered that fact, though with good eyes it can be seen as such on a clear night. May not this indicate that the eyesight of the human race is improving? With a telescope we can see that each part of this double star is itself a double—in other words, that Epsilon Lyræ is indeed a magnificent system of four suns.

LIGHT THAT MUST TRAVEL 5,000 YEARS TO REACH US

A little past the zenith is the constellation Hercules. It isn't a particularly bright group, not a single star in it being brighter than the third magnitude; but it has an easily found trapezoidal figure of five stars, the base turned toward the north. On the west side of this trapezoid, about one-third of the distance from the base, is what appears to be a faint and fuzzy little spot, visible only on the clearest nights; but train a high-power telescope on it and you will see one of the finest star-clusters in all the heavens.

Ritchey's photograph of this cluster, taken with the big 60-inch Mount Wilson reflector, discloses that it is made up of more than fifty thousand stars, very many of them as big and as bright as our own sun. Photographing the cluster first with plates sensitive to blue light and then with others sensitive to red indicates that they are giant red-and-yellow worlds like Arcturus and Antares.

How far away they are cannot be said, for they are too remote for measurement with the finest instrument yet devised. It is certain, however, that they are at least so distant that the light coming to the earth from them this year may have started on its hurtling journey through space about the time of Joshua's conquest of Jericho.

In other words, if a space-penetrating eye on one of the stars of this Hercules cluster could be looking down on the earth today it might be watching the armies of the Lord encircling the doomed city.

SUNS THAT PUT OURS TO SHAME

To the west of Hercules, easily located by continuing the curve of the handle of the Great Dipper for a distance approximately equal to that which separates Polaris from the nearest Pointer, is Arcturus, king bee of the constellation Boötes, the Hunter.

Of a deep orange color and of the first order of brightness, Arcturus is a sun that makes our own pale in comparison as a tallow dip pales before an arc lamp. Indeed, it is thought to radiate five hundred times as much light as our sun.

Away down toward the southwestern horizon, as viewed from Washington, is Antares, two hours past the meridian. The starry heart of the Scorpion, this blazing sun is fiery red in hue and gives off two hundred times as much light as the orb of our day.

Altair, the bright star of the constellation Aquila, the Eagle, forms the head of a great cross, of which the Pole Star is the foot and Vega and Deneb the two arms. Far brighter and bigger than our sun, Altair is rushing toward us at the rate of eight hundred million miles a year.

THE LETTER WRITTEN IN THE HEAVENS

About as far east of the meridian as Hercules is west is the constellation

THE RING NEBULA IN LYRA, TAKEN WITH THE 60-INCH MOUNT WILSON TELESCOPE

The power of the big telescopes is strikingly shown by this picture. With the naked eye one cannot see this nebula, which is in the neighborhood of Vega (see chart on page 170). A cube, whose sides equal the distance across this nebula, would occupy a space large enough to provide room for hundreds of millions of solar systems like ours.

Cygnus, the Swan, with Deneb as its principal star. Deneb is so far away that the light rays entering our eyes from it this year left it during the reign of Queen Elizabeth. It is driving through space toward us at the rate of nearly two thousand miles a minute, spectroscopic advices say.

Eastward from the Pole—about as far from Polaris as the latter is above the northern horizon—is Cassiopeia, the Woman in the Chair. The major stars of this constellation form a letter "W." The star at the middle of the third stroke is a double, its two members revolving around a common center of gravity in a period of about two hundred years. If either of them has a family of planets, their system of day and night, as well as their seasons, must be powerfully complicated.

Well down toward the eastern horizon is the constellation Andromeda, the Chained Woman. It contains no first-magnitude stars, but has a line of stars of the second magnitude extending from the northeast to the southwest, by which it can be located. About fifteen degrees

Photograph from Yerkes Observatory

VERITABLE CLOUDS OF STARS

Not a single star in this whole picture is visible to the naked eye; yet every tiny dot is the image of a world that wrote its "image and superscription" on the photographic plate (see page 169).

