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THE NATIONAL GEOGRAPHIC MAGAZINE

Eclipse Hunting in Brazil's Ranchland

By F. Barrows Colton

With Illustrations by Staff Photographers Richard H. Stewart and Guy W. Starling

HIGH on a rolling Brazilian plateau, on May 20, 1947, we kept a date with the vast, black, racing shadow of the moon.

On schedule to the split second, the shadow came speeding at 2,000 miles an hour across our camp site in the semi-jungle, and after more than a year of preparation and a flight of 6,500 miles we were there to meet it.

From within the shadow's cold half-twilight we saw Nature's most dramatic and awe-inspiring spectacle—a total eclipse of the sun.*

Our Army Air Forces–National Geographic Society Expedition did not travel so far merely to see a sublime celestial show. We made the trip to grasp a rare and fleeting opportunity, only 228 seconds long, to learn something more about that great hot star, our sun, around which our earth circles year after year and on which we depend for life itself.

That is the real drama of an eclipse—man, riding through space on his tiny planet, snatching one more chance to get a quick look at secrets hidden from him at all other times, secrets not only of the great star to which his fate is forever tied, but of other stars resembling the sun, and secrets as well of the vast universe far beyond his ken.

New Life Comes to Bocaiuva

Exciting rumors already had begun to spread in the sleepy little Brazilian town of Bocaiuva, nestling in the green hills of Minas Gerais State, 400 miles north of Rio de Janeiro, back in August, 1946, many months before that great day of May 20.

An advance party of scientists, khaki-uniformed officers of the U. S. Army Air Forces, and officials of your Society had appeared suddenly one day in this out-of-the-way corner of the world. Exploring the countryside far out into the tangled bush that covers the region roundabout, their bustling jeeps had startled the oxcarts and pack trains plodding along the rough, dusty roads (page 287).

Mysterious observations had been made by the visitors and there had been talk that the sun was to be blotted out.

Later the AAF officers had returned and engaged men to clear a large area on a hilltop at a remote spot out in the scrub forest, and to carve a long new airplane landing strip in the red earth at the edge of Bocaiuva itself, where large airplanes previously had been almost a curiosity (page 290).

And meanwhile, out in the empty depths of space, the barren, lifeless moon was slowly moving toward a point where, many months later, it would come between the earth and the sun and draw the end of its long, trailing, pencillike shadow across South America, the Atlantic Ocean, and part of Africa (map, page 295).

The inevitable coming of that shadow was stirring up preparations all over the world to observe the eclipse in Brazil. In the United States, scientists of six different institutions

* See, in the NATIONAL GEOGRAPHIC MAGAZINE: "Nature's Most Dramatic Spectacle," by S. A. Mitchell, and "Eclipse Adventures on a Desert Isle," by Capt. J. F. Hellweg, both in September, 1937; "Observing a Total Eclipse of the Sun," by Paul A. McNally, November, 1932; "Photographing the Eclipse of 1932 from the Air," by Capt. Albert W. Stevens, November, 1932; and, by Irvine C. Gardner, "Observing an Eclipse in Asiatic Russia," February, 1937, and "Crusoes of Canton Island," June, 1938.

During Totality Instruments Are Etched Against Light on the Horizon

This picture gives an impression of greater darkness than actually prevailed, because the photographer timed his exposure to catch the light in the distance and silhouette the instruments against it. A band of light extended around the horizon where the sun was shining outside the moon's shadow, which enveloped the camp (page 316).

under the auspices of your Society were building complicated instruments, testing cameras, and making precise calculations in their notebooks.

From Army headquarters orders were going out to assemble water-purification equipment, medical supplies, electric generators, rations, cots, mattresses, blankets, weather-observation apparatus, radios, and DDT spray bombs.

Officers and sergeants of the Air and Ground Forces who had seen service on the fighting fronts of China, India, North Africa, Europe, and the Pacific islands were getting travel orders again—this time for Brazil.

Thus preparations went forward at increasing tempo to keep our date with that shadow, which astronomers knew for a certainty would one day come racing across that very clearing that was being carved out on the hilltop beyond Bocaiuva.

Led by Dr. Lyman J. Briggs, chairman of your Society's Research Committee, 16 scientists, 55 officers and noncommissioned officers of the Army Air and Ground Forces, and five members of the National Geographic staff took part in our expedition.

Thanks to the enthusiastic cooperation of Gen. Carl Spaatz, commanding general of the AAF, it was the first large eclipse expedition ever to be completely airborne. All personnel, and 75 tons of supplies and apparatus, were transported by aircraft of the AAF's Air Transport Command from the United States to within a few miles of the expedition camp, saving incalculable time and making transportation infinitely easier.

General Spaatz further arranged for the AAF to operate our camp, make weather observations, and supply rations and pure water. The AAF also handled numerous details of arrangements in Brazil, through Brig. Gen. Gordon P. Saville, Chief of the Air Section of the Joint Brazil–United States Military Commission.

Keeping a Date with a Shadow

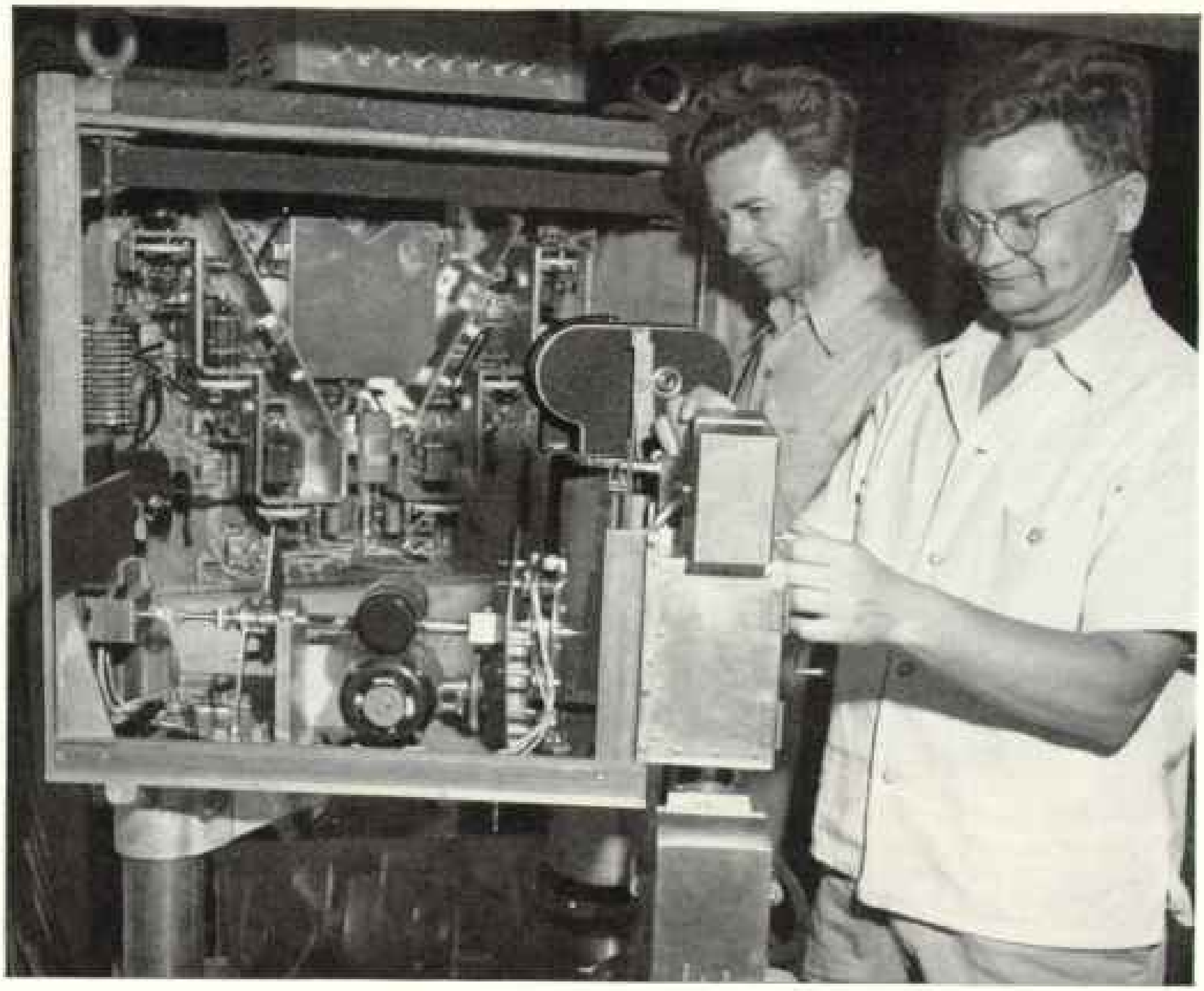
Keeping our date with the moon's shadow, we carried out one of the most complete programs of observations of a total eclipse of the sun ever undertaken. Our scientists, working feverishly through precious minutes, made hundreds of photographs and other observations. From these will come information obtainable in no other way concerning that all-important giver of life, the sun—how it affects the earth on which we live, how it

Transported by Air from Rio, a Water-tank Trailer Is Unloaded at Bocaiuva

Two of these trailers and seven jeeps were among pieces of heavy equipment flown to within a few miles of the camp. The trailers, lent by the Brazilian Air Force, hauled water from a stream. The plane is one of several C-47s of the Air Transport Command, which carried men and equipment.

Brazilian Pack-train Drivers Pause to Cook Lunch near the Expedition's Camp

Baskets piled behind them have been unloaded from their mules. The meal consisted of coffee and rice, meat, and beans prepared in the pot hung over the fire. Pack trains carry goods to and from the smaller towns in this comparatively undeveloped region of Brazil, where paved highways and railroads are few.



With This Maze of Apparatus They Probed 250 Miles Aloft into the Ionosphere

Radio signals, sent up to the radio-reflecting region high above the earth, echoed back and revealed what happened there before and during the eclipse. James Watts (right) and Franklin Kral of the National Bureau of Standards carried out the project, which will supply new information useful in long-distance radio communication. Movie cameras (center) recorded returning radio echoes on film (page 310).

rules some phases of our daily lives, and other knowledge which will reach deep into the heart of the atom and far out into the mysterious distant reaches of the great universe itself.

As we strapped on our parachute harnesses on April 1 and climbed aboard a huge four-engined C-54 of the Air Transport Command, we already were talking about the weather—not that day's weather, but the weather to come on May 20 at our destination in Brazil.

For every eclipse expedition is a gamble on weather, a gamble in which thousands of dollars, months of preparation, and weeks of travel are staked on the chance that the sky will be clear over the observation point at eclipse time.

An Astronomer Needs Luck

A total eclipse of the sun occurs somewhere on earth about every year and a half, but much less often does one take place in a location accessible enough and of a duration long enough to make it worth observing. No total eclipse can last much more than seven minutes, and most of them are much shorter, so that even with the best possible luck an astronomer can hardly hope to have as much as an hour of total time for observing eclipses in his entire life. No wonder, then, that the scientists joked a little hollowly about starting on April Fool's Day.

Flying southward, we gained a vivid impression of the far-flung, time-telescoping operations of the great Air Transport Command, and realized anew how today's air age has shrunk the globe. The big C-54s that carried various sections of our party could make the 6,500-mile trip from Washington to Rio de Janeiro in only three days!

Our course south followed the chain of great airbases built during World War II for the planes that flew by the thousands down to the territory of our loyal ally, Brazil, and

Eclipse Camp "Pioneers" Needed a Roof over Their Fire to Keep Off the Rain

Three soldier members of the expedition's advance party cook a meal outdoors under difficulties. Construction of the landing strip and main camp was begun during the rainy season under supervision of military personnel who arrived many weeks before the scientific group.

thence across the Atlantic to the African, Indian, and Chinese fronts.

While we were gazing down from above scattered clouds at the vast, swampy, jungle-clad delta of the mighty muddy Amazon far below, our navigator came aft to remind us that we would cross the Equator in a few minutes. The Polliwogs aboard, who never had crossed the Line before, began to fidget uneasily in their seats, while knowing grins appeared on the faces of the initiated old-timers.

Suddenly the pilot waggled his wings as a signal that we had crossed from the Northern Hemisphere into the Southern. In the excitement nobody happened to see Jupiter Rex come aboard, but there he was, complete with rope-yarn beard, crown, and flying jacket. (Jupiter initiates those who cross the Equator in the air, just as Neptune handles it on board ship.)

One by one the sheepish Polliwogs were herded back to the rear of the cabin, where they knelt before the Ruler of Winds and Weather to receive initiation into Jupiter's Empyrean Realm. Rising, they received a smart wallop on an appropriate portion of their anatomy, for flyers do not follow the shipboard ritual of ducking in a tank.

Over Rio's Famed Harbor

Late the next day we were circling for a landing over Rio de Janeiro's incomparably beautiful mountain-rimmed harbor.

Brazilian Army bugles from a fort on a near-by point, sounding shrilly through the pounding of the surf on world-renowned Copacabana Beach, woke us in our ocean-front hotel early next morning.

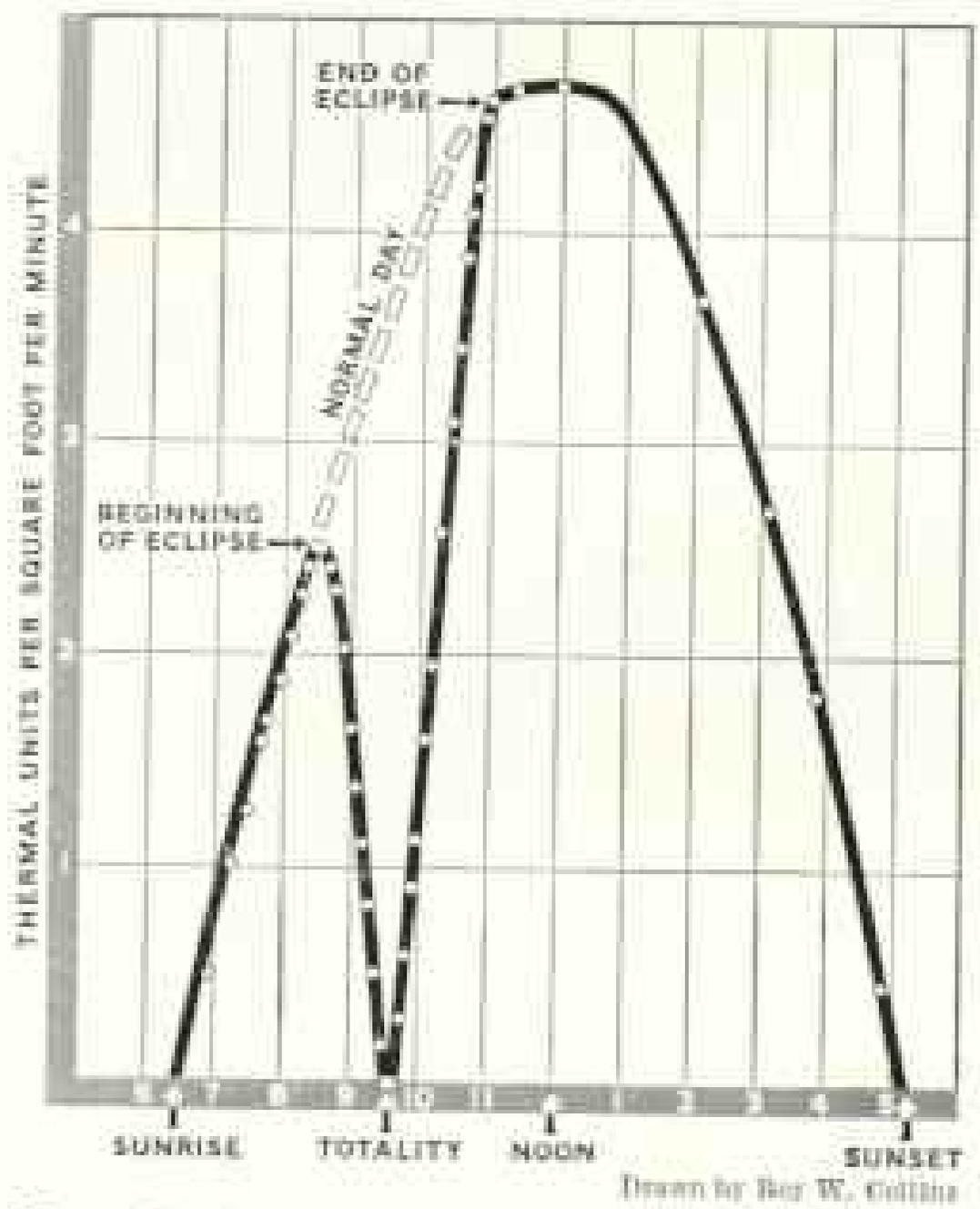
Soon we were flying again, this time in an AAF C-47 two-engined plane, over the lofty, rocky crags of the 7,000-foot mountain range that lies between Rio and Bocaiuva, 400 miles to the north.