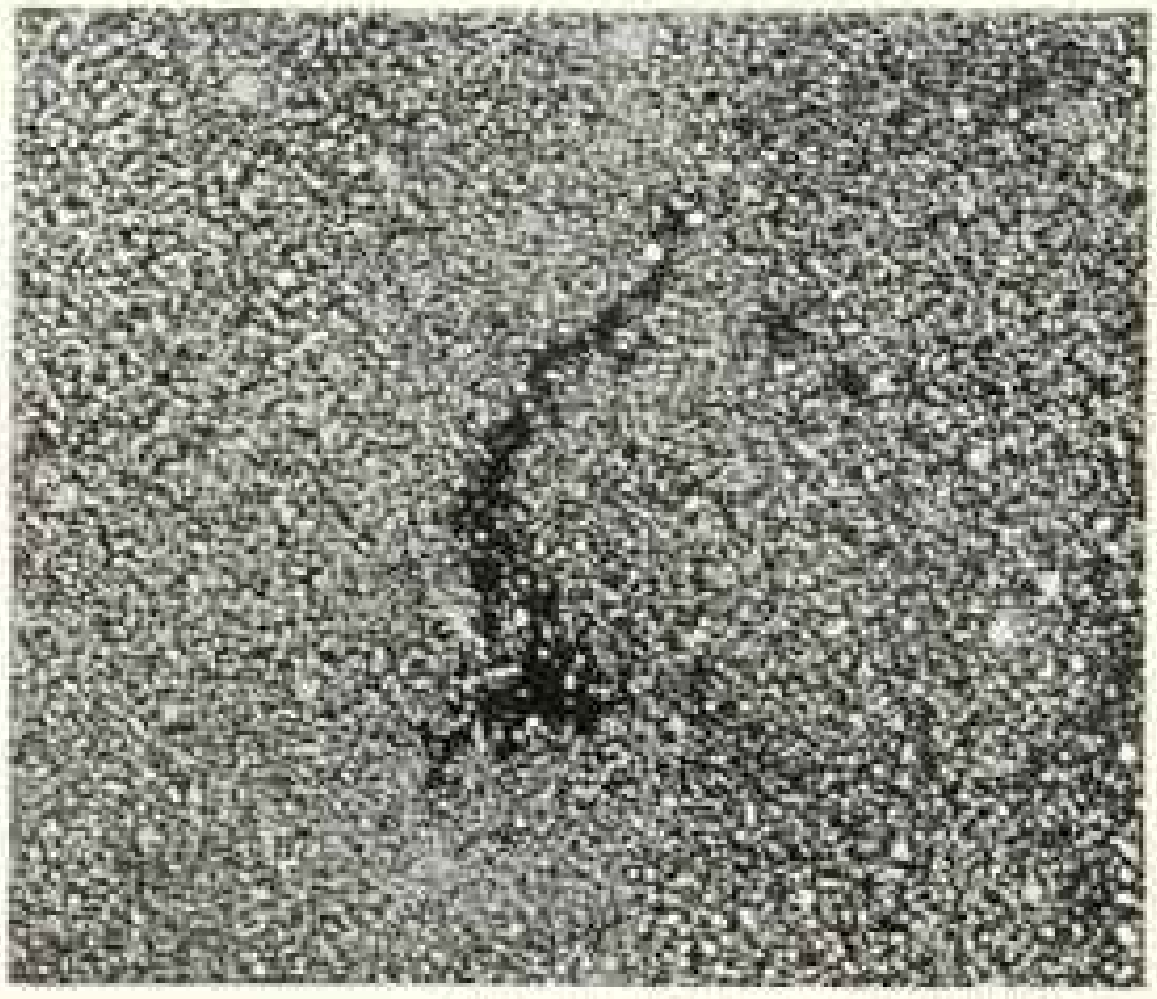
directly south of the brightest star of the group is a little patch of light that can barely be seen. Whether this is a nebula, or whether another universe so immeasurably distant that its light is only a haze, has not been determined. The spectroscope seems to translate its light message as saying that it is composed of solid or liquid material surrounded by cooler gases (see picture, page 172).

Down on the northeastern horizon is the constellation Perseus, the Champion. Its brightest star is the center of a twinkling field regarded by many as the finest spectacle in the heavens when viewed through field-glasses. Its second star has been called Algol, the Demon. It varies in magnitude, losing two-thirds of its light between its brightest moments and its darkest, which follow one another every sixty-odd hours.

One might pass by Pegasus, the Winged Horse, with its famous square, in the southeastern heavens; Delphinus, the Dolphin, with its closely grouped stars, lying between Pegasus and Aquila; but away down on the southern horizon, on the very meridian, is a constellation, Sagittarius, the Archer, which rivets the beholder's attention. It lies in a region full of star-clusters and nebulæ of great beauty.

With the exception of a few minor constellations, this completes the list of the principal people of the sky visible at the hour named. But those who will take the trouble to watch as the months go by will see many others of rare beauty and striking appearance.

Aldebaran, a star that is well past middle age, as disclosed by its color, and yet driving toward us at the heart-breaking speed of two thousand miles a minute; Capella, so distant that our sun could barely be seen by us if as remote, but so bright that it outshines our sun as a candle outshines a fire-fly; Rigel, so hot that it would roast us alive if it were to come as close to us as the sun; Betelguese, Sirius, Procyon, Castor and Pollux, Regulus, Spica and Fomalhaut—all



Photograph from Yerkes Observatory

A RIFT IN THE SKY

This picture shows how thickly the constellation of the Swan is peopled with stars. But why the apparent abyss in the center? Astronomers are seeking the answer.

these are in the heavens of the daytime in late August and therefore not visible at night.