Landing Strip, 3,750 Feet Long, Was Specially Built for Army Planes that Transported the Expedition to Bocaiuva

The mast carried antenna used in radio measurements of the ionosphere. Building housed airplane and vehicle repair shop, and kitchen (page 296).

"Camp Eclipse" Occupied a 12-acre Clearing in Scrub Forest on a Rolling Plateau in Brazil's Interior

Pyramidal Army tents served as living and working quarters (page 392). The building at left housed the mess hall and kitchen. Water tank on a tower is at extreme left. Eclipse observation area, with some instruments in place, is to right of center. Open grasslands mingle with the woods in the distance.



Drawn by Roy W. Collins

How Sun's Heat Dropped During Eclipse

The black line shows the heat starting from zero at 6:30 a.m., increasing until the eclipse began at 8:22, then falling off as the moon began to cover the sun, dropping to zero during totality from 9:34 to 9:38 a.m. It increases again as the moon moves off from the sun, reaches its high point at noon, and decreases to zero at sunset. Heat was measured by Dr. Lyman J. Briggs and AAF weather observers in British thermal units. One such unit is the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit.

Less than three hours later we had landed at the airfield specially built for the expedition's planes and were bouncing in jeeps over the 14 miles of country road out to camp, swallowing generous quantities of red, dry-season dust.

This road, originally a rough, narrow track through the bush, was widened and graded, and its primitive wooden bridges strengthened so that it could be negotiated by the Army trucks that transported our scientific instruments, equipment, and food supplies from the landing field to camp (page 291).

Your Society's Funds Build Base Camp

Incidentally, the entire cost of the airfield, improvement of the road, and construction of the camp, as well as the purchase of fresh food used in the mess, expenses of the scientists, and construction of their apparatus, was financed by research funds of your Society.

Bocaiuvans wondered why our camp was placed so far from town, out at "Extrema," as they called it. The reason was that it had to be located as near as possible to the center line of the path to be followed by the moon's shadow. Duration of the eclipse is longest at the center line, and our scientists wanted to make use of every possible second of the all-too-short period of totality.

A Cattle Rancher Aids Science

Use of the land was donated by its owner, Senhor João Antonio de Sigueira, a cattle rancher whose little adobe house sat beside a stream in a pleasant glade about a mile down the road. A friendly host, he visited us often, and the women of his family were kept busy doing our washing.

At the camp site, the advance party of Army personnel and Brazilian workers, starting weeks before in the mud and discomfort of the rainy season, had erected three dozen pyramidal tents in neat rows, and a semi-permanent building of adobe brick with a tile roof to serve as our mess hall and kitchen (Plate IV).

Under the efficient direction of Col. Paul C. Schauer, project officer of the AAF for the expedition, his able assistant, Maj. Jerome Alexander, and our hard-working camp commander, Capt. John M. Rice, the camp, run in standard Army style, became a little bit of home set down in the midst of this far-off patch of Brazil.

Almost everything, even to the heavy portable electric generators and our seven jeeps, had been flown to Bocaiuva by AAF transport planes, most of it all the way from the U. S. A. (page 287).

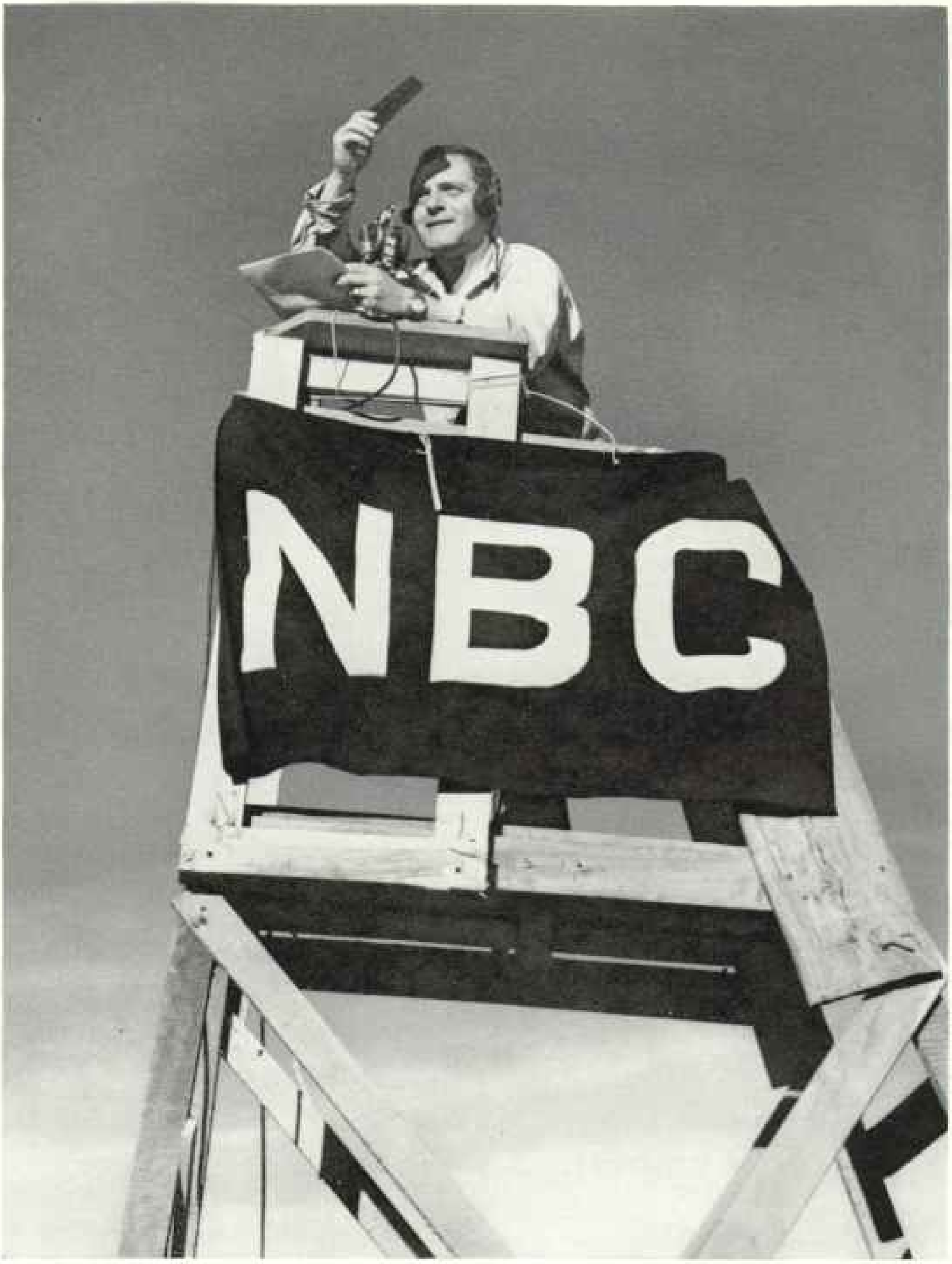
Only the big six-wheeled truck and three lighter trucks, or weapons carriers, had been driven under their own power from Rio as far as the condition of the roads permitted, then loaded on the narrow-gauge wood-burning railway that runs through Bocaiuva.

We had electric refrigerators for the kitchen, lent by the Brazilian Air Force, electric lights in the tents, mess hall, and camp "streets," and a public-address system that made it possible to page anyone in the broad camp area.

Field telephones linked the weather tent, radio tent, scientific laboratory tent, and headquarters of The Society's project officer, Melvin M. Payne, who was busy from dawn to bedtime with never-ending administrative details. The sheets on our Army cots were flown each week to Rio for washing, an 800-mile round trip to the laundry!

Under supervision of our doctor, Lt. R. V. Ramirez, water from a near-by stream was filtered and chlorinated (Plate XVI).

Just before sunrise each morning, at 6 a.m.,



Ben Grauer of NBC Describes the Eclipse "Play by Play" for American Listeners

From a platform overlooking the scientific instruments he views the gradual blackout of the sun through exposed film and sends an eyewitness account across 6,500 miles. Engineers installed special short-wave equipment by which the program was relayed to New York and broadcast on the NBC network. Four Brazilian radio networks also broadcast from the camp.

Adjusting Instruments to Measure Sun Brightness and Upper-air Temperature

Dr. E. O. Hulburt (left), of Naval Research Laboratory, calibrates an illuminometer with which he recorded the amount of light-energy emitted from various parts of the sun's surface at eclipse time. Ralph E. Richardson (right), his assistant, used a photometer to measure sky brightness during the eclipse, which indirectly gave information on the temperature of the air at very high altitudes (pages 299 and 310).

our leather-lunged veteran Army cook, Sgt. Bill Vaughan, banged on his iron gong and shouted in stentorian tones, "Let's go! Let's go! A h-a-p-p-y good morning to you all! C-o-m-e and g-e-t it!" (Plate XVI.)

Sleepy, tousled campers emerged protestingly from their warm blankets and lined up Army style in the mess hall for "chow." A typical breakfast was fresh grapefruit, pancakes and bacon, bread, jam, and coffee.

By 7 a.m. everyone was at work. From the scientists' "workshop" tent came the steady "beep, beep" of the Naval Observatory radio time signal from Washington, with which our chronometers were checked daily (page 406). At the same time could be heard the loud hiss of hydrogen gas being released from a steel cylinder to inflate one of the weather unit's radiosonde balloons, sent up four times a day around the clock.

As the balloon soared off into the blue, soon disappearing from sight, the little radio hanging beneath it sent back a continuous code message telling the temperature, pressure, humidity, and wind conditions far aloft.

Constantly in the background, day and night, was the unceasing hum of the electric generators, all-important heartbeat of the camp, supplying power for lights, radio, refrigerators, and scientific instruments.

As work went forward, the scene in camp reminded me of the arrival of the circus in town back home. Against the background of colorful flags and dark green tents, trucks chugged across the field, piled high with varicolored boxes and packing cases.

Gangs of swarthy Brazilian workers, directed by Army noncoms and scientists, unloaded the trucks, raised more tents, strung electric wires, hammered, sawed, and mixed concrete. Cumbersome native carts, with huge solid wooden wheels, drawn by six or eight patient, plodding oxen, hauled lumber and sand (Plates XII and XIII).

Adding to the circus atmosphere, Brazilian cowboys often rode into camp, sporting leather hats, colorfully dyed sheepskin saddle blankets, and huge spurs sometimes strapped on bare feet. Tame green parakeets squawked in their cages.

The final touch was furnished by our Brazilian visitors, who came almost every day to stare curiously at the unfamiliar sights, peer discreetly under tent flaps, and ask questions.

As the sun climbed higher, shirts came off and men worked stripped to the waist in the tropic heat. In the cosmic-ray tent the Geiger counters clicked steadily along, recording the passage of the invisible rays raining down

Drawn by Ben W. Collins

Eclipse Followed This Route Across Two Continents

Black line shows the path followed by the central cone of the moon's shadow from off the coast of Chile across to East Africa. Observers within this path, approximately 100 miles wide, saw a total eclipse. It was partial, with the moon partly covering the sun, over almost all of South America, the South Atlantic, and Africa. The shadow moved from west to east.

constantly from outer space. Every two hours, day and night, an alarm clock rang to remind Harvey Taylor, the observer, to read his meters.

Sound of the gong from the mess hall at 11:15 called the camp to midday dinner of meat, vegetables, bread, coffee or lemonade, and dessert of canned or fresh fruit, pudding, or homemade pie.

Snakes and Giant Ants

Men off duty played horseshoes and volleyball or explored the woods by way of the innumerable cattle and oxcart tracks that crisscrossed the region, hunting rock crystals or game. Every so often someone killed a snake near the edge of the clearing or stopped to watch the long processions of industrious giant ants excavating underground nests and carrying in bits of leaves for food.

By late afternoon a steady parade of towel-bearing figures was wending its way toward the outdoor showers.

Camp Eclipse had no hot water except in the kitchen, but everyone became hardened (more or less!) to shaving, bathing, and even washing clothes in cold water.

Soon after 5 the supper gong sounded and another hot meal of meat, vegetables, fruit, bread, and coffee was dispatched. Card players sat down around a mess table covered with a blanket. As the sun sank behind the western hills, the air almost at once became cool enough for tent flaps to be rolled down and sweaters put on.

At night the temperature often dropped to the middle 50's. People congregated in little groups to look at the stars and point out the

Ambassador Pawley and Brazilian General Coelho Were Among Eclipse Day Visitors

The United States envoy to Brazil (left) and the general headed a delegation of distinguished American and Brazilian guests who made the trip from Rio de Janeiro to witness the solar blackout. Much assistance was given to the expedition both by the Embassy and by Brazilian military authorities (Plate XI).

Southern Cross and other constellations of the Southern Hemisphere not visible in the northern skies.

"Now hear this," droned a voice over the public-address system. "The movie tonight will be . . ." That final touch of home was provided through courtesy of the War Department Motion Picture Service.

Soon after 9 o'clock most of us were in bed, but for some work went on through the night hours.

Out in the darkness of the scientific observation area a tiny electric motor hummed quietly, keeping a telescope pointed at the Milky Way shining brightly in a broad band across the sky overhead.

Father Francis J. Heyden, S. J., of Georgetown College Observatory, stood by patiently, now and then clicking a switch to keep his instrument focused accurately.

He was taking advantage of our presence in the Southern Hemisphere to make photographs with two-hour exposures of vast aggregations of stars in the Milky Way, at inconceivable distances from the earth. Halfway through the night he awoke his assistant, Father Laurence C. McHugh, S. J., to relieve him at his lonely task.

At an hour past midnight the soldiers on the night shift in the weather tent sent another balloon soaring aloft toward the stars to radio back its message on conditions high in the sky. Over a wood fire, in a big caldron, other weather men were busy boiling their synthetic rubber balloons to restore the "stretch" after long storage.

Long before dawn the cooks and their Brazilian helpers were busy in the kitchen mixing pancake batter and making gallons of coffee for another breakfast.

Food and Supplies Brought In by Plane

Not all of our people shared the comparative comfort of the big main camp. Two of the scientists, James Watts and Franklin Kral of the National Bureau of Standards, and half a dozen officers and soldiers, under command of Lt. Charles Webb, served as a small but essential outpost at the landing field near Bocaiuva to which all our food, mail, and supplies were transported by plane from Rio.

Their tents and the open shed which served as combination kitchen, mess hall, and repair shop for planes and motor vehicles, were baked by the tropic sun and swept by clouds of dust that blew off the field whenever a plane landed or took off. For a time they

Brazilian Scientists Calculate the Camp's Exact Location

Dr. Allyrio Hugueney de Mattos (right) and Senhor Lysandro Vianna Rodriguez, with two assistants, made observations of stars from which they computed the latitude and longitude of a concrete marker within a few feet of perfect accuracy. This was essential for precise observations of the moon's motion (page 299).

General Pinheiro, of the Brazilian Air Force, Pays a Friendly Visit to Camp

On an inspection tour the general (center) confers with a group including, left to right: the author; Capt. John M. Rice, camp commander; Maj. Everett J. Burlando of the AAF, and Melvin M. Payne, Assistant Secretary of the National Geographic Society and the expedition's project officer.

Roasted Hot Dogs Still "Hit the Spot" 6,500 Miles from Home

Scientists, soldiers, radiomen, and press correspondents at the expedition camp join in an evening of relaxation around a fire. Movies supplied by the War Department, volleyball, and horseshoe pitching also provided recreation in the campers' spare time.

had to drive two miles by jeep to take chilly shower baths under a small waterfall!

Watts and Kral manned the radio apparatus used for observing behavior of the ionosphere before and during the eclipse. They had to be well removed from the main camp so that their signals would not interfere with the radio we used for communicating with Rio and receiving Naval Observatory time signals (pages 288 and 310).

One never-ending task at the landing strip was fighting the ants which built subterranean nests. These nests, undermining the field, were capable of causing an accident if an airplane wheel should break through. Whenever a new ant nest was discovered, Brazilian workmen injected cyanide gas into the hole.

Photographing the Milky Way

As the weeks passed, some of our scientists carried out projects not connected with the eclipse.

One was Father Heyden's program of photographing the Milky Way, the great wheel-shaped galaxy of stars within which our sun and earth are located, about four-fifths of the way out from the center of the "wheel." Looking up at the Milky Way, we see a dense

mass of stars because we are looking out through the thickness of the wheel from the inside toward the rim.

Years ago Dr. Frank E. Ross, now of Mount Wilson Observatory, made a series of fine photographs of the northern Milky Way which constitute a standard atlas of reference.

Father Heyden borrowed his camera and photographed the southern part of the Milky Way, not visible from the Northern Hemisphere, on the same scale.

His photographs, added to those taken by Ross, will give a continuous picture of how this great star wheel looks from within, so to speak, looking outward all the way around from the inside.

Balloon "Trains" Measure Cosmic Rays

Cosmic rays, raining down into the earth's atmosphere from outer space, were measured on the ground, and at altitudes up to 50,000 feet by Geiger counters carried aloft by "trains" of eight balloons launched from camp and on an AAF B-29 and B-17 (p. 315).

The balloon trains, sent up by Martin Pomerantz and Peter Morris, were equipped to radio back to earth the number and intensity of cosmic rays, which increase with altitude. At 50,000 feet the total number of cosmic rays was 50 times that at sea level, and the intensity of the more penetrating rays was 10 times greater than on the ground.

All this was part of the great cosmic-ray measuring project being carried out under joint auspices of your Society, the Bartol Research Foundation of the Franklin Institute, and the Army Air Forces.

Weather information was collected continuously for more than two months by Maj. William E. Walk and his 18 enlisted specialists of the AAF Air Weather Service. They measured temperature, pressure, humidity, and the speed and direction of the wind from the ground up to altitudes as high as 69,000 feet.

Their job was not to forecast the weather, but to gather data to be used by some of the expedition's scientists in calculating results of eclipse observations (page 311).

Their weather facts also will be added to the collection of world-wide weather information which is constantly being gathered by the Army Air Forces and filed for use by commercial air lines and others interested.

Measurements of the light from all parts of the sky at various times of day were made by Dr. E. O. Hulburt and Ralph E. Richardson of the Naval Research Laboratory.

This information will be utilized in development of an instrument which airplane navigators may use for seeing stars in the daytime at altitudes of 10,000 feet and above as an aid to navigation. Brightness and polarization of the sky's light determine what stars can be seen in the daytime at various altitudes (pages 294 and 310).

As eclipse day drew nearer, preparations were intensified. One essential task was establishing the exact location of our little clearing on the vast curving surface of the earth, for the observations to time the motion of the moon would be worthless unless the precise point from which they were made was known. This job was done for us by genial Dr. Allyrio Hugueney de Mattos and three of his assistants from the National Council of Geography of Brazil.

Bringing with them from Rio a complicated array of precision instruments, they calculated the latitude and longitude of a concrete monument in our camp within less than 20 feet of perfect accuracy, no small accomplishment on a globe nearly 25,000 miles in circumference! That monument, incidentally, will become a permanent landmark in Brazil's national survey system (page 297).

Other Brazilian friends, too, came to visit us in increasing numbers—civil and military officials, newspaper reporters and photographers, groups of scientists, engineering students, even school children with their teachers—all made the trip out to camp over the miles of rough, dusty road (Plate XI). One Sunday afternoon the Bocaiuva Boy Scout troop arrived in full uniform with its drum corps and staged a snappy drill.

All Brazil displayed a genuine, friendly interest in our expedition. Military and civil officials alike smoothed the way for us, lent us road-building machinery, tents, water pipe, water-tank trailers, and many other things.

A Brazilian engineer had charge of building our airport and improving our road. Brazilian Air Force planes helped fly our equipment from Rio to Bocaiuva. Many of us were hospitably entertained by friends both in Bocaiuva and in the progressive city of Montes Claros, near by.

Why Observe an Eclipse?

Why is it important, people ask, to travel so far and spend so much time, effort, and money to observe only a few fleeting moments of an eclipse of the sun? What can you learn, and what good comes of it?

Scientists can do a surprising number of things during the short space of an eclipse of the sun. They can time very accurately the motion of the moon through the sky. They can measure how much a ray of light from a distant star is bent as it passes the sun,

which is a way of checking the Einstein theory of relativity. They can get a quick look, indirectly, at the hot gases seething in the outer layers of the sun and make records which will tell something about what those gases are and how they are behaving under conditions of temperature and pressure impossible to duplicate on earth.

Such data furnish clues not only to what is happening on the sun itself but help explain the structure and behavior of other more distant stars. The sun is the only star near enough to us to appear as a disk, on which different parts of the surface can be studied.

At an eclipse, too, it is possible to gather facts about the huge, nebulous, gaseous corona of the sun, extending far out into space around the sun proper and visible in its entirety only at eclipse time (Plate I).

Something also can be learned about how the upper levels of the earth's own atmosphere are affected by the sun's rays, by noting what happens in the atmosphere when those rays are cut off during an eclipse.

What good is it all? In the first place, man is always trying to push the frontiers of his knowledge farther out into the unknown. Moreover, it seems only common sense to try to learn everything possible about the sun, since in the long run it is the most important thing in our lives. Out of its white-hot inferno, very probably, our earth was born.

As the sun speeds on through the vast reaches of space, we are inexorably dragged with it on the end of an invisible but unbreakable chain of gravitation. Without its light and heat no life on earth could exist.

Ways the Sun Affects the Earth

Coming closer to home, the sun's rays produce effects on the earth every day that are of vital importance in our daily lives. The sun is the motive power of our weather. Its rays, raining down into the upper levels of our atmosphere, create the reflecting layers of the ionosphere, 60 to 250 miles up, which reflect radio waves and make long-distance radio communication possible.

Those rays also create winds, little-understood conditions of temperature, and layers of ozone and other gases in the upper atmosphere which we need to know about in this age when stratosphere planes, high-flying rockets, and guided missiles are penetrating into a brand-new world at ever greater altitudes.*

This last, incidentally, plus the desire to support the advance of science in general, was one of the important reasons why General Spaatz was interested in having the Army Air Forces take part in our expedition.

The Practicality of Relativity

Out on the advancing frontiers of modern science, Einstein's famous theory of relativity plays an important role. It takes a mathematician to understand fully relativity's strange ideas that space can be curved, that things can have a fourth dimension, which is time, and that energy and mass (roughly described as weight) are the same thing. But even relativity has its "practical" side.

It has helped explain the structure and behavior of the atom, and thereby is playing an indirect part in the development of atomic energy, both for peace and for war.

One of our expedition's most important projects was to make a check on relativity. You don't need to understand Einstein to grasp the drama and amazing precision of that experiment.

Einstein years ago predicted that one of the tests of his theory of relativity would be that the rays of light from distant stars would be bent slightly as they passed near the sun. He said that this bending would be equivalent to a very small angle, a tiny fraction of one degree of a circle, one and three-quarters seconds of arc. That is the angle made by two straight lines a mile long, touching at one end and only about half an inch apart at the other!

The bending of starlight is caused by the gravitational attraction of the sun, pulling the light rays slightly away from a straight path as they go past, as though they had actual weight.

Dr. George Van Biesbroeck of Yerkes Observatory set out to measure that bending. He did it by making two photographs of the same group of stars, one during the eclipse, and another which he is scheduled to make as this story goes to press, for he returned in August to our camp site where his telescope was left in position. In August that group of stars that surrounded the sun during the eclipse could be seen and photographed in the night sky at the same position in which they were located on eclipse day.

On the photograph made during the eclipse, the stars appear around the edge of the sun, but because their light was bent in passing by it on the way to the earth, their images on the photograph are slightly displaced away from where the stars actually are located in the sky.

On the second photograph, taken at night when the sun is not there, the light rays from

* See "New Frontier in the Sky," by F. Barrows Colton, National Geographic Magazine, September, 1946.

Aero Kodachrome by Brian C. Gardner and Lee W. Reidt

Full Glory of the Corona Bursts into View as the Moon's Disk Covers the Sun

The corona, a glowing mass of gas surrounding the sun, becomes visible when the sun's light is cut off during the total eclipse of May 20, 1947, observed by the Army Air Forces-National Geographic Society Expedition.

Aero Keshanlist by U. S. Army Air Forces

Huge Red Hydrogen Flares on the Eclipsed Sun Extend Out Beyond the Moon's Rim

Though the moon's black disk covers the sun proper, the flamelike "prominences," rising thousands of miles above the sun's surface, are still visible. This short-exposure photograph shows less of the corona than Plate I.

Edge of the Advancing Moon Seems to Bite into the Sun. Note Group of Sunspots
Pictures on this and the opposite page were taken from an Army Air Forces B-17 flying at 30,000 feet.

Aero Kodachrome by U. S. Army Air Forces

At the Instant Totality Ends, the "Diamond Ring" Effect Appears
It is the brilliant spot of light on the upper left rim of the moon's black disk, produced by sunlight shining between mountains on the moon. This phenomenon is seen just at the beginning and end of totality.

IV

Flags of Brazil, the United States, and Your Society Fly Before the Expedition's Brick-and-tile Mess Hall

Photograph by Willard R. Culver

Wearing Oxygen Masks and Heated Suits, This Army Air Forces Crew Photographed the Eclipse from 30,000 Feet

VI

Photograph by Richard H. Stewart and Guy W. Starling

With Muzzles Aimed Aloft Like Heavy Guns, the Expedition's Instruments Stand Ready to "Shoot" the Eclipse

From left to right the instruments are: telescope for checking the Einstein theory of relativity (painted white and protected by a canvas windscreen—Plate VIII); large camera to photograph the sun's corona; two small corona cameras (behind men near stepladder); two spectrographs for studying the sun's outer layers; telescope for investigating the motion of the moon; piers for movie cameras that recorded the entire eclipse. All apparatus was mounted on concrete bases.

Spectrograph Breaks Up Sunlight into Rainbowlike Spectrum

Dr. C. C. Kiess used the instrument to study gases on the sun's surface.

Foreign-language Markings Show This Camera's Wide Travels

Dr. J. C. Gardner used it in Russia, Canton Island, and twice in Brazil.

Kodachrome by Richard H. Stewart and Gus W. Starling

This Big Telescope Made Pictures to Help Check Einstein's Theory of Relativity

Dr. George Van Biesbroeck (with beard) used the 20-foot instrument to photograph certain stars during the eclipse to measure bending of their light as it passed near the sun. If the amount of bending proves to be what Einstein predicted, it will be new evidence in favor of the theory of relativity. Though relativity plays no part in everyday life, it is important in knowledge of the atom and the universe. Dr. Harold F. Weaver, right.

the stars will not be bent, and the stars will appear in their true positions.

Measuring the difference in the stars' positions on the two photographs, Dr. Van Biesbroeck can determine how much their light was bent in passing the sun and see if it was as much as Einstein predicted. If the angle comes out as Einstein said, it will be new evidence that the theory of relativity is correct.

Dr. Van Biesbroeck had to make his first photograph during the eclipse because only then, when the sun's light was blotted out, was it possible to catch on his photographic plate the faint images of stars that are drowned out by the sun's brilliant light at all other times (Plate VIII).

Earth's Atmosphere Bends Starlight, Too

Others have measured this bending of starlight at previous eclipses, but their results varied. One difficulty was that the starlight was bent not only in passing the sun but also by refraction as it passed through the earth's atmosphere. To allow for the bending caused by the atmosphere, you need to know the temperature, pressure, and humidity of the air, since they govern the refraction.

During the eclipse the AAF weather men sent up balloon-borne radiosondes that radioed back the temperature, pressure, and humidity of the air up to 50,000 feet, and Dr. Briggs measured temperature near the ground (page 292). These data will help Dr. Van Biesbroeck to calculate more accurately how much bending of the starlight was caused by the atmosphere and how much by the sun.

As a further aid to accuracy, he photographed on his two plates not only the stars he will measure for the bending of their light but also another group of stars off to one side in the sky, reflected into the telescope tube by a mirror.

Since the light from these stars did not pass near the sun, it was not bent; so this "check group" of stars will be in the same position on both pictures, providing an unvarying standard of reference in case temperature or other changes in the telescope cause a slight variation of scale in the two pictures taken three months apart.

Results of Dr. Van Biesbroeck's work will be awaited with the greatest interest by scientists all over the world.

More on the practical side were the measurements of the motion of the moon, made by Fathers Heyden and McHugh of Georgetown. They measured precisely the times of the four "contacts" during the eclipse.

Those are the times when the edges of the sun and moon appear to touch—first, just at the moment when the moon begins to move in front of the sun; second, the instant when it has completely covered the sun; third, when the sun begins to reappear from behind it; and fourth, just as the moon and sun part company at the end.

Checking Schedule of the Solar System

Timing those contacts is a method of checking up on the solar system to see if it is running on schedule. It shows whether the astronomers who forecast the eclipse made a correct calculation of when it would begin and end. It also applies to predictions of future eclipses, and is useful in calculating backward to learn the dates of eclipses in the past, knowledge which sometimes helps in fixing the dates of historical events. It furnishes another check also on the complicated motion of the moon around the earth.

This enters into the accurate prediction of the times of high and low tides, information essential to mariners. Incidentally, the motion of the moon is changing; for it is gradually picking up speed as it moves around the earth.

To time the contacts, Heyden and McHugh made a series of photographs which show the moon gradually covering and uncovering the sun. On these pictures, by careful measurements, they can determine the times of contact more accurately than if they had tried to catch the actual moments when the edges of the sun and moon seemed to touch.

Looking into the outer layers of the fiery furnace of the sun itself was the job of our spectrograph operators, Dr. C. C. Kiess of the National Bureau of Standards (Plate VII) and Dr. Harold F. Weaver of Lick Observatory.

For countless millions of years, atoms of hydrogen in the sun have been combining to form atoms of helium. In the process a small amount of matter is left over and is converted into the energy which keeps the sun shining with its terrific heat.

Each chemical element in the sun and stars, when excited by heat, sends out light waves vibrating on certain frequencies, different frequencies for each element. With the spectrograph it is possible to split the sun's light into a rainbowlike spectrum, an arrangement of lines in which each element can be identified by its own lines which represent its special frequencies.

The spectrum lines of each element furnish as characteristic and certain an identification as the fingerprints of a human being.

By studying the spectrum it is possible to tell what chemicals are present in the sun's

outer layers, and the intensity of the lines indicates the temperature, pressure, and density of these layers.

Ordinarily, you cannot get a good spectrum of the individual outer layers of the sun because the light from the various layers is mixed together. But at the time of an eclipse, just before the moon covers the edge of the sun, each layer appears by itself for a brief moment along the edge of the moon, and its spectrum can be photographed with no light from the other layers mingled with it.

Mysteries of the Corona

Out around the sun extends the vast halo of the corona, a thin, nebulous cloud of gas whose origin still is not fully understood (Plate I).

One of the mysteries of the corona is that it contains atoms of iron, argon, nickel, and calcium that are highly ionized—that is, many of their electrons have been stripped off, a process requiring tremendous energy.

Some astronomers believe this atom stripping takes place in the corona; others that the atoms are ionized deep within the interior of the sun by the great heat prevailing there, and then ejected into the corona through openings in the sun's surface. Study of the spectra of the corona, photographed during the eclipse, would help solve this problem.

Unfortunately the spectrographs, which had worked well during rehearsals before eclipse day, failed to function properly at the crucial time, so that the full program of observation could not be carried out.

Some answers to the secrets of the sun's corona were captured, however, by the big cameras of Dr. Irvine C. Gardner, a veteran eclipse observer (Plate VII), and his assistant, Mr. Leo W. Scott, both of the National Bureau of Standards. Using special filters and color film, they made photographs of the corona to determine the intensity and color of its light, the extent of its long streamers, and how its light was polarized. (Light that is polarized vibrates in only one plane.)

The amount of polarization of the corona's light will help indicate how much of it, if any, is sunlight reflected by solid particles.

Pictures of the corona also were taken by Father Heyden. They show streamers extending out to distances equal to two or three diameters of the sun.

Other members of the expedition probed into the upper atmosphere many miles above the earth to investigate what happened there when the sun's light was cut off during the eclipse. They used two kinds of probing tools, sensitive photometers to record intensity of light from the upper atmosphere and high-frequency radio waves.

Dr. Hulburt and Ralph Richardson measured the temperature of the air at great altitudes, up to perhaps 40 or 50 miles, beyond where it is possible to measure it by any other means until rockets are perfected.

As the moon's slanting shadow gradually moved over the camp, they could look up through it to the lofty heights above where molecules of the rarefied air were still sunlit.

Measuring with great precision the light reflected back to earth from these molecules, it was possible to estimate how many molecules there were in the region beyond the shadow on out to the top of the atmosphere. From this can be calculated the temperature and pressure at these lofty altitudes.

Builders of high-flying airplanes, guided missiles, and rockets will use this information in designing their craft to operate efficiently in the cold, rarefied air at great heights.

Dr. Hulburt also measured the diminishing brightness of the sun as it was gradually covered by the moon, which will help reveal the amount of light-energy emitted from various layers of the sun's outer surface (p. 294).