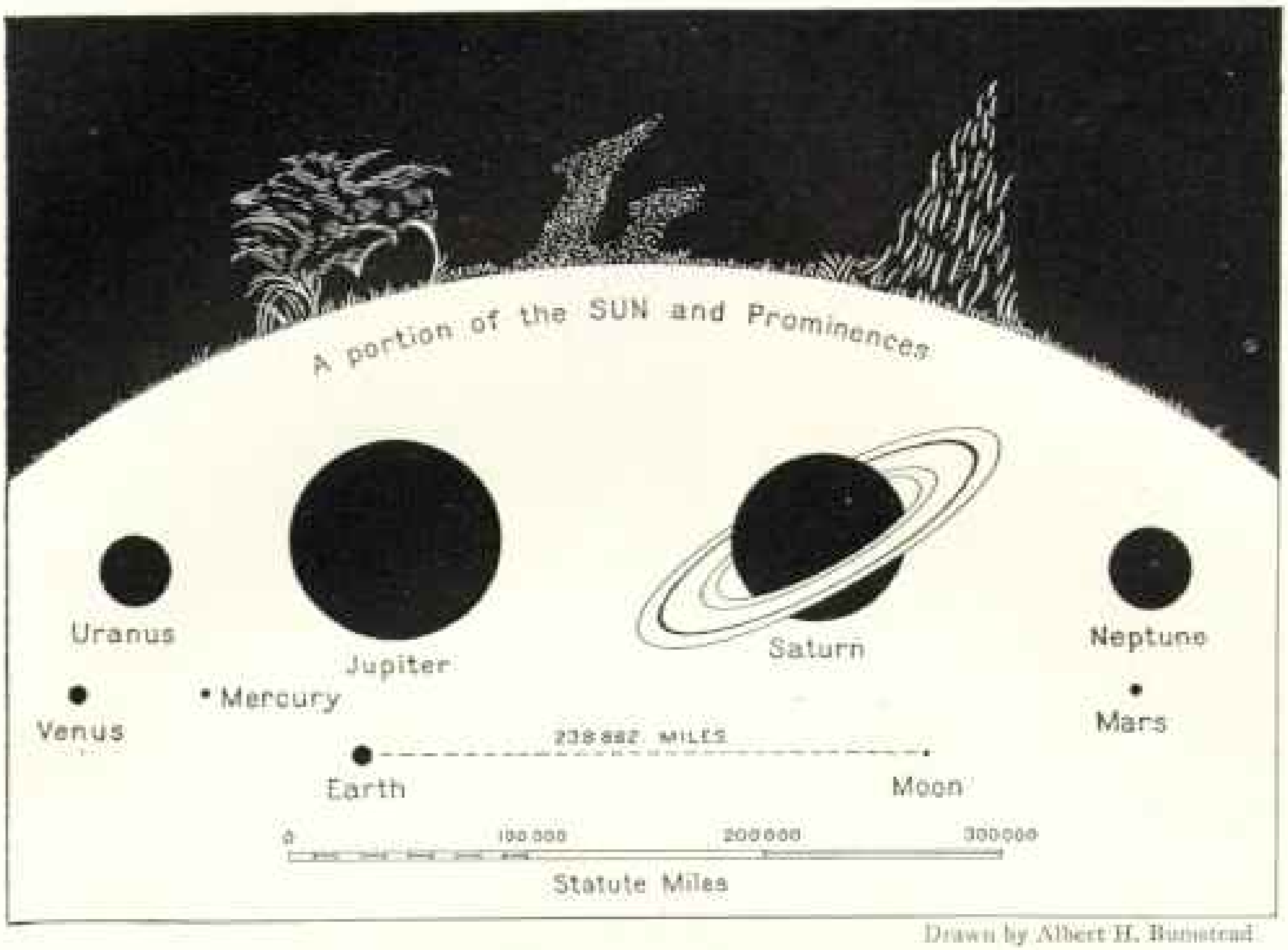
But next March they will be in their glory in the night sky, vying in beauty with the Milky Way. To know them is to add new joy to a walk in the open air on a clear winter's night.

One fain would pass on to ten thousand others of the hosts of heaven and to the wonderful stories they can tell. The variable stars, like Algol, in which the brighter member of a double star is eclipsed by a darker one at regular periods, are hard to pass by.

THE "SPEED MERCHANTS" OF THE HEAVENS

So, also, are the "runaway stars" that are speeding through space at gaits that astound the astronomer. In the southern heavens is a runaway called "243 in the fifth hour of right ascension, in the Cordoba Zone Catalogue." It is traveling 170 miles a second—eight times as fast as the average star. No. 1830, Groombridge, in the Great Bear, has a velocity of perhaps 200 miles a second. At that rate it could fly around the earth in a shade more than two minutes.

Either the universe is vastly more ex-



Drawn by Albert H. Buhstead

CHART SHOWING THE RELATIVE SIZE OF THE SUN, MOON, AND MAJOR PLANETS

The stupendous size of the sun in comparison with the several members of its planetary family is emphasized by the distance of the moon from the earth as here plotted on the face of the sun. The differences in their sizes play peculiar tricks of gravity. A hundred pounds would weigh 2,764 pounds on the sun, 252 pounds on Jupiter, 36 pounds on Mars, and 16 pounds on the moon. Spots on the face of the sun are often six times the diameter of the earth, and prominences frequently reach so far into space that they would completely envelop our moon if they started from the earth (see also page 166).

tensive than the most advanced astronomer dares think or else these stars will run clear through it and out into God only knows where, unless they shall sooner pass close enough to some bigger star that can tame them.