From the ionosphere measuring station, James Watts and Franklin Kral bounced radio waves off the radio-reflecting region in the upper air, seeking to learn what happened there during the eclipse. The three main layers of this region lie at heights of approximately 60 to 100, 100 to 150, and 150 to 250 miles. Long-distance radio signals travel around the earth in great bounces between this region and the earth (page 288).

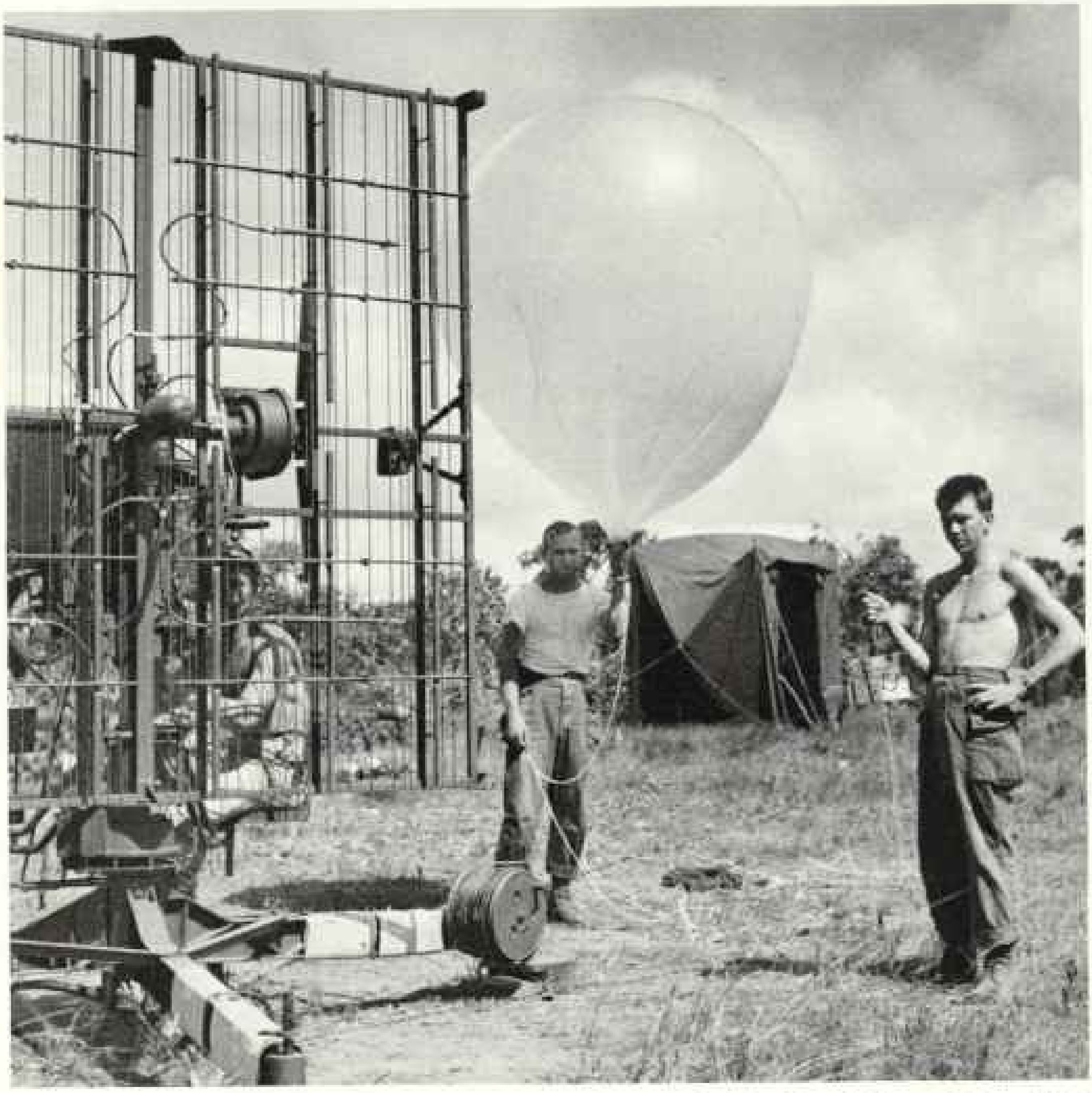
The ionosphere is created by ultraviolet light from the sun which breaks up molecules of the upper air and makes them electrically conducting. (Scientists call this process ionization; hence the word "ionosphere.")

Effects on Radio Signals

The radio signals echoing back from the ionosphere indicated that, as might be expected, when the sun's light was cut off during the eclipse the layers decreased in ionization somewhat as they do at night, but the effect on the individual layers was different from what it is at night.

The echoes were recorded on movie film both before the eclipse, to indicate normal conditions, and during the eclipse itself. When the film is run through a projector it shows images of the layers fluctuating up and down and varying in density. At the time of the eclipse, the movies show the layers changing in height, thickness, and density.

After totality the ionization increased again,



With a Balloon-borne Radio, They Measure Winds and Weather Ten Miles or More Aloft

Army Air Forces weather men prepare to send up a rawinsonde outfit, which automatically sends back signals as it rises, telling the temperature, atmospheric pressure, and humidity at increasing altitudes. The balloon, inflated with hydrogen gas, carries beneath it the small radio transmitter held by the soldier at right. The antenna at left, resembling a radar set, "tracks" the balloon and picks up signals indicating wind direction and velocity (page 299).

but in a different way from that at sunrise.

Study of the pictures will help determine whether some of the ultraviolet light that creates the ionosphere layers comes from the sun's corona rather than from the sun itself. It also will furnish a better idea of processes that take place in the ionosphere region, giving a better understanding of its behavior both at night and in the daytime. All this information eventually will be useful in improving long-distance radio communications.

Several Brazilian scientists joined us at camp to make eclipse observations. Dr. Mario de Souza, representing the Brazilian Geographic Society, measured the apparent altitude of the sun during the eclipse, which will supply further useful information on the refraction of the atmosphere for Dr. Van Biesbroeck's measurements of starlight bending.*

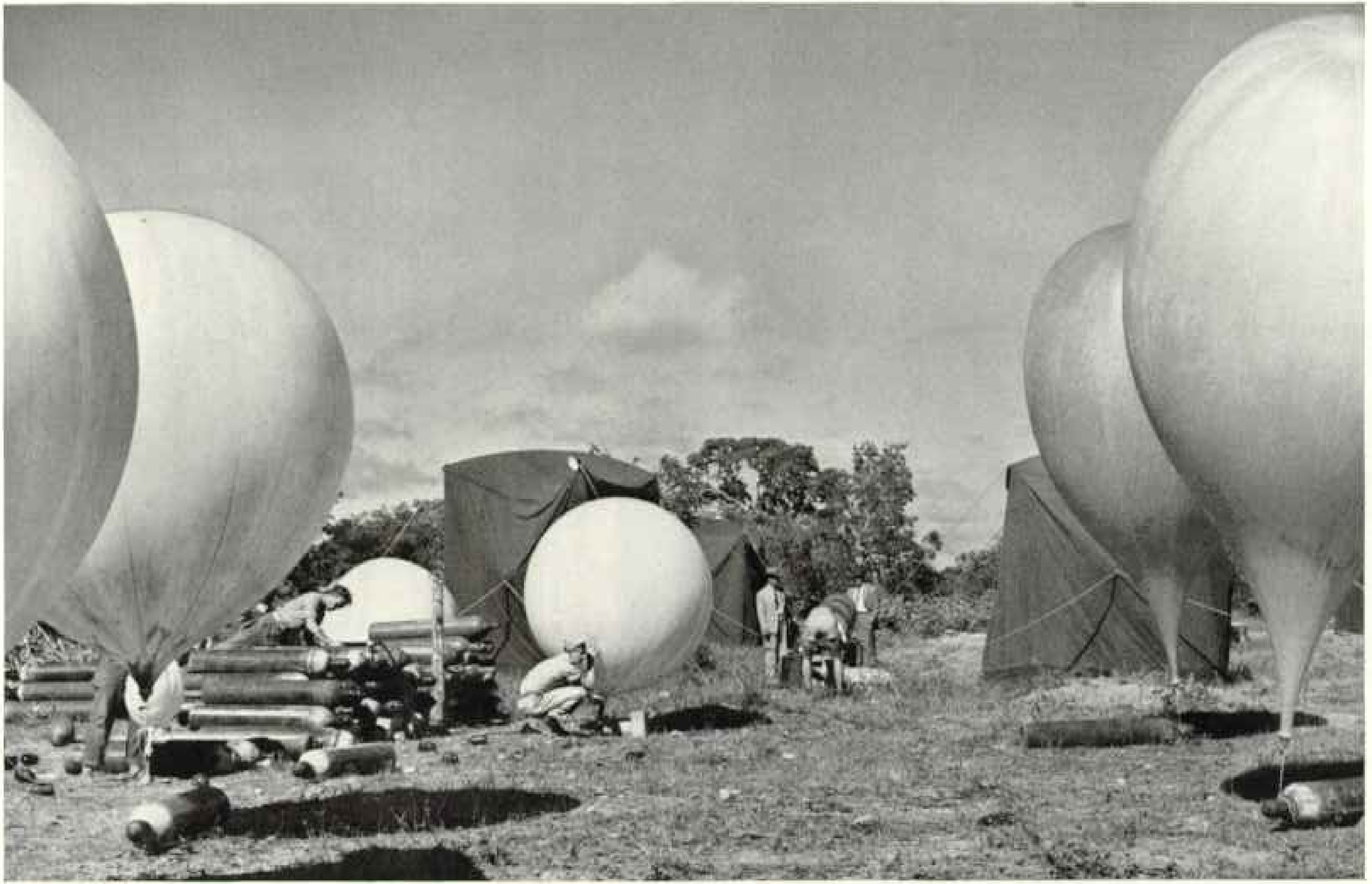
* The Brazilian party also included Dr. Allyrio de Mattos, of the National Council of Geography; Dr. Gleb Wataghin, of the University of São Paulo; Dr. Bernard Gross, Dr. Joaquim Costa Ribeiro, and Father F. X. Roser, S. J., representing the National Observatory, Rio de Janeiro; Capt. Cierson de Macedo Soares, Lt. Comdr. Jose de Figueiredo Lima, and Lt. Comdr. Alvaro Alberto da Motta e Silva, of the Brazilian Navy; Dr. Apicio de Macedo, of the Meteorological Survey; and several assistants.

Lens of a Giant Eclipse Camera Gets a Final Cleaning

Perched on the huge tube of the instrument, Leo W. Scott wipes away all traces of dust and dirt in preparation for photographing the sun's corona (Plate I). The lid that protects the lens is open. The electric cable at the left operates the shutter.

Expedition's Military and Scientific Leaders Compare Notes

Col. Paul C. Schauer, Army Air Forces project officer, stationed in Brazil, and Dr. Lyman J. Briggs, chairman of the National Geographic Society's Research Committee, discuss plans for observing the eclipse. They stand beside one of the AAF's transport planes.



Big Balloons, to Be Hitched Together in Tandem, Are Inflated to Carry Cosmic-ray Measuring Apparatus Aloft

Hydrogen gas for inflation comes from steel cylinders at left. "Trains" of eight balloons were sent up to about 50,000 feet with 35 pounds of Geiger counters and other instruments, which registered changes in the number and intensity of cosmic rays with altitude and radioed the data back to the ground (page 299).

U. S. Army Air Forces, Official

Eclipse Flight of the B-17 Is Charted on Your Society's Map of South America

Maj. Delbert M. Clark, the pilot, briefs his crew of nine before the flight of the *Heavenly Body* to photograph the eclipse from an altitude of more than 30,000 feet (Plates II, III, and V). Col. George W. Hansen, lower right, was in charge of the project. The crew included both military and civilian photographic specialists from the AAF research center at Wright Field, Ohio.

Others made observations of the ionosphere, cosmic rays, and the influence of the eclipse on the ion content of the air and its electrostatic condition.

On the day before the eclipse, some of us, wondering what tomorrow's weather would be, began to feel pretty nervous. But Dr. Van Biesbroeck, whose entire success depended upon making one single, crucial photograph, was cool as a cucumber. Just before supper I found him in the washroom, calmly doing some laundry, as if tomorrow were just another day!

"Are you an optimist?" I asked.

"No," he replied, with a twinkle in his eye. "On eclipses, I'm a fatalist!"

Eclipse day dawned bright and clear, but soon narrow, thin waves of high cirrus clouds, composed of myriad tiny particles of ice, began to move across the sky from the west, with wide spaces of clear sky between. Would the clouds dissipate before eclipse time? If not, would the eclipse come in one of those open spaces between the waves of cloud?

That was the question in everyone's mind as we gulped an early breakfast and hurried to make last-minute preparations. A number of distinguished visitors were in camp to see the show, including the U. S. Ambassador to Brazil, Hon. William D. Pawley, Brig. Gen. Gordon P. Saville, Brig. Gen. Francis L. Ankenbrandt, official observer from AAF headquarters, and many high Brazilian military and civil officials (page 296).

Spectators began to drift in. Ben Grauer of NBC and the announcers of four Brazilian radio stations began their preliminary broadcasts. Two airplane loads of Brazilian and American newspapermen arrived from Rio, having left there at 3 a.m. to reach the camp in time.

Meanwhile, at 3:30 o'clock that morning,

U. S. Army Air Forces, Official

AAF Cameramen Breathe Oxygen as They Photograph the Eclipse at 30,000 Feet

Lying on air mattresses and wearing oxygen masks and heated flying suits, two of the crew of the Army Air Forces special photographic plane, a B-17, take pictures with aerial cameras equipped with telephoto lenses. Ten cameras were used to record various phases of the eclipse. The plane cruised within the moon's shadow nearly six miles above the expedition camp site.

the AAF's photographic crew, in the *Heavenly Body*, a B-17 equipped with 10 still and movie cameras, took off to photograph the eclipse from high altitudes (Plate V). They flew above 30,000 feet for six hours, breathing oxygen during the entire time as they cruised back and forth within the moon's shadow, taking eclipse pictures (Plates II and III).

First Contact!

Everyone was at his station. It was 8 o'clock now, and first contact, when the moon would begin to move down across the sun, was due in 20 minutes. The loud-speaker system was already broadcasting the amplified ticks of a chronometer, counting off the seconds as a guide to the scientists in their precisely timed operations. Then the timer's voice broke in—"Ten minutes to first contact . . . five minutes . . . two minutes . . . one minute . . . *first contact!*"

Exactly on schedule, as if it had been waiting for the cue, the round edge of the moon began to bite into the upper edge of the sun. A murmur went up from the crowd.

At the same instant, Father Heyden's team sprang into action like a well-drilled gun crew (Plate X). He and Father McHugh, assisted by Lts. Edgar Smith and John Kramer of the AAF, were to photograph the eclipse every 15 seconds from then until the end.

Dick Stewart and Roy Phelps started their movie cameras (Plate IX). Stewart was making a documentary film on the entire expedition. Phelps's movies were to be flown back to the United States for showing over the NBC television network.

The loud-speaker continued to sound its second-ticks, with the timer's voice calling off five-minute intervals. Through my piece of exposed photographic film I could see the moon moving gradually down over the sun.

Father Heyden's crew was working feverishly. Every so often he would dash back with an exposed plate to the darkroom in the tent behind and rush fresh plates out.

Darkness and Chill Creep over Earth

"Nine twenty-five," said the voice. "Nine thirty. Five minutes to go." Now, within a few minutes of totality, it was growing noticeably darker. The sun was almost covered. A perceptible chill crept into the air. Some people pulled on coats (page 292).

Dr. Van Biesbroeck wound up his driving clock. Under his direction, Oliver Westfall adjusted the "Einstein" telescope until the guide star came into view in the small telescope on one side.

"One minute to go," said the loud-speaker. "Ten . . . twenty . . . thirty . . ."

It was much darker now. Hardly a sliver of the sun was left along the black advancing edge of the moon.

The "Diamond Ring" of Totality

"Zero!" That was the signal for totality. At that instant a ring of bright light burst out all around the edge of the black disk of the moon, and on its lower edge a blindingly brilliant point of light shone forth, a bit of the sun still shining through between two mountains on the edge of the moon. It was the beautiful "diamond ring" effect (Plate III). Alongside the brilliant point of light, others less bright, the Baily's beads, also shone for an instant between other lunar mountains.

Then the sun was completely covered, and around the black moon shone out the great halo of the corona, with faint streamers extending out in all directions (Plate I). Here and there along the moon's edge could be seen red spots of light, prominences on the sun, great flamelike eruptions of hot hydrogen gas rising beyond the edge of the moon's obscuring rim (Plate II).

"Ready, go!" called Dr. Van Biesbroeck.

An assistant lifted the shutter off the end of his telescope tube.

"Ten . . . twenty . . . thirty," said the voice, counting off the precious seconds of totality. Dr. Kiess and Dr. Weaver were bending over, peering through their guiding eyepieces, keeping their spectrographs focused on the sun. One of the weather balloons soared off. Soldiers held another ready to go.

Above, as the moon's shadow passed over, the sky was dark, and below the sun Mercury was shining brightly, with Venus and Mars a little above. A few bright stars could be seen. The darkness was not the darkness of night but more like that of a semi-twilight, and around the horizon there was a ring of light where the sun was shining outside the limits of the moon's shadow (page 286).

A hush fell over the spectators. We strained our eyes to see whether one of the waves of cirrus cloud was in front of the sun during this crucial period of totality. Some clouds were there, but so thin that they were no hindrance to most of the observations. Inexorably the count of time went on. Already we were in the second of the four short minutes. "Twenty . . . thirty . . . forty . . . middle." Totality was half over.

Eclipse Drama Reported by Radio

On a high platform overlooking the scene, Ben Grauer, NBC's special-events announcer, was describing the spectacle in dramatic and thrilling words for early-morning listeners back home (page 293).

"Ten . . . twenty . . . thirty," said the voice, counting off the fourth minute. "Ten seconds to go! End of totality!" On the instant the beautiful Baily's beads and diamond ring again flashed out, this time at the upper edge of the sun. Then a crescent of light appeared, gradually widening as the moon moved on downward.

In a few minutes the darkness had disappeared, and the returning heat of the uncovered sun drove off the chill.

Newspapermen crowded around with swiftly written news bulletins, and I rushed them to the radio tent. They told the world that our observations had been successful.

Then everyone relaxed—all but Father Heyden and his team. They labored on for 80 minutes more until fourth contact and the end of the eclipse, still timing their actions to the continuing count of the loud-speaker.

Between 8:22 a.m. and 11:00 a.m. they took 600 pictures, one every 15 seconds for more than two and one-half hours. When the nerve-wracking job was done they dropped exhausted on their cots.

Everyone was congratulating Dr. Briggs, Dr. Kiess, and those who concurred with them in choosing this part of Brazil for the observations. Their judgment in locating the site well away from the cloudy weather of the coast had been fully vindicated.

Two weeks later only two Army sergeants, James Kerns and George Williams, were left in the bare deserted clearing. They had volunteered to stay and guard Dr. Van Biesbroeck's telescope until his return in August. Only when they finally leave will our 1947 eclipse expedition really come to an end.

His Camera Photographs the Eclipse Reflected in a Mirror that Follows the Sun

In this way Staff Photographer R. H. Stewart obtained clear, steady motion pictures. Note sky reflection in mirror.

Photographs by Richard H. Stewart and Gee W. Sterling

Protecting Their Eyes from the Glare, Brazilian Visitors Watch the Eclipse

Before and after totality, when the sun is only partially covered by the moon, its light is still so bright that it cannot be observed safely except through smoked glass or pieces of exposed photographic film. Many citizens of Bacaiuva and the surrounding country visited the expedition camp on eclipse day. The fence separated spectators from the scientists' observation area. Keen interest in the eclipse was shown throughout Brazil.

Photograph by Richard H. Stewart and Guy W. Starling

They Photographed the Eclipse Every 15 Seconds for Over Two and a Half Hours

Father Francis J. Heyden, S. J. (with cap), of Georgetown College Observatory, and his three assistants made 600 pictures for checking the motion of the moon from the beginning to the end of the eclipse.

Part of the Usual Sunday Crowd of Visitors Hears the Expedition Explained

Photographs by Richard H. Stewart and Guy W. Starling

Dr. Carl C. Kiess Describes the Instruments to Visiting Brazilian Officers

Several delegations of military and civilian officials inspected the eclipse camp. The Brazilian Air Force and various civil agencies lent essential equipment and gave valuable assistance to the expedition in many ways.

Brazilian Workmen String Wires and Erect the Photographic Darkroom. Local Labor Built Most of the Camp

Elsewhere by Richard H. Stewart and Guy W. Starling

Kodachrome by W. Robert Moore

Slow-moving Oxcarts Haul Building Materials for the Expedition Camp Through Scrub Forest Typical of the Region

Tondaphoto by W. Robert Moore

Gay with Colorful Flowers and Shrubs, Bocaiuva's Main Square Bustles with Activity on Weekly Market Day

Brazilian Shoppers Buy Meat, Chickens, and Produce Brought In by Oxcart, Pack Train, and on Foot

Sample of Camp Drinking Water Gets a Chemical Test from the Doctor (Center)

Tablet added to water in the vial indicates by a color change if enough chlorine has been added.

 Kodachromes by Richard H. Stewart and Gus W. Starling

Sgt. Bill Vaughan, Camp Cook, Plays with His Tame Green Parakeets

Many soldiers of the expedition made pets of the birds. In the woods around the camp there were also monkeys, owls, hawks, deer, foxes, and snakes. The sign "Take All U Want" hung inside the mess hall.

Exploring America's Great Sand Barrier Reef

By Capt. Eugene R. Guild, USA, Ret.

With Illustrations by the Author and Staff Photographer John E. Fletcher

FOR some 200 miles southward from the mouth of Chesapeake Bay, North America's great barrier reef of sand extends into the Atlantic. It angles seaward from Cape Henry until at Hatteras it is nearly 30 miles offshore. It varies from a narrow bank periodically covered by storm tides and cut by vagrant inlets to stretches three miles wide.

There, sheltered by the barrier dune, grow deep and quiet woods festooned with Spanish moss and graced with palms.

As a seeker of unbeaten trails, I drove along this salt sand shore toward a strange and mirage-distorted horizon for more than 150 miles. My tires seldom left the sea-wetted sand.

I found myself in a land of history and heroism. Here was born the first white child of English parents in America; there, witches were ducked; at one place, man first flew; at another, pirates cached their stolen treasure; and for every mile of this shore brave men have given up their lives in following the creed of the surfman, which tells him to put out to the aid of a stricken ship but is silent about his coming back.

I was in a land where there is at once elemental strife and serenity. Hurricanes from the Caribbean drive great seas to batter away at the reef; and against them the wonder grasses of the sand fight back quietly. Their glistening blades wave like banners as they grow and spread and, with the help of the gentler winds, gather the sand into dunes to resist the sea.

Near my pathway, in a tree hung with red-berried greenbrier, wood ducks nested beside the dark-amber water of a cypress pool; farther off an eagle soared above the dunes. I passed a raft of whistling swans riding on the quiet waters of a great coastal lagoon. I found treasure in shells and in queer sea life on every mile I drove.

One curb of the highway through this Land of the Sea is the crashing surf; the other, forest or dune, pond or broad sound. Its pavement is washed new and clean by the incoming sea twice each day. I drove it south from Cape Henry, past the pleasant resort of Virginia Beach (Plate II and page 328), past False Cape, and across the line from Virginia into North Carolina (map, page 329).

The finger of sand led me between the vast fresh-water sound of Currituck and the sea to Kitty Hawk; thence past Kill Devil Hill and the Dunes of Dare to the island of Sir Walter Raleigh, called Roanoke.

Still southward I drove, to Oregon Inlet where the gods of the fishermen live. Beyond it my tires left fleeting prints on 40 miles of shifting, wreck-strewn beach till I came to the candy-striped lighthouse of Cape Hatteras.

There I turned with the cape abruptly southwest, through deep pine forest and open heath to Hatteras Inlet. The trail led across it down a dune-flanked beach and through several miles of shallow-water driving to the live oaks and whitewashed neatness of Ocracoke, an Ocracoke whose tranquillity belies its history as a lair of Blackbeard.

A Coast of Many Moods

As man—or woman—has moods, so has the Land of the Sea. It can be a place of storm and hardship when a northeaster blows and rain and spindrift cut the face and blind the eyes; or when a chill gale drives out of the northwest, carrying the sand head high in stinging blasts, turning the sea to sullen lead.

But for every day like this there are many days the year round when the sun is bright and warm, and the long blue combers break lazily like the slow smile of a woman; when the scent of warm pine needles comes from the woods behind the dune, and song sparrows sing in the bayberry bushes. This land is good then.

Again, there are boisterous and invigorating days when great seas crash on the bar, and the east wind tastes of salt; or the wind shifts to a whooping breeze from the west, making the steep, toppling waves toss back their white manes like wild Palomino stallions. This land is good then, too.

I could find no rock, nor sod, nor loam, nor clay in this land; it is a world of sand. But sand is not lifeless, sterile; deserts are made by climate, not by sand. Sand gives life to its plants, its grasses, its forest; and it shelters the furred and winged creatures that live in it, on it, and above it. It has beauty in its ripples and in the shadowed curves of its dunes.

I found a zest to driving on sand; it has a feel, a buoyancy, that no road has ever had.

But there is much to learn about sand driving. I listened to Coast Guardsmen and fishermen expounding the lore of the wash,

For 156 Years Cape Henry Lights Have Guided Ships into Chesapeake Bay

The old sandstone lighthouse, lower right, was the first light erected by the Federal Government. Before 1791 bonfires on this spot directed vessels to Baltimore, Norfolk, and other Chesapeake ports. The present iron lighthouse replaced the old veteran in 1881. Gray buildings are part of Fort Story, guardian of the water approaches to the Nation's Capital.

the wet sand at low tide: how its firmness varies from falling tide to rising tide, with onshore and offshore winds; the danger in gravel overlain by a deceptive layer of sand; how to make a skidding turn when trapped on a narrow, steep wash; and how to climb a steep bank and cross the soft berm, or crest.

But sand driving cannot be learned by ear; it must be learned by doing. There is a psychological hurdle which must be surmounted first, for here, at the end of the concrete and asphalt, begins the unknown.

The driver on the sand must combine caution with a bit of daring. To him the words, "You can't get through," should be an invitation to go ahead, his way well lighted by his bridges burning behind him. He must rush in where angels, and perhaps outerbankers and Coast Guardsmen, fear to tread.

All reef drivers get stuck at one time or another, be they sandlubbers, as I was, or able sandmen. The long sand trail needs one who can drive by guess and by gosh and feel cheerful in the midst of seeming chaos and catastrophe. He must bluff the sand, or the sand will bluff him.

Before starting south, I explored Cape Henry, northern anchor of the great sand

Beach Driver's Nightmare—Stuck in the Incoming Tide!

Near Nags Head, North Carolina, the photographer's jeep, flying the National Geographic Society's flag, bogged down. Mr. Fletcher went for help; when he returned, waves were lapping the fenders and the driver was perched on the hood. A Coast Guard truck, helped by the jeep's four-wheel drive, pulled it out.

Sea-blasted Stumps Bear Witness to an Ever-shifting Front

Constant warfare between sea and land along the reef alters the beach, makes and unmakes capes, cuts new inlets and fills old ones. These stumps were part of a forest at False Cape, Virginia, when it was a true cape. Deep taproots withstood the sea's assaults. False Cape is so named because to coastal vessels its topography resembles that of Cape Henry, some 24 miles to the north (page 331).

Who's the Most Popular Man on Any Beach?

During summer months Virginia Beach bulges with six times its off-season population. Vacationists throng its six miles of beach; colorful umbrellas dot the shore. Rubber rafts ride the breakers, replacing the LCIs which raced ashore in practice maneuvers during wartime (Plate II).

reef. It is a geographical shuttlecock, a true migrant, no more securely fixed to the map than its wandering dunes. To everyone's dismay it is wandering off, leaving behind it nothing more substantial than fathom lines on a mariner's chart.

Vagrant Cape Henry

This is not the first time Cape Henry has gone on a pilgrimage. It was once eight miles to the south. Were it to resume its old place, the shore resort of Virginia Beach might be embarrassed to find itself two miles inland in a dense forest.

I saw evidence of its former position in the old stumps and peat beds which are sometimes uncovered at low tide near the resort. The Army has placed riprap at the tip of the cape in an attempt to prevent further movement.

Taking to the air over the cape, I was able to trace its growth and recent recession by the lines of ancient dune series which were as easily readable as tree-growth rings. The story they told me is one of line after line of sandspits followed by dunes.

As each new series of dunes was formed, those behind it became covered, first with sand grasses, then with bayberry, and finally with trees. Thus was built a cape about five miles broad and three miles in depth.

Then I could see where the picture had changed, about the time the Jamestown colonists landed on the cape in 1607. The sea had counterattacked, throwing up a great marching dune, three miles long, which rolled its steady way inland.

Between this great curved dune and the shallow bays behind the cape, sheltered from gales from the sea as well as from cold blasts out of the north and west, a wilderness grew up, one of venerable oaks, hickories, beeches, gums, and pines, alternating with pools peopled with cypress and tupelo. This wilderness has been known to Virginians at least since

the time of George Washington as the Desert.

The grassy foredune running along the beach is a bulwark against the sea, but the moving dune can be likened to an amphibious task force landed to push inland and prepare the way for the final attack by the sea. So this dune traveled more than a mile into the Desert, rearing itself more than 90 feet into the air. It left far behind the old lighthouse, first Federal beacon in the United States, built in 1791 and still standing on a remnant of the old dune (page 326).

In the dune's wake I saw a ghost forest—gray skeletons, headless and limbless, entombed for 200 years and now being exhumed to bleach in the sun. They were mainly of cypress; other less-enduring trees had disappeared.

The trees in the path of the dune could only stand and die, but others fought back by counterattack from the rear. They tried to overtake the dune, to climb upon its back, and to smother it by depriving it of its motive power, the wind. They sent their winged seeds spinning downwind to grow into more trees and to send more seeds out to attack.

But the dune fought a delaying action, scorching the tender seedlings with its summer sand and imprisoning the seeds in its dry top layer until their germs died of thirst. The forest could not catch up.

Help was needed, for the dune was not only destroying the forest but covering the military features of Fort Story, which defends the Chesapeake. I had been there to witness, 15 years ago, the beginning of the defeat of the dune. The forester had been called in, and the dune was covered with pine needles to bind the sand temporarily and keep its fierce heat from killing the seedlings.

Then some hundreds of thousands of six-inch pine

Checking In at a Canine Hotel in Norfolk

Visitors to Virginia beaches may park their pets for the day in this comfortable kennel. Norfolk, on Chesapeake Bay, is within easy reach of seaside resorts on the Virginia and North Carolina coasts.

seedlings had been planted. They had thriven, and when I returned this time the moving dune was gone; in its place I saw a young pine forest, some of its trees 30 feet tall.

The Desert Is Rescued

No longer menaced by the great dune, the Desert was threatened from another direction, and I again watched its rescue. It had become a place of significance to scientists and nature lovers from all over the country. A pair of sandy wheel tracks wandered through it—just a wilderness trail, not pretending to be a road. Ferns brushed the tires, and dogwood blossoms reached into the car windows of those who drove it.

Suddenly the Government descended upon it with plans to put men to work, raking, cutting, trimming, and substituting modern landscaping for its "untidiness." They started to slash the "Friendly Trail" into a 75-foot right of way, and had a man in a boat go through the pools, figuratively taking the bags out of the cypresses' knees.

But the women of Tidewater Virginia, who considered the Desert and its trail their charge, rallied to its defense, stormed officialdom, and won their case. The Friendly Trail would not become a turnpike; denaturing the forest would stop. A part of America's disappearing wilderness area was reprieved at Cape Henry.

Leaving the cape, I drove to the end of the concrete and dropped my wheels off into the sand. With my tires down to 20 pounds and my foot heavy on the accelerator, I roared across the dry bank, bound for the hard sand of the wash. At its edge was a two-foot drop cut by a recent storm.

There was nothing in the book about what to do; my sand-driving mentors had neglected to mention such a possibility. So I pulled around, hitting the bank squarely to prevent capsizing, locked my wheels, and slid gently over the drop, crumbling the edge as I went, and landed on the wave-packed wash with hardly a jar.

For a while the wash was level; then I reached a stretch of undulations formed by breaking waves, where the occupants of the rear seat found themselves in a continual state of suspension. To the very young such a stretch of beach is always a delight, but for some the motion causes real seasickness; therefore I ran up on the dry bank until the undulations ended.

A half dozen miles or so south of Virginia Beach I turned inland to search crumbling records in the old courthouse of Princess Anne, Virginia. They told me a strange tale, a parallel to a well-known story of colonial New England. I found that as Massachusetts had had its Salem witch hangings, so Virginia had had its Princess Anne witch duckings.