THE MILKY WAY

Called the Silver River of Heaven by the Japanese, pronounced by the ancient mythologists the dust stirred up by Perseus as he hastened to the rescue of Andromeda, the Milky Way sweeps in a vast circle around the celestial sphere. Herschel said it might be likened to a great grindstone. It is made up of millions of small stars that cannot be separated without optical aid.

This great star stream, coursing its way around the heavens, in a sweep that may require as much as two hundred million years for its circuit, seems to have captured the vast majority of the folk of the universe, and is flowing in unending procession onward and onward. Here it branches and flows around an island in space; there it is crossed by a bridge of blackness; at another place it is narrow, as though passing through a gorge; and elsewhere it widens out as though flowing through an alluvial valley.

Composed of great clusters of multitudinous suns, many of the individual members vastly larger than our own, one who looks upon the Milky Way can feel, with Buchanan Read, that the stars that are faintest to us may to diviner vision be the noblest of them all.

Nor is it easy to neglect those wonderful objects of the sky, the nebulæ, those

wonderful aggregations of gas or microscopic dust. Look on a winter's night at Orion. Between Betelguese and Rigel is his belt, and suspended from this belt his sword. The central star of this sword appears to the naked eye as merely a fuzzy little fellow that might be passed over without thought.

THE INUTTERABLE GREATNESS OF THE NEBULÆ

But train a big telescope on it and instead you see the most magnificent nebula in the heavens. Its diameter is thought to be twenty million times as great as that of our sun. Even if its density were as much more attenuated than air, as air is lighter than lead, it would still be, according to figures suggested by Professor Moulton, as much heavier than the sun as the great Pyramid of Cheops is heavier than one-tenth of an avoirdupois grain (see page 175).

Of such attenuated material as this are worlds called into being under laws made in the beginning. How many worlds have met, and are meeting, the description, "the earth was without form and void"! And from such new-born worlds, with their blazing white light, of which Rigel is a type, down through the bluish white of which Sirius is a representative, and then through the yellow, like our sun and Procyon and Arcturus, to the red ones, like 19 Piscum, and again to those that are black and eclipse their brighter neighbors in the variable stars, we run the gamut of star life, with here mewling infancy, there gay youth, elsewhere sturdy manhood and ripe age. And in the end come dead suns, derelicts in the ocean of space.

When the sweet singer of Israel sang that "the heavens declare the glory of God and the firmament sheweth His handiwork," he had never seen more than five thousand stars. With the latest Mount Wilson reflector three hundred million will write themselves upon the photographic plate.

IN DAVID'S TIME AND OURS

What in David's time and with the naked eye were only gems to render a sky more beautiful and wondrous for mundane dwellers, are revealed, through such powerful instruments, as worlds and systems, immeasurably distant the one from the other, but each and all actuated by laws so all-pervading that they apply alike to infinitesimal and to infinite, so enduring that they survive all wreck and change, so powerful that all things created are controlled by them, and yet simple enough that with patient endeavor the astronomer and the chemist and the physicist are learning their principles one by one.

BETWEEN MASSACRES IN VAN

By Maynard Owen Williams

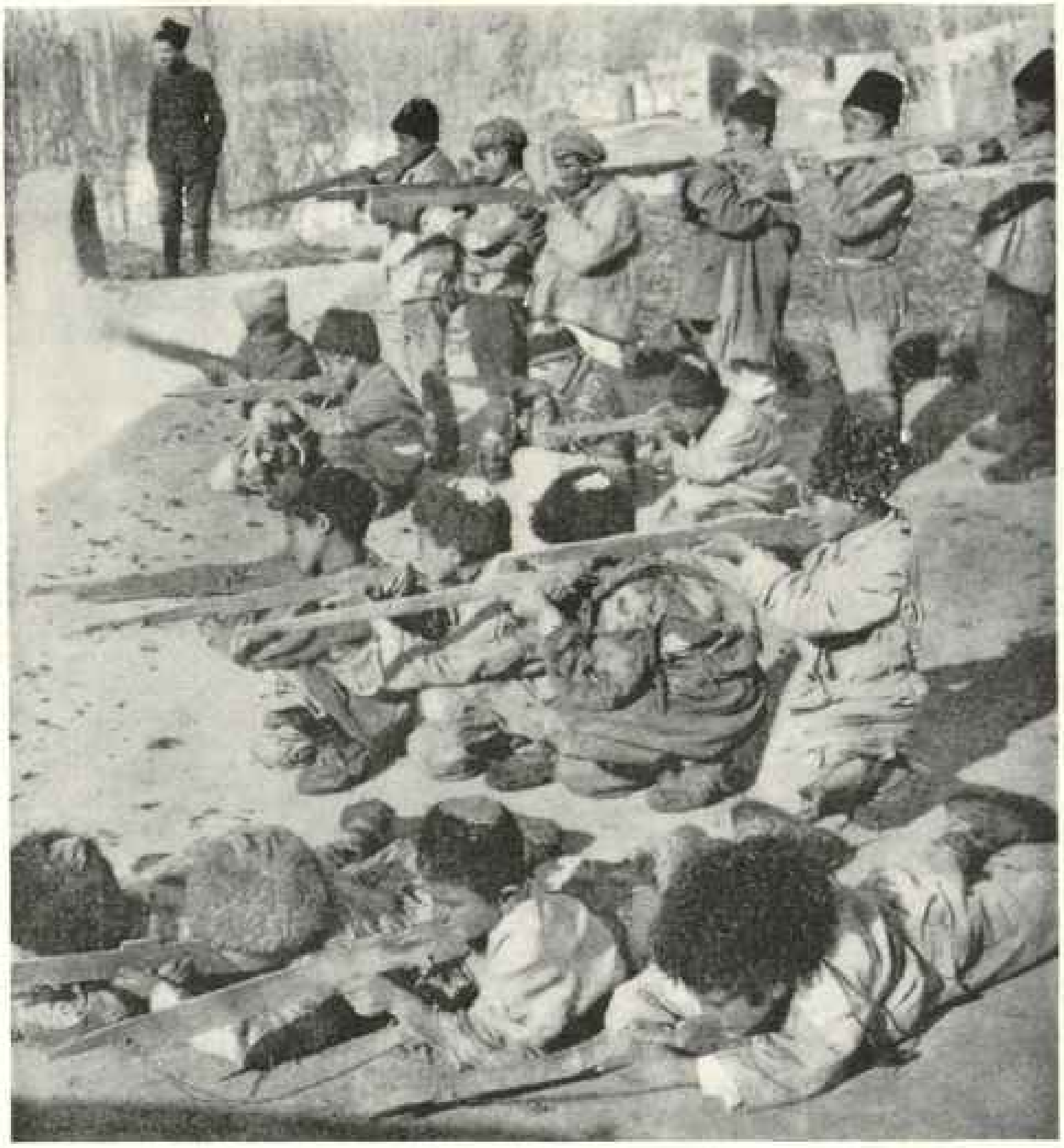
THE scene is Van, historic capital of Armenia, whose antiquity is proven by the inscriptions of the conquering kings of many tribes carved in Castle Rock.