Here Witches Were Ducked

Ducking was not so harmless as it sounds. A woman accused of witchcraft was stripped of her clothing, bound, and cast into the water. If she floated, she was guilty, and was promptly hanged. If she sank, she was innocent; but, being dead from drowning, she profited little in her vindication.

Grace Sherwood was Princess Anne County's famous witch. The records tell how she was indicted in 1706 for being a witch, was taken to a place aptly named "Witch Duck," bound, and thrown into the water by the sheriff.

The affair ended in anticlimax, however. Bound as she was, Grace Sherwood confounded her would-be executioners by clambering ashore and, far from being hanged, lived on more or less happily, as far as the record states, for 34 more years, and died in bed.

Returning to the beach, I reached the bulge in the coastline at False Cape, where the wash widened and became as flat and smooth as a pool table. After picking my way through the stumps of the submerged forest, which indicate that there was once a true cape there, probably the one shown on old maps as "Point Barkley," I picked up speed (page 327).

But I passed too many blurred, interesting-looking objects and had to turn back for another look. They were, respectively: a hammerhead shark and a large sea turtle which had come to an unknown end; an osprey which had caught a fish too large to handle (page 334); and a concentration of sea shells.

Amphibious Pigs Like Sea Food

Some moving dots on the horizon became pigs in the surf. We stared at one another for a while, and then the pigs went back to sticking their heads under the breaking waves. They were uncovering a queer little mole crab (*Emerita talpoida*), which is about the shape and size of a pigeon's egg (page 335).

There were hundreds of these crabs just under the sand, and they migrated up and down the slope of the wash as the tide moved in and out. As the swash of each wave receded, I could see the V-shaped marks made on the sand as they spread their antennae to catch food, their bodies remaining hidden under the sand.

The pigs get fat on this and other sea food; but since their pork is a bit fishy to the taste, they are penned up and fed a landlubber diet before being marketed.

Nine miles inside North Carolina, I climbed Lewark Hill, an 80-foot marching dune, for a preview of what was to come. Four miles to the south, among great yellow dunes, was tall, slim Currituck Beach Light. On my right was Currituck Sound, 5 miles wide and 30 miles long.

Many years ago there was an inlet just to the north, and the water of the sound was salt. Then a great dune, probably Lewark Hill itself, had a part in closing the inlet, and the water turned fresh. The State hopes to keep the water fresh, because great damage to plant and animal life would result if the sound ever became salt again.

As I left Lewark Hill, I began to meet bald eagles on the beach. There were several pairs of adults and a number of young in immature plumage. In the next nine miles I counted 17 of them, nearly two to the mile, a noteworthy density. Eight years before I had seen only two in 140 miles from Cape Henry to Hatteras Inlet.

Chronicles of Whale Head

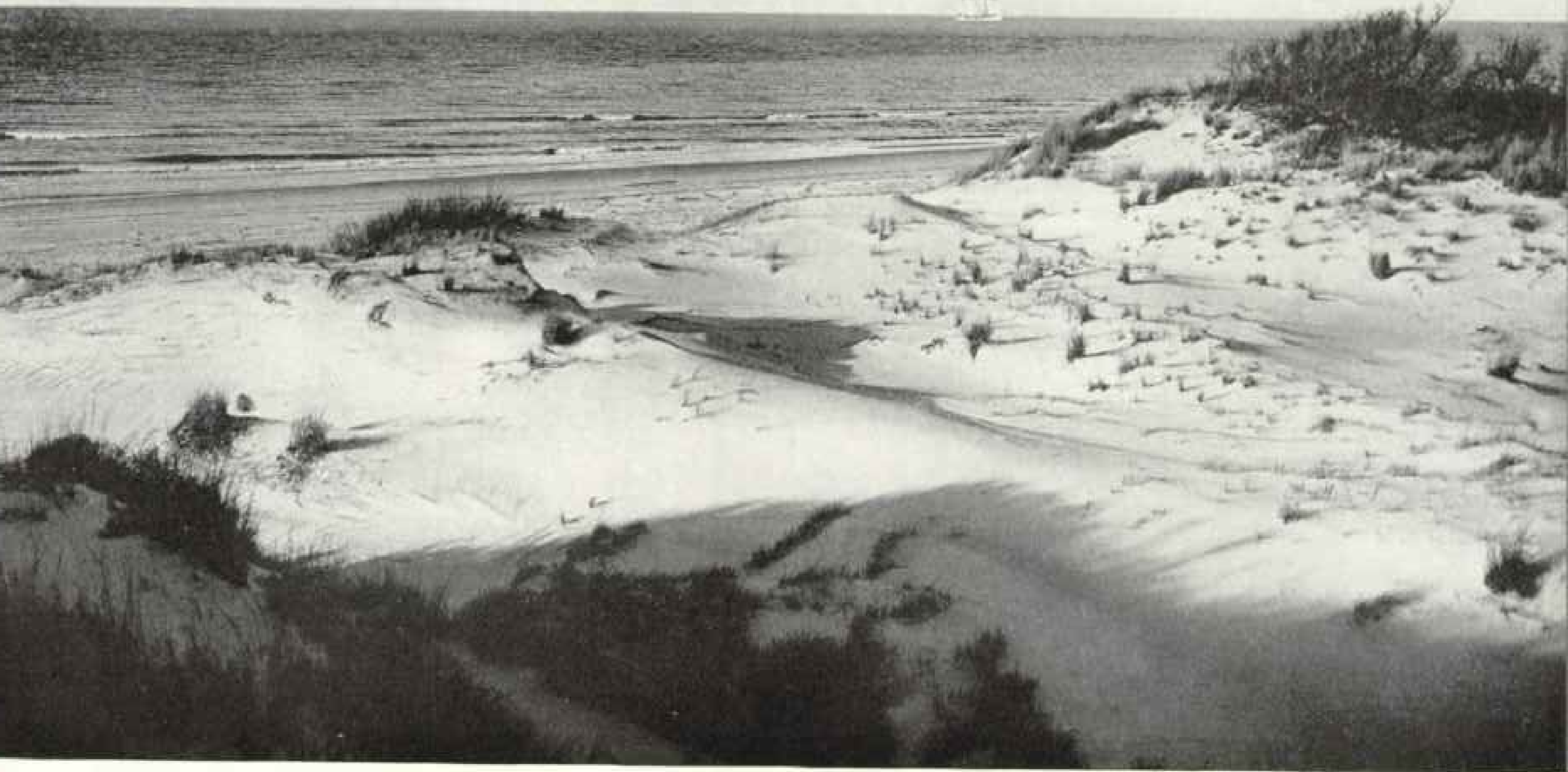
I crossed the steep foredune to Currituck Beach Light and the green oasis nestling at its foot. Locally the place is thrice named: Whale Head for the bay, Currituck Beach for the light, and Corolla, North Carolina, for its post office. Few beach travelers suspect its presence behind the dunes.

Its narrow lanes are hedged in by green thickets, which on that day were alive with myrtle warblers, mockingbirds, and cardinals. Children were playing under the live oak in front of the white schoolhouse with tiny bell tower, and a cow and some chickens foraged on the grass-grown street by the general store.

Currituck Beach Light is of unpainted red-brown brick, mellowed by 70-odd years of storm and sun to the color and texture of the tanned, ruddy cheek of an old sea captain. It fills the 80-mile gap between Cape Henry Light and Bodie Island Light at Oregon Inlet, warning against a coast that is a dangerous lee shore when a northeaster is blowing.

At such times the surf is incredibly violent; mighty seas curl forward and crash their untold tons of water vertically down. They batter men to death even before drowning them, and tear massive-timbered ships as if they were orange crates.

Such was the surf which took 85 lives in sight of the light on the last day of January in 1878, when the *Metropolis* was wrecked.



Peace along the Hatteras Reef Marks a Truce in the Endless Strife Between Sea and Sand

Spray Flying, a Coast Guard Lifeboat Fights Its Way Through Choppy Surf near Oregon Inlet

Quickly the Coast Guard helmsman pulls on his oar to straighten the craft before she broaches and capsizes. Pulling boats now are little used for rescues.

Eliot Porter from National Audubon Society

Prey Clutched in Talons, a Wide-winged Osprey, the Reef's Best Fisherman, Begins Its Nestward Flight

Known also as the fish hawk, it frequents both salt- and fresh-water fishing grounds. Scouting 30 to 100 feet above water, it dive-bombs its target. To reduce wind resistance it carries its catch end on, like the belly tank of a plane. The osprey's wingspread may reach six feet.

A Drive on the Reef's Treacherous Inside Route May End by Calling the Coast Guard for a Car, not a Lifeboat

Much of the sandy "road" behind the dunes is tortuous and soft. Automobiles use it only at high tide and during storms, for the beach is faster and easier. The ocean near Oregon Inlet is a quarter mile to the left; Pamlico Sound, a half mile to the right.

Knuckle Deep, Aquatic Porkers Root for Mole Crabs Which Migrate with the Tide on the Great Sand Barrier Reef

U. S. Army Air Forces, Official

Gaping with Cutlass Wounds, a Pirate's Current-sculptured Head Lies Beneath the Waters of Hatteras Inlet

Tidal currents and storms carved this reminder of the days when Blackbeard made near-by Ocracoke Inlet his winter quarters. Born Edward Teach, he fought Spaniards in the Caribbean as a privateersman. He turned pirate, converted a captured French merchantman into a 40-gun warship, and made his name feared from Virginia to the Spanish Main. In 1718 Lt. Robert Maynard of the Royal Navy surprised the buccaneer in his lair and killed him in personal combat.

There is an unsolved mystery, too, still hanging over this beach. Keeper Gale and all hands were lost when they went out in their surfboat to the aid of an Italian bark. No one knows what happened there, but some think the would-be rescuers were knocked on the head by the bark's crew, who mistook them for wreckers.

A crew of lifesavers shot a breeches-buoy line aboard another foreign ship preparatory to bringing its crew ashore. The astonished surfmen saw the ship's crew heave the line overboard and in a panic take to their boats and start north toward the Chesapeake. A lifesaving crew farther north had to row out and convince them that wreckers did not await them ashore.

The old light has seen strange things, but none was stranger than the occurrences of December, 1903. Just to the north, a craft never before seen on that coast drove ashore in a gale. It was the submarine *Moccasin*, one of the first in our Navy.

Orville Wright's Telegram

While the Nation was busy watching to see whether it could be refloated, something else happened at Kill Devil Hill, 25 miles to the south. As a result of it, two brothers walked over to the Kitty Hawk weather station to send a telegram. Relayed to Norfolk, it was addressed to someone's father in Ohio, saying, "Success four flights Thursday morning . . . home Christmas." The message was

signed by a man named Orville Wright.*

Below Currituck Beach Light I met a whale on the wash. He was a pilot whale, or blackfish, about 12 feet long, and he had not long been separated from his mother.†

A herring gull stood near by, eying him speculatively, as at intervals the whale sighed dismally and tremendously through the top of his head and once in a while struggled feebly. He had evidently struggled a long time to get afloat and was getting discouraged.

The pilot whale seems to be subject to blind panic, and a leader will suddenly dash ashore, followed like sheep by the rest of the herd. I wondered what could have frightened this pilot whale.

He was an example of symmetry and streamlining—clean and sleek and shining. He had the high, noble forehead of a thinker. But he was, I am afraid, not quite bright; if he was so wise, why did he strand himself?

Nevertheless, I was sorry for him, and later I was relieved to find that he got afloat on the next tide, to the probable disgust of the herring gull.

Helping Hands in the Sand

I stopped on the dry bank to investigate an old wreck, the ribs of which from a distance resembled the bleached skeleton of a steer beside some desert trail.

There was no sign of habitation or human being from horizon to horizon; yet in five minutes I looked up to find a Coast Guard car, two fishermen in a model T, and a traveling butcherman with his shop on wheels, all stopping to see if I was in trouble.

Then along came an orange-colored bus labeled "Dare County Schools." It was loaded with children enthusiastically bent on giving help should it be needed.

No traveler on the beach passes another without a greeting, and it is unknown for anyone ever to pass a stopped car without offering aid.

I turned inland at the site of old Caffeys Inlet and drove some miles on the sandy shore of Currituck Sound. My trail plunged into a dark forest of oak and holly, where the sand ruts, to my embarrassment, took me through the front yards and almost across the front porches of the dune-forest village of Duck, North Carolina.

Near Kitty Hawk I crossed the paved Wright Memorial highway. Offshore was once enacted a sea tragedy, the details of which have remained a mystery—the disappearance of the daughter of Aaron Burr.‡

Farther down the beach, the ill-fated Swedish steamship *Carl Gerhard* came ashore in 1929. She sat there for some years on an even keel, then sank straight down in the sand. Today there is no trace of her, not even her bridge, on the smooth sand of the wash.

America's Greatest Barkhan

Four miles south of Kitty Hawk Lifeboat Station, and about a mile inland, stands what was once the largest and most nearly perfect barkhan, or crescentic marching dune, in the United States. It is 91-foot-high Kill Devil Hill. From December, 1903, when the Wright brothers made their first flights, until the dune was immobilized in 1929, it marched southward 500 feet, or roughly 20 feet each year.

This rate of travel agrees with that of the barkhans of North Africa. As a rule, small dunes travel faster than large ones; in Egypt dunes about 60 feet high, being one-third smaller than Kill Devil Hill, travel some 50 percent faster, or 30 feet per year.

I saw the great dune before man laid his restraining hand upon it; it was pure wind-sculptured beauty. Now it has been covered with woods debris and planted to grass and weeds to stop its movement. A beautiful monument stands on its summit, a memorial to the Wright brothers (Plate I).

But it is a dune no longer; it is just a hill with parklike curlicues of walks and drives around it. Those who love the wildness of the Land of the Sea would prefer to see the dune covered with a flowing golden robe of sea oats, which would have stopped its movement but preserved its beauty.

From the top of Kill Devil Hill I could see to the south, across a narrow sound, Roanoke Island, site of the Lost Colony and the birthplace of Virginia Dare (Plates VI, VII). But before crossing over to it, I drove west over arched wooden bridges to Colington Island in Albemarle Sound.

There I learned that the Lost Colony of 1587, which antedated Jamestown by 20 years and Plymouth by 33 years, may itself be antedated by another lost colony perhaps several centuries older.

Some years ago, so the story goes, an old live oak growing on an Indian shell burial mound was uprooted in a storm. In its roots were two carved pipes which were not Indian in design or composition. They were thought

* See "Motor-coaching Through North Carolina," by Melville Chater, NATIONAL GEOGRAPHIC MAGAZINE, May, 1926.

† See "Whales, Giants of the Sea," by Remington Kellogg, NATIONAL GEOGRAPHIC MAGAZINE, January, 1940.

‡ See "A Bit of Elizabethan England in America," by Blanch Nettleton Epler, NATIONAL GEOGRAPHIC MAGAZINE, December, 1933.

U. S. Coast Guard, Official

Angry Waters, Whipped by Hurricane Winds, Topple Beach-side Homes at Nags Head

Storm-raised floods overrun roads and lawns and undermine houses. West Indian hurricanes that veer north usually blast the eastward-bulging reef. That of September, 1944, drove salt water clear across the reef into Pamlico Sound. Reversing direction, it hurled the piled-up water back to the sea (page 339).

by some to be Mayan and by others to be associated with the "Kettles of Kilmarlic," found across the sound on the mainland and likened to Roman urns. The Indian taught the white man to smoke. But who taught the Indian to smoke?

Continuing southward, I drove past Nags Head, where wreckers were supposed to have originated the name through the custom of luring ships to their doom by tying a lantern to a horse's head to simulate a light on a vessel. It makes a good story, but reference to the map shows Nags Head to be the name of a village in southern England; and the early settlers of this reef, many of whom came from England, brought the names of some of their towns with them.

For ten miles south of Nags Head I drove an inside trail, my car lurching mightily in the deep meandering tracks like a skiff in a short beam sea and scraping its belly on the sand and grass till it shone like a newly minted coin. I was in search of Oregon Inlet, the exact position of which is a bit uncertain because of its constant southward travel.

Going to Sea in an Automobile

Suddenly I emerged from among the dunes on to a wide marsh covered with a foot of water in which there was a maze of channels through the grass. Beyond it was the inlet: the waters of Pamlico Sound were flowing swiftly seaward, meeting a succession of heavy seas coming in. The resultant maelstrom I was to cross was not reassuring. There was no sign of a ferry or a ferry slip, and it was nearly sailing time. Some tire tracks disappeared into the water, but in that marshy labyrinth

there was no sign of where they emerged, if they ever did emerge instead of continuing down to Davy Jones's locker.

Being without compass, sextant, or channel buoys, I lay to for a pilot. He came in the form of a Government truck, which took to the water in a cloud of spray. I followed circumspectly, hub-deep in the water. After half a mile of channels we came to a marshy bank, and there was the ferry.