Tragedy is depicted in each ruined home, but the background is one of striking charm. To the left, or southwest, there lies the majestic line of snow mountains which separate Armenia from the Tigris Valley.

Before us are the peculiarly lovely waters of the lake of Van, with Nimrud's cratered peak showing hazily forty miles away. A little to the north, one sees the graceful cone of Sipan, where the ark of Noah first sought rest, only to have this hoary-headed mountain resign its fame to mightier Ararat, still farther north.

To the right—a ribbon of dark brown across the snow expanse—there runs the road of the retreats, the way that leads to the Valley of the Shadow of Death.

My part has been building barracks out of fire-scarred mud shells, where once choice carpets and silk hangings gave a touch of Oriental luxury to a city of beautiful homes and green gardens, and providing work through which proud women could earn bread.



PART OF THE BOYISH COMPANY OF VOLUNTEERS WHO TRAMPED FROM ARTEMID TO VAN; ARMENIA

Through winter snows they came to petition the Armenian Governor for real guns with which to defend their homes. The oldest of these boys was twelve. They were self-trained and set out on their six-mile tramp without the permission or knowledge of their guardians in Artemid.

In one huge house carpenters are fashioning windows and doors to make more habitable the hovels where the people herd. And tons of matted wool are there being cleaned, carded, and spun for clothing to protect weakened womanhood from piercing cold.

American charity is at work where misery is anesthetised by hope for future peace, where barefoot children, trudging through the crunching snow, smile as they swing small blackened pails in which they hope to get some watery soup to soften the black bread on which their lives depend.

The Governor and I are closest friends. When he was young he ran an elevator in Boston and learned his English from

the kindly people whom he served. Now his is the task of husbanding this pitiful group of Armenians until victory shall come to the Allied arms and liberty to the land he loves.

As we returned one day from our tasks to the modest mud house which was the humble home of government, we were confronted by a grotesque group of tiny lads whose ages ran from eight to twelve.

The Governor saluted the small, but dignified, commander gravely and asked:

"What can the Governor do for these loyal citizens?"

"We have come to exchange these wooden guns which we have made for real guns. We want to protect our country."

"We have great need for all our guns, my men," said the Governor. "We only issue rifles to those who can drill."

TWO PRIVATES IN THE ARTEMID ARMY OF SMALL BOYS

The reply was immediate:

"We can drill, sir!"

The busy man's eyes twinkled a little at this delay, but he said:

"Let me see what you can do."

The 12-year-old leader gave a sharp command, and 28 wooden guns, carved from light boards, came to the snowy street with a thud.

Up they came again to "present arms," back to "right shoulder arms," and then to "charge bayonets." Not a smile showed on the youthful faces.

Then the untanned skin moccasins shuffled back and forth in fours and around to "company front"—just such play at soldiering as makes us smile proudly, but with a little catch at the throat, whenever we see this youthful imitation of a world at war.

But most of *these* small lads had a murdered father or a suicide mother, hounded to her death by Kurdish fiends, as his background.

The Governor was deeply moved.

"Where are your homes?" he asked, expecting that they came from some near section of the city.