I drove up the landing ramp and then helped pry the ferry away from the bank. The waves of the inlet kept the deck under a few inches of water during the crossing, but that, I learned, was normal.

A Haven for Birds

In the inlet we passed a flock of 300 black skimmers, known locally as shearwaters; and a large flight of cormorants, called there "nigger geese," passed close aboard.

The ferry sailed up to a likely-looking smooth spot on the far shore and dropped its ramp. Its three vehicles backed off and wandered over the sand flats in a generally southerly direction. There was no road; each knew where he wanted to go and made his own tracks in that direction. The sand driver is an individualist and an optimist; he always seeks a better route over the sand but almost never finds it.

In shooting the dry bank en route to the wash, I failed to build up my speed high enough before hitting the deep dry sand and got stuck. I did not spin my wheels, but tried rocking out in a rhythmic forward and backward motion. My tires went deeper.

With the help of a passenger I gave the car the rather violent lateral rocking treatment. The tires were momentarily jerked up on the high side each time, and a little sand flowed beneath them.

After ten minutes my tires were back on the level. I scooped the worst of the dry sand from the ruts ahead, let my tires down from 20 to 15 pounds, and, being careful to keep my power even with my traction and not ahead of it, pulled out and down to the wash. I was learning.

I spoke the Oregon Inlet Station and the Pea Island Station, now inactive. The latter was manned by Negroes.

Aside from its professional efficiency, it was noted for its pork chops and pan-fried cabbage, and for the bowl on the mess table into which went a contribution whenever some profanity slipped out. Near by is the Federal migratory waterfowl refuge where, with the game birds, thousands of laughing gulls breed.

Surprisingly, New Inlet had closed, and I sped over its former site on the wash.

A few miles south I spoke Chicamacomico Station, where I got more details on the hurricane of September 14, 1944, about which I had been hearing all down the coast. With the barometer fallen to 27.97, and the onshore winds blowing, the sea rose and passed completely across the reef, piling up water in Pamlico Sound and flooding the mainland.

Suddenly the wind decreased in velocity with approach of the storm center; then, increasing again, it blew violently from the opposite direction, and the piled-up water from the sound surged back and washed across the reef, meeting the seas coming in from the ocean.

Many houses came adrift in the near-by villages of Rodanthe and Avon, but, thanks to quick action by Coast Guardsmen and fishermen, there was no loss of life.

Out at sea it was a different story. Two Coast Guard cutters, *Jackson* and *Bedloe*, were convoying a torpedoed ship northward. Mountainous seas laid them over on their beam ends, and they foundered.

After drifting in life belts and on rafts in shark-infested waters for more than 50 hours, survivors were picked up by Coast Guard air and sea units. Forty-eight officers and men lost their lives, 17 dying on the second night. In this rescue work, the motor lifeboat from the Oregon Inlet Station did yeoman service.*

Thrice-accursed Spot

Ten miles farther on, I reached a spot which is thrice accursed. In the August hurricane of 1899, the schooner *Aaron Reppard* drove ashore here, hitting with tremendous force. Surfmen shot a line 500 yards across her headstays, but her crew was powerless to reach it.

The report goes on: "Ship started to go to pieces; deckhouse first, hatch combings, decks, and bulwarks. The passenger, Cummings, in the mizzen shrouds was caught by one leg in the ratlines and slammed back and forth until dead before the mizzenmast fell over the side. Mainmast broke in two and followed overboard. Seaman Tony Nilsen was carried with it, worked himself clear and disappeared.

"Captain Wessel jumped from fore rigging to try to swim ashore; turned back and drowned within five yards of the ship. Mate and three seamen in fore rigging fell into the sea with foremast. Surfmen with line around waists waded into the heavy surf filled with

* See "Life with Our Fighting Coast Guard," by F. Barrows Colton, NATIONAL GEOGRAPHIC MAGAZINE, May, 1943.

planks, timbers, and broken spars; saved three men. Captain E. O. Hooper of Little Kinnakeet Station nearly lost his life, broke leg."

That was not enough. The next day the barkentine *Priscilla* came ashore there. Four lives were lost, but surfman Rasmus S. Midgett of Gull Shoal Station, on mounted patrol and with the sea up to his saddle girth, went into the surf and single-handed saved ten persons.

That was still not enough. In the 1933 hurricane the four-masted schooner *C. A. Kohler* was driven ashore at this same spot, but the water was so high that she rode far up on the beach. Nine men, a woman, and a dog were taken safely ashore by breeches buoy. Captain Hooper, who had broken his leg in the *Aaron Keppard* rescue 34 years before, took part in the *Kohler* rescues.

The hero of the *Priscilla* wreck, Rasmus Midgett, bears a name that is a proud one on the reef. The history of the Coast Guard and the old Lifesaving Service is inseparably linked with the name Midgett.

When Keeper John Allen Midgett took a surfboat out from Chicamacomico in 1918 to the aid of the blazing tanker *Mirlo*, the crew were all in the Midgett family: Keeper John, Arthur, Clarence, Zion, Leroy, and Lee O'Neal, whose mother was a Midgett. Midgetts not only served in lifeboat stations in this war, but their names are known all over the Pacific, where they manned landing craft for amphibious operations.

Sixteen more miles, and I was at Cape Hatteras Light. Darkness was falling, the sea was rising, and the bank was steep and soft. I made it to the dunes, however, in a breathless dash, after first reconnoitering on foot and placing sand monuments on wash and crest to guide my turns.

Soldiers of the Sand

Hatteras Light was saved by grass after the Government had given it up for lost and built a new tower inland. The water had come in nearly 500 yards since 1872, threatening the light. Brush fences raised a dune, and sea oats were planted on it. The dune has grown and expanded until now the light is out of danger. A lowly grass did what engineer and steel groins could not.

There has been constant warfare on the reef between the sea and the wonder grasses of the sand. Before men came, the grasses were victorious. They built the barrier dunes behind which the forests of Hatteras grew.

Man has been almost an enemy; at best, a poor ally. He cut the trees, and his stock ate and trampled the sand grasses. Loss of the northern forest of Hatteras and inroads by the sea followed. Not until lately has man learned to help the grass, to replant it when the sea washes it away, and to keep his stock from it.

Like two Coast Guard beach patrols, two sand grasses meet here on the reef: beach grass comes down from the north to meet sea oats coming up from the south. They form no sod, but they do better than that. They force the wind to drop the sand, and as the sand rises each year they send out roots at the new sand level and step by step keep pace with the rising dune. In the meantime their subterranean stems spread the grass widely.

A third, salt-meadow cord grass, which covers the range of both, has similar properties; and a fourth grass, which I call "purple hair," takes over back of the dunes and in October forms a purple blanket from northern to southern horizons.

Though residents are skeptical, these grasses, if handled right, can protect Hatteras and the rest of the reef from both sea and sound, again making it the forested paradise it once was. Much of the extensive grass plantings made in the late '30's has been lost, because during the war there was no money or labor for replacing the grass washed out by hurricanes.

Buxton woods were a pleasant change from the wind and sun of the beach. The wind was but a whisper in the tops of the pines as I drove past red-berried yaupon, the lovely lavender-fruited French mulberry, fragrant bayberry, and grapevines which grew to the treetops. And I met here, at its farthest north, an adventurer from the south—the dwarf palmetto, a true palm.

In 1937 the Government took steps to make Hatteras into a national seashore recreational area. The war temporarily held up the project, and oil companies moved in to explore for oil. Deep test wells brought up thousands of tiny fossil animals instead of oil, and plans for making Hatteras into a national playground are again being considered.

Humor on Hatteras

During the war a Coast Guard doctor ministered to the people of Buxton and the other villages up and down the reef. He delivered many babies and relieved much suffering. But residents were not unconscious of the humor in the situation when he stepped out of his official station wagon to visit an expectant mother, for on the side of the vehicle was the sign "United States Coast Guard Recruiting Service"!

Beyond the woods I drove through the

From Great Sand Barrier Reef Wilbur and Orville Wright First Flew an Airplane

Atop Kill Devil Hill near Kitty Hawk, North Carolina, this winged granite pylon honors their conquest of the air. From the hill, then a large moving sand dune, they learned to glide. Near by, on December 17, 1903, they made the first successful flights in a power-driven, heavier-than-air craft. Grass has anchored the marching dune.

Kodachrome by John E. Fletcher

Bathers Breast the Surf of Virginia Beach Where Landing Craft Charged Ashore in Practice Drills During the War

LCIs roared in from the sea through the breakers to disgorge soldiers down their ramps. Now the Virginia resort near Hatteras reef's northern end has become again the gateway to "The Land of the Sea." A mile to the left, beach drivers may drive on to the sand and roll more than 50 miles before seeing a road.

Off the Beach at Cape Hatteras, Graveyard of Ships, the Author's Son Experiments with Rubber Life Raft and Green-dye Marker

Like a Sunday Driver on a Country Road, the Author Found Cattle on This Surf- and Dune-lined Highway

Stranded pilot whale, crab-rooting pigs, wild horses, giant sea turtles, and goats were other driving hazards. The cattle graze on marshes behind the dunes.

Kodachrome by John E. Fletcher

On Cape Henry a Simple Granite Cross Marks the Jamestown Settlers' First Landfall on the American Continent

The voyagers came ashore on April 26, 1607, and named this southern portal to Chesapeake Bay for the Prince of Wales. There they opened the London Company's sealed instructions, explored, and repelled an Indian attack. Before proceeding, they assembled a prefabricated shallop and tasted succulent Chesapeake oysters.

Kodachrome by J. Baylor Roberts

Warm Gulf Stream Tides and Endless White Beaches Make the North Carolina Coast a Paradise for Salt-water Bathers

Flowing close to the great sand barrier reef, the tropical ocean current keeps water temperatures comfortable from May to November. The reef angles seaward from Cape Henry, Virginia, until at Cape Hatteras it is nearly 30 miles offshore. Then, in a graceful arc, it again approaches the mainland.

Kodachrome by John E. Fletcher

On Roanoke Island the Epic Story of Raleigh's Lost Colony Lives Again in Lyric Drama

Islanders, college students, and professional actors present Paul Green's play, *The Lost Colony*, in a rustic open-air theater overlooking Roanoke Sound. Music, dance, and pantomime are important parts of the pageant. Here Sir Walter, pipe in hand, presents the Indian braves Manteo and Wanchese to Queen Elizabeth.

Kodachrome by John E. Fletcher

"Leave Me in Peace, Will You? Be Scarce and Get Gone!" Shouts Old Tom, the Philosopher-buffoon, to an Admiring Squaw

To the smiling English girls he adds, "Whew, she's all anointed with bear grease again!" *The Lost Colony* is based on Raleigh's attempts to plant a colony in America in 1585 and 1587. Both were established on Roanoke Island, inside the Hatteras reef. The fate of the second colony remains a mystery.

These Old Mortars Shot Many a Life Line to Vessels Wrecked Near Caffeys Inlet
Before a gun was fired the pegs were removed from the "faking box," thus clearing the line for easy running. Modern Lyle gun and paillike container for line replace this old equipment.

Reproductions by John E. Fletcher

To the "Beachcomber" the Great Sand Barrier Reef Yields Rich Treasures
They range from tiny wedge shells, at lower left, through scallops, center foreground, to white knobbed whelks at either side. Ribbed shells are cockles. Whelk's spiral egg ribbon is above starfish.

open moor to the fishing community of Hatteras village. It is a place of shrimp, croakers, gray trout, flounders, spot, and a number of other food fishes. Offshore, around the wrecks that litter the bottom, sportsmen find amberjack and dolphin. One took a 594-pound blue marlin; and red drum, or channel bass, are caught in Hatteras Inlet.* A three-car ferry makes the three-hour trip across Pamlico Sound to Engelhard on the North Carolina mainland.

Across the inlet to the southwest I drove the length of Ocracoke, an island that is half land and half water, for I drove the last few miles through shallow water. They told me of another mystery ship, the *Caroll A. Deering*, a three-master. With her table set for dinner, she sailed into the shoals in February, 1921, with no one aboard except a cat. The cat lived for years at the Cape Hatteras Lifeboat Station, but the mystery is still unsolved.

On the southern end is the village of Ocracoke, the metropolis of the reef. It has a concrete street which served its former Naval Amphibious Training Base. Here Blackbeard lived between raids, and in Hatteras Inlet there is an eerie reminder of his cutthroat days. An Army Air Force photographer brought to light the presence under water of the immense current-sculptured figure of a pirate, his head gaping with cutlass wounds (page 336).

Driving the Dark Reef

On the return trip north, darkness overtook me at Caffeys Inlet (Plate VIII). The wash was smooth as velvet and hard; there was no vibration—just the hum of the engine. There was nothing outside by which to judge speed or distance. The beams of my headlight seemed to be absorbed into the sand and the air: it was like flying at night.

For a time the surf fog curled into my lights, cutting down my speed. Then it blew aside, and before I knew it my speed had mounted too high for the occasional tidal gully and the stumps which I knew lay ahead.

I drove by dead reckoning, checking my speedometer to the tenth of a mile against the detailed log kept on my way down; there was nothing else to tell me where I was. There was the curious feeling that I was veering from my course. So a pilot feels when he is on instruments. But when I turned the wheel, I ran into the swash of the waves and had to straighten out again.

Something was wrong. I should have raised the beam of Currituck Beach Light, but it was not there. I considered and discarded the possibility that I had somehow made a circle on the wide wash and was headed south. I waited until my computations showed that I should be abreast of the light, then zoomed up over the crest of the bank for a look.

The tower was there, all right, looming up dimly in the darkness. But it was dark. It was like a good Samaritan, after many years of help to travelers, suddenly gone blind.

I returned to the wash and after a few miles turned around for another look. The light was on! It had been but a temporary stoppage. I did not feel quite so lonely.

Suddenly there were green eyes peering in from the sea. I relaxed when the eyes became my friends, the pigs. Farther on I pulled up sharply as more green eyes faced me from dead ahead, and threaded my way carefully through a herd of cattle lying at the edge of the surf, placidly chewing their cuds. They were refugees from the insect-ridden marshes.

As I rounded False Cape, plovers wheeled in my lights, and myriad ghost crabs danced weirdly in the beams as if they played before footlights. The seas were reaching higher now, and the rim of foam on the advancing wash was like a necklace of diamonds in the headlights.

Because the wash was narrowed by the advancing tide, I had to turn partway up the bank as each wave came in and then follow it back to the harder sand. This, with the undulating beach as I breasted Little Island Station, gave the car the effect of a ship yawing and pitching in a quartering sea, and I was glad when I splashed through Rudy Inlet and was at Virginia Beach.

The lighted streets dazzled my eyes; I had come from a strange, dark world into the land of Neon and Mazda.

Cold Flame in the Night

Back in my cottage on Cape Henry I went to bed tired, but I did not sleep well. There seemed to be a flickering before my eyes.

I awakened to see a queer, recurring flash on my wall. Raising myself on my elbow, I looked out, straight into a fantastic dream, at what might well have been a page from Dante's *Inferno*; at what, to my sleep-filled eyes, was a flaming sea where molten waves were breaking upon a brazen beach. Each wave was tipped with fire which changed from a pale green to a vivid blue; and as it broke there was a bright flash, bright enough in which to read the fine print of a newspaper.

I shouted to rouse my family, and in swim-

* See *The Book of Fishes*, edited by John Oliver La Gorce, published by the National Geographic Society.

An "Improved Road" on Cape Hatteras!

Extending only a few hundred feet, the wooden tracks were built to protect an artificial dune rather than to aid motorists. The license plate on the car indicates the owner is a visitor. Cars kept on the reef need not have tags.

ming clothes all of us, grown folks, children, and dog, ran down to the water.

When we got there it was no longer a scene from Dante; instead, we were in a veritable Land of Oz, a pale-emerald land of shimmering light.

Entranced, we plunged into the water. When we arose we wore suits of shining mail; the water running down our faces became a cascade of jewels.

On the wet sand the footprints of running children glowed briefly as their figures stood out black against the incandescence of the breaking seas.

Blue Crabs with "Headlights"

When we swam, our fingers beneath the surface were glowing embers. Small fish darting swiftly in the lagoon behind the bar were like miniature comets, and for once the scurrying, sharp-pointed blue crabs, so painful to the ankles, could be avoided.*

They came sculling along as recklessly as ever, but they were now equipped with headlights, and on each sharp point they carried a running light.

The children, braving this strange water, took mouthfuls of it and breathed magician's fire by simply spouting it out again. Jerry, the family Airedale and expert retriever of rubber balls, shared the excitement. The thrown ball hit the water like an exploding magnesium flare and lay there radiating green ripples of light until the dog, his coat set with a thousand emeralds, swam out to get it.