"We come from Artemid, sir!" was the challenging reply, mentioning a lake-side village six miles distant on the road to the Turkish lines.

The day before there had been a heavy snow and the afternoon shadows were already lengthening. Even a strong man

THE COMMANDANT OF VAN, SON OF ONE OF ARMENIA'S POETS, PRESENTING A WOODEN SWORD TO THE CAPTAIN OF THE GROUP FROM ARTEMID

would have difficulty in reaching Artemid that night.

So Governor Hambartsoumiantz called in the youthful commandant and myself to a council, which resulted in the issue of an army ration of black bread, tea, and sugar to the boys, while a room was provided for them in the headquarters of the city troops. Still the lads said they would not return to their homes unless they were given guns.

Relief work is not a matter of stomachs alone, but of morale. So in the morning my head carpenter set to work on the choicest board we could find, and while he was fashioning it into a blade with all the curves of Saladin's sword, the boyish company inspected the varied industries which American relief had established, and each received a pair of heavy woolen socks.

Then the lads drew up at attention on the flat mud roof of our premises.

There the young commandant, son of one of Armenia's famous poets, gracefully presented the 12-year-old captain with a saber, whose wooden fabric could not conceal the lines which were smilingly, yet tearfully, worked into it by the master carpenter, who entered with all his heart into this simple commission of love.

"This time we can only give your leader a sword," said the Governor, who had left an important conference to wish these lads farewell.

"But I wish you to keep up your discipline and training, for the time may come when we shall need your aid. Hold your command in readiness, Captain, for your country may call on you."

"We shall be ready, sir!" said the proud possessor of the new sword.

Then he turned to his motley gang:

"Right shoulder arms! Column right, march!" And the volunteer army of Artemid started proudly on their long tramp to the village through which, a month later, the Turkish hordes passed on their way to massacre in Van.

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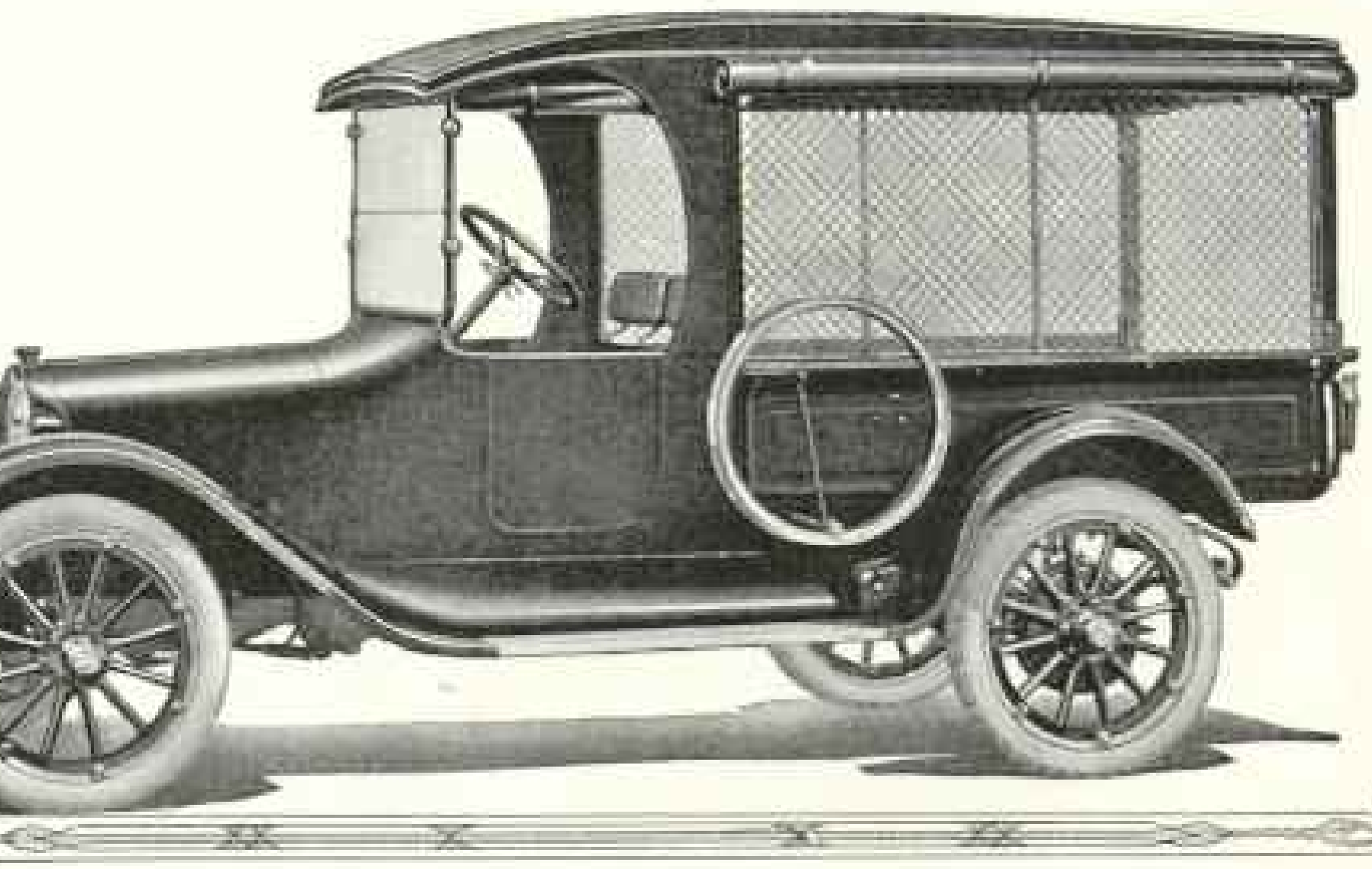

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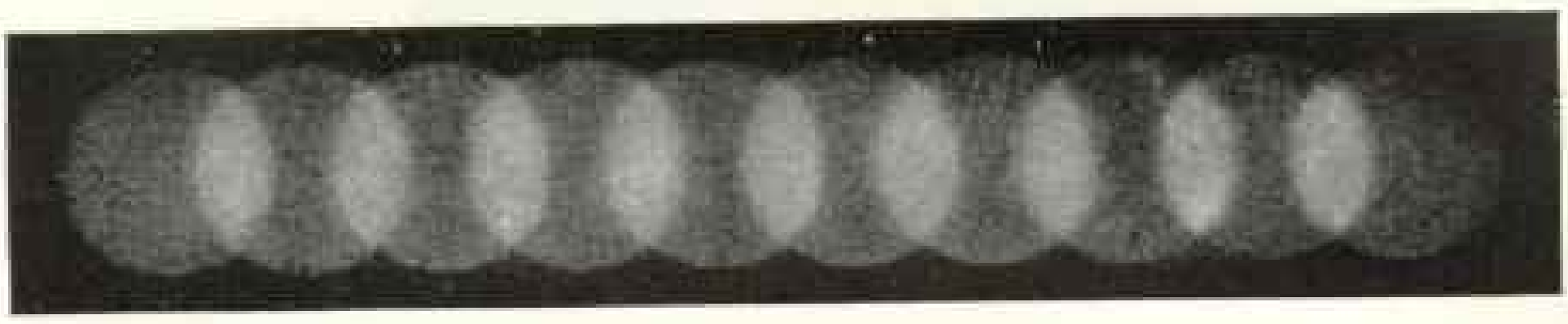

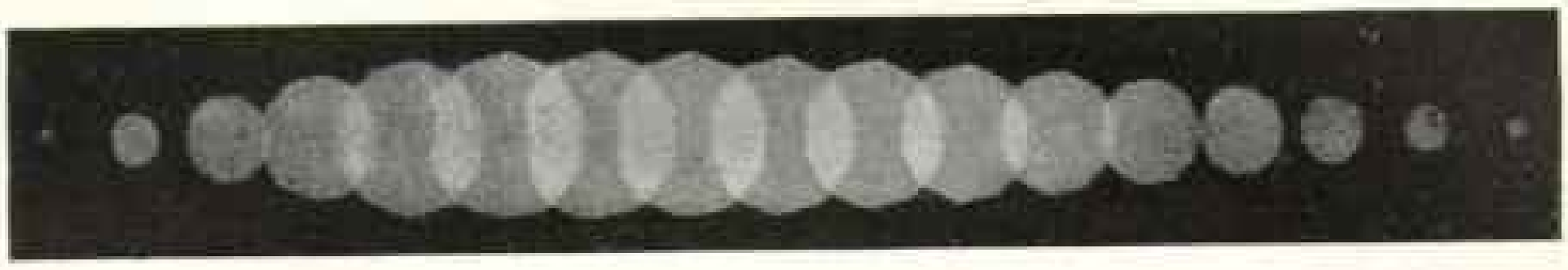

The illustrations above are reproduced from actual photographs, made at the Kodak Research Laboratory, of the light projected by a lens through a Graflex Focal Plane Shutter, and a between-lens shutter. The upper illustration shows that with the Graflex Focal Plane Shutter there is no diminishing of the volume of light due to the opening and closing of the shutter. The lens works at its full efficiency during the entire period of exposure. The lower cut shows how a between-lens shutter, when making fast exposures, uses up most of the exposure period in opening and closing, allowing the lens to work at its full efficiency during but a small fraction of the exposure.

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That film clings to teeth. It enters crevices, hardens and stays. It absorbs stains, so the teeth discolor. It is the basis of tartar. It holds food substance which ferments and forms acid. It holds the acid in contact with the teeth to cause decay.

Millions of germs breed in it. They, with tartar, are the chief cause of pyorrhea. So the great problem of teeth cleaning is to daily combat that film.

A way has been found to do that. Authorities have proved this by convincing clinical tests. Now that way is embodied in a dentifrice called Pepsodent, and we urge you to see what it does.

Watch It 10 Days

Analysis shows that this film is albuminous. Pepsodent is based on pepsin, the digestant of albumin. The object is to dissolve the film, then to constantly combat it.

Pepsin alone can't do that. It must be activated, and the usual method is an acid, harmful to the teeth. That made activated pepsin impossible on teeth.

But science has discovered a harmless activating method. Patents have been granted by five governments already. That method is now used in Pepsodent to solve this great film problem.

Let it prove itself. Send the coupon for a 10-Day Tube. Use like any tooth paste. Note how clean the teeth feel after using. Mark the absence of the slimy film. See how teeth whiten as the fixed film disappears.

Your present methods are not ending film. See what this new-day method does. It will be a revelation.

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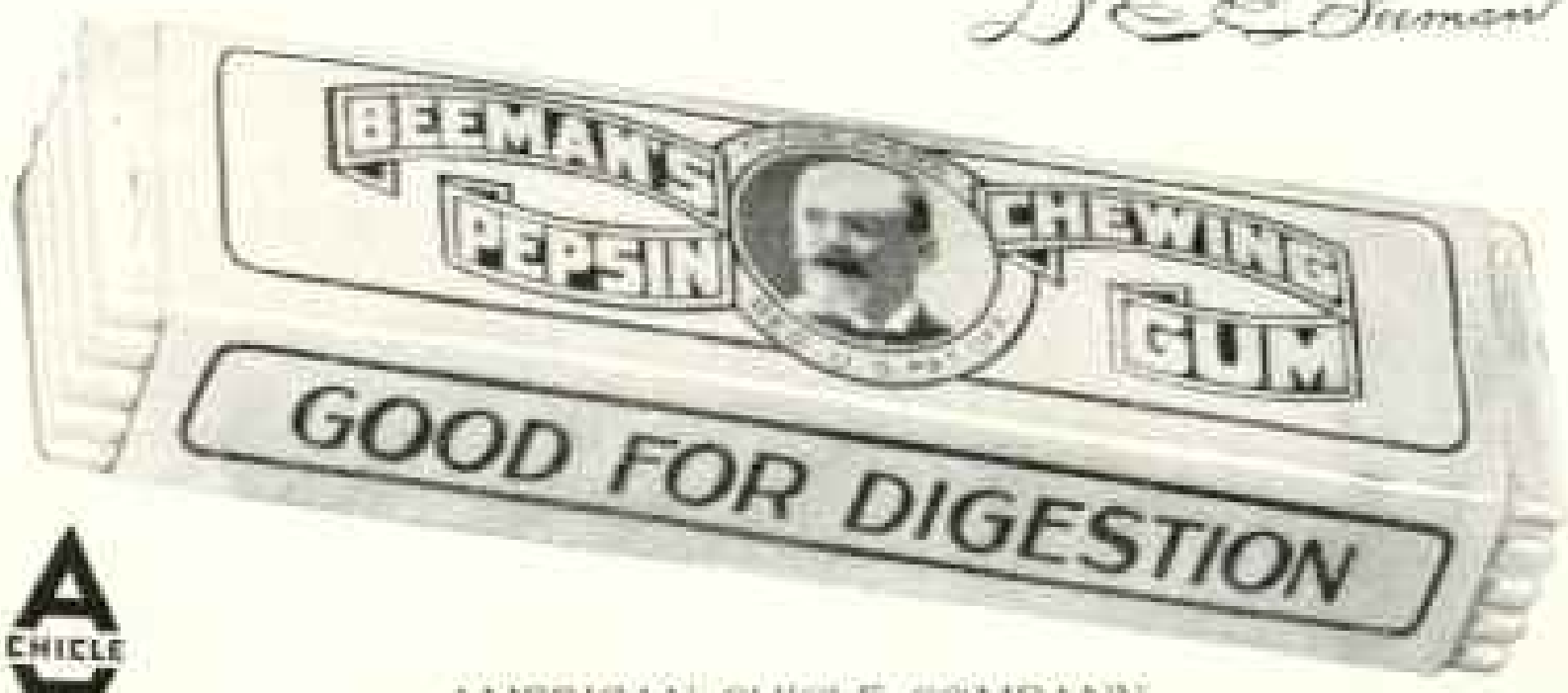

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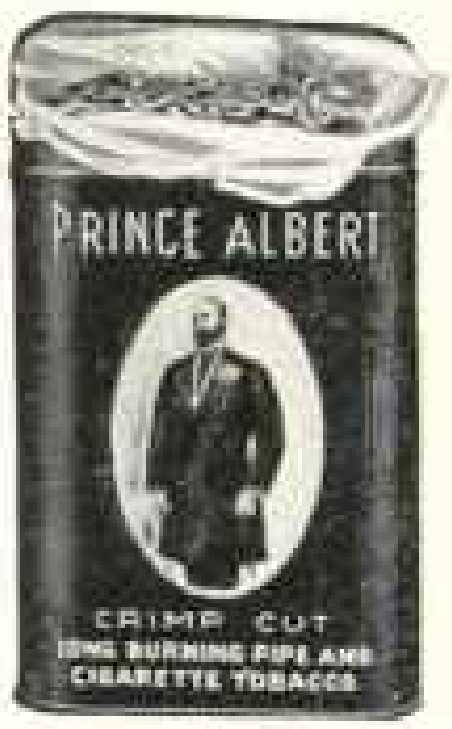

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