At last, reluctantly, we went back to bed; we had lived for a while in fairyland.

The night of cold fire was due, scientists say, to the presence in the water of myriad luminescent planktonic organisms. Such displays of phosphorescence are not uncommon in tropic waters, but I had never seen so bright a display so far north.

Something like it occurred once at Santa Cruz, California, and again years later at Marshfield (Coos Bay), Oregon. Weak displays of phosphorescence are of common occurrence.†

The great sand reef had shown me many things, but it had waited till the last night to fill my eyes with splendor.

* See "Crabs and Crablike Curiosities of the Sea," by William Crowder, National Geographic Magazine, July, 1928.

† See "Living Jewels of the Sea," by William Crowder, National Geographic Magazine, September, 1927.

Indian Life Before the Colonists Came

By Stuart E. Jones

TODAY'S pictorial journalists, whose work with camera and typewriter brings the world into every home, had their 16th-century prototypes in two European artists who "covered" America less than 100 years after Columbus made his historic landfall.

The artists were Jacques le Moyne de Morgues and John White. Le Moyne, in 1564, participated in an ill-fated attempt to establish a French Huguenot colony in Spanish Florida. White, as one of Sir Walter Raleigh's colonists, made three trips from England to "Virginia," in 1585, 1587, and 1590.

Each was commissioned to map and paint what he saw. The results stirred Europe much as a similar pictorial record of life on another planet would affect the world today.

Le Moyne's New World sojourn ended suddenly on September 20, 1565. On that day the Spaniards, established in Florida since its discovery by Ponce de León in 1513 and determined to block any attempt of the French to gain a foothold there, assaulted the Huguenots' Fort Caroline and killed most of the defenders.

With a few others, Le Moyne escaped to a French ship. Storms swept the vessel to Swansea, Wales, instead of the intended destination in France. Le Moyne later turned up in London, where he was employed by Raleigh.

Florida Scenes in Water Colors

Le Moyne was not heard of again until 1587, when Richard Hakluyt translated into English René Goulaine de Laudonnière's narratives concerning the French colonists in Florida. Hakluyt's introduction to the English edition revealed that Le Moyne, working mainly from memory during the two decades following his flight from the New World, had produced a series of water-color paintings depicting Florida scenes.

News of Le Moyne's paintings excited the interest of Theodore de Bry, a Flemish goldsmith, engraver, and publisher who had fled from his birthplace, Liége, to Strassburg and then to Frankfurt to escape religious persecution. De Bry journeyed to London and offered to buy Le Moyne's paintings, planning to use them to illustrate a book on Huguenot sufferings. The artist refused to sell, and De Bry returned to Germany.

A year later De Bry went back to London and bought from the artist's widow (Le Moyne died in 1588) not only the paintings but his Florida narrative.

On the advice of Hakluyt, whose main interest was in English colonization of the New World, De Bry postponed engraving Le Moyne's pictures and gave priority to those painted by John White on the Roanoke colony.

White came to America with Raleigh's first expedition in 1585, but returned to England after nearly a year on Roanoke Island and the near-by mainland of what later became North Carolina. He was back again, as governor, in 1587, intending to stay in order to complete his pictorial record and help justify Raleigh's faith in England's future in America.

Persuaded to return for supplies, he soon reluctantly sailed away. Behind him he left more than a hundred colonists—among them his daughter and his new granddaughter, Virginia Dare, first English child born in the New World. Not until 1590 could White make his last voyage to America.

Mystery of the "Lost Colony"

When he reached Roanoke Island the colony had vanished, leaving the single word "Croatoan" carved on a tree. White attempted to follow the colonists to a near-by island of that name, but a storm intervened. Eventually the ships sailed back to England.

The "Lost Colony" remains one of America's most absorbing mysteries.

Most fascinating to Le Moyne and White were the copper-skinned natives of this incredible new land. At no small peril they went boldly among the Indians and, with meticulous attention to detail, recorded all aspects of New World life for the edification of the Old World. Along with their paintings they made copious explanatory notes.

Certain Indian customs inspired the artists to astonished admiration; others moved them to observe that some aboriginal achievements matched those of the cultured Europeans.

Describing a festive gathering around a roaring fire on the Virginia shore (Plate I), White reported that such events occurred when the Indians "escaped any great danger by sea or lande, or be returned from the warr . . . in token of joye." He noted also their manner of chanting songs while shaking gourd rattles. "It is a strange custome, and worth the observation," White concluded.

Village Life of the Indians

Indian towns like Secota (Plate II), with its houses and gardens in neat array, were described by White as "commonlye fayrer" than those encircled by poles, such as

Pomeiooc (Plate III). These two scenes depict many aspects of Indian life—feasting, dancing, raising corn, pumpkins, and *uppowoc* (tobacco), hunting deer in the adjoining forest, and obtaining water from a near-by stream or pond.

Visiting Dasamonquepeuc, a village near Roanoke Island, White was intrigued by the way the women there carried their children (Plate IV). "For our women," he noted, "carrie their children in their armes before their brestes, but they [the Indians], taking their sonne by the right hand, bear him on their backs, holding the left thighe in their left arme." Here the artist erred, for in his drawing, with front and rear views, the mother holds her child by the left hand and right thigh.

"When they go to battle they paynt their bodyes in the most terrible manner that they can devise," White said of the "weroans or greate lordes of Virginia" (Plate V). "They carry a quiver made of small rushes holding their bowe readie bent in one hand and arrowe in the other, readie to defend themselves."

Le Moyne reported the existence of mountains, "called in the Indian language Apalatcy," a great distance from Fort Caroline. In these, he said, "are found much gold, silver, and brass, mixed together. Accordingly, the natives dig ditches in these streams into which the sand brought down by the current falls by gravity. Then they collect it out (Plate VI), and carry it away . . . and after a time collect again what continues to fall in."

The Virginia Indians' method of fashioning dugout canoes aroused White's greatest enthusiasm (Plate VII). "For whereas they want instruments of yron," he reported, "they knowe howe to make them as handsomelye, to saile with whear they liste in their rivers, and to fishe with all, as ours."

An Example for White Men

Le Moyne spoke approvingly of the Florida Indians' custom of storing their crops in public granaries (Plate VIII). This system spared the owners of the provisions any apprehensions of being defrauded. "Indeed," Le Moyne observed further, "it is to be wished that, among the Christians, avarice prevailed no more than among them, and tormented no more the minds of men."

Le Moyne's devotion to detail is evident in his painting of an Indian chief, liberally tattooed and bedecked with feathers and metal ornaments, surrounded by keening widows, and with other Indians and colonists standing at a respectful distance (Plate IX). In another Florida scene, however, he apparently succumbed to a tendency to exaggerate, for his "crocodrilles," or alligators, are depicted as of unbelievable size (Plate XIII).

The Virginia Algonquians' habit of cooking and eating their fish immediately after catching them, as compared with the Florida Indians' thrifty practice of curing theirs for later use, was noted by White (Plate X).

White called the Indians' earthen vessels, in which they cooked stews (Plate XI), "so large and fine that our potters with large wheles can make noe better." Of the Indians' moderate eating habits he said: "I would to God wee would follow their example. For wee should bee free from many kynes of diseasyes which wee fall into by sumptuous and unseasonable banketts, continually devising new sawces, and provocation of gluttonye to satisfie our unsatiable appetite."

Conjurers, or medicine men (Plate XII), were important personages in early American tribal life, and the Indians, White reported, "give great credit to their speeche, which oftentymes they finde to bee true."

An Early American Festival

One of White's most elaborate works was his interpretation of a festival scene (Plates XIV, XV) in which men and women prance in a kind of endless conga line around a circle enclosed by seven curiously carved posts, with "three of the fayrest Virgins" revolving slowly in the center. These events presumably were related to some phase of the crop cycle.

Beside the entombed bodies of their departed chiefs (Plate XVI), White wrote, the Indians "sett their idol Kiwasa . . . for they are persuaded that the same doth kepe the dead bodyes of their cheefe lordes that nothinge may hurt them." And he added: "These poore soules are thus instructed by nature to reverence their princes even after their death."

In 1590 De Bry published in Latin Thomas Hariot's *Admiranda Narratio*, illustrated by copperplate engravings from White's original Virginia water colors. The Florida volume, *Brevis Narratio*, with engravings of Le Moyne's paintings, appeared a year later. These two works launched De Bry's great publishing project, *Grands et Petits Voyages*.

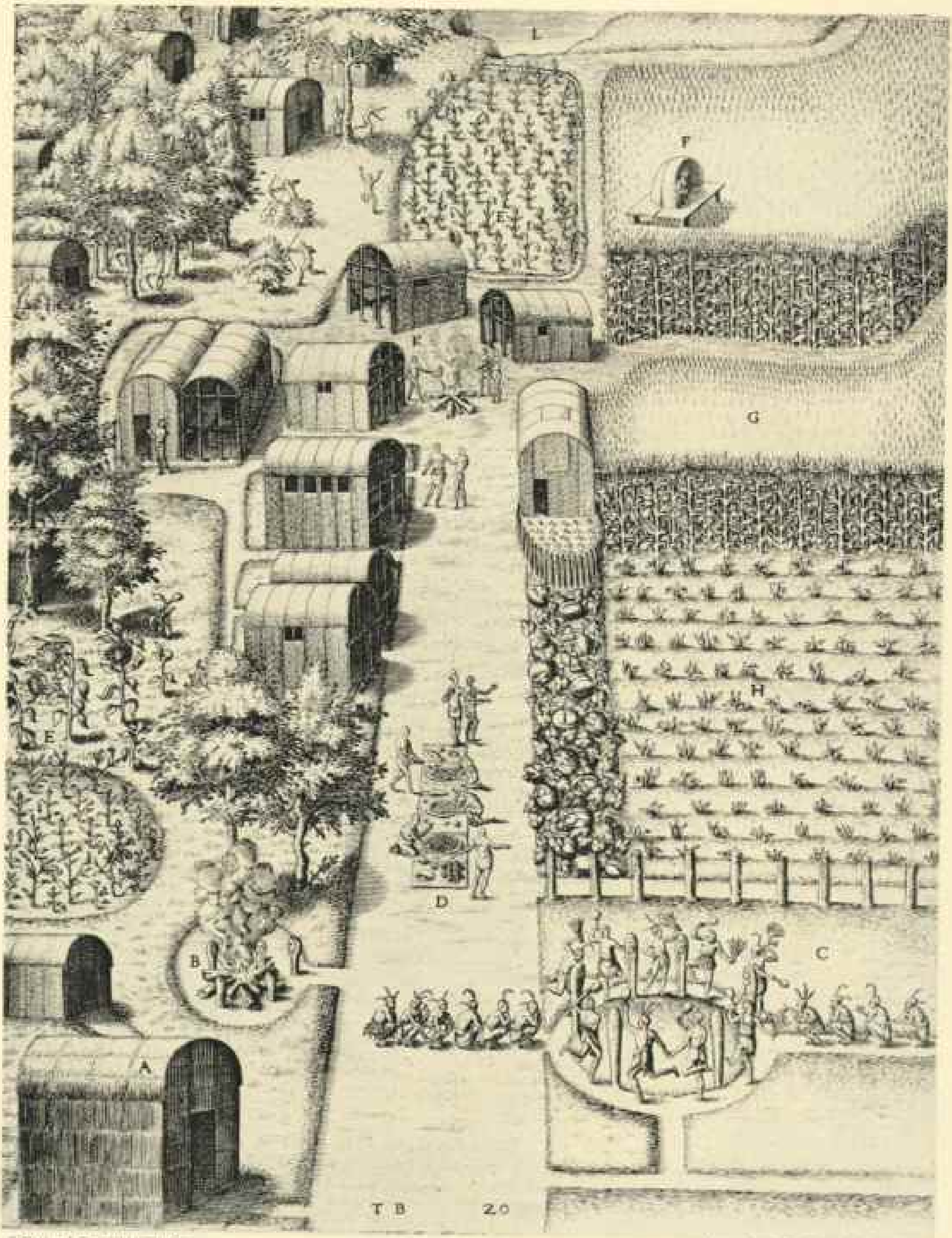
The eleven De Bry engravings after White and four after Le Moyne, reproduced on the following 16 pages of the National Geographic Magazine, have been taken directly from *Admiranda Narratio* and *Brevis Narratio*, in the Rare Books Division of the Library of Congress, Washington, D. C.

The Lessing J. Rosenwald Collection in the Library contains one of the few copies of De Bry's 1590 English version of Hariot.

© National Geographic Society — Engraving by Theodore de Bry, 1590

"When They Be Returned from the Warr . . . They Make Merrie about the Fyer"

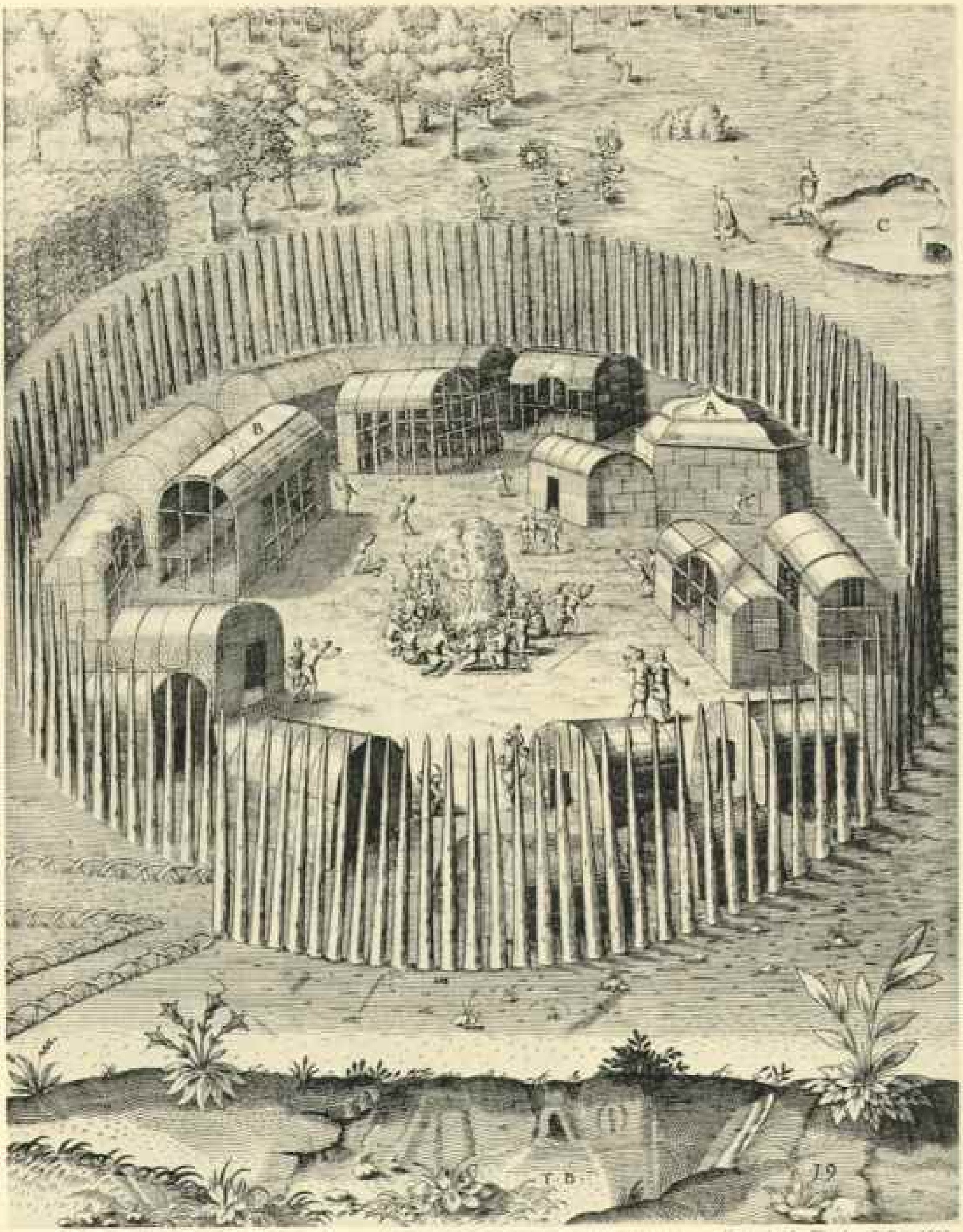
Here John White depicts the Indians' "manner of prainge with rattels" and singing to celebrate a victory.



Engraving by Theodore de Bry, 1588

"Howses of the Towne of Secota Have Gardens . . . Wherin Groweth Tobacco (E)"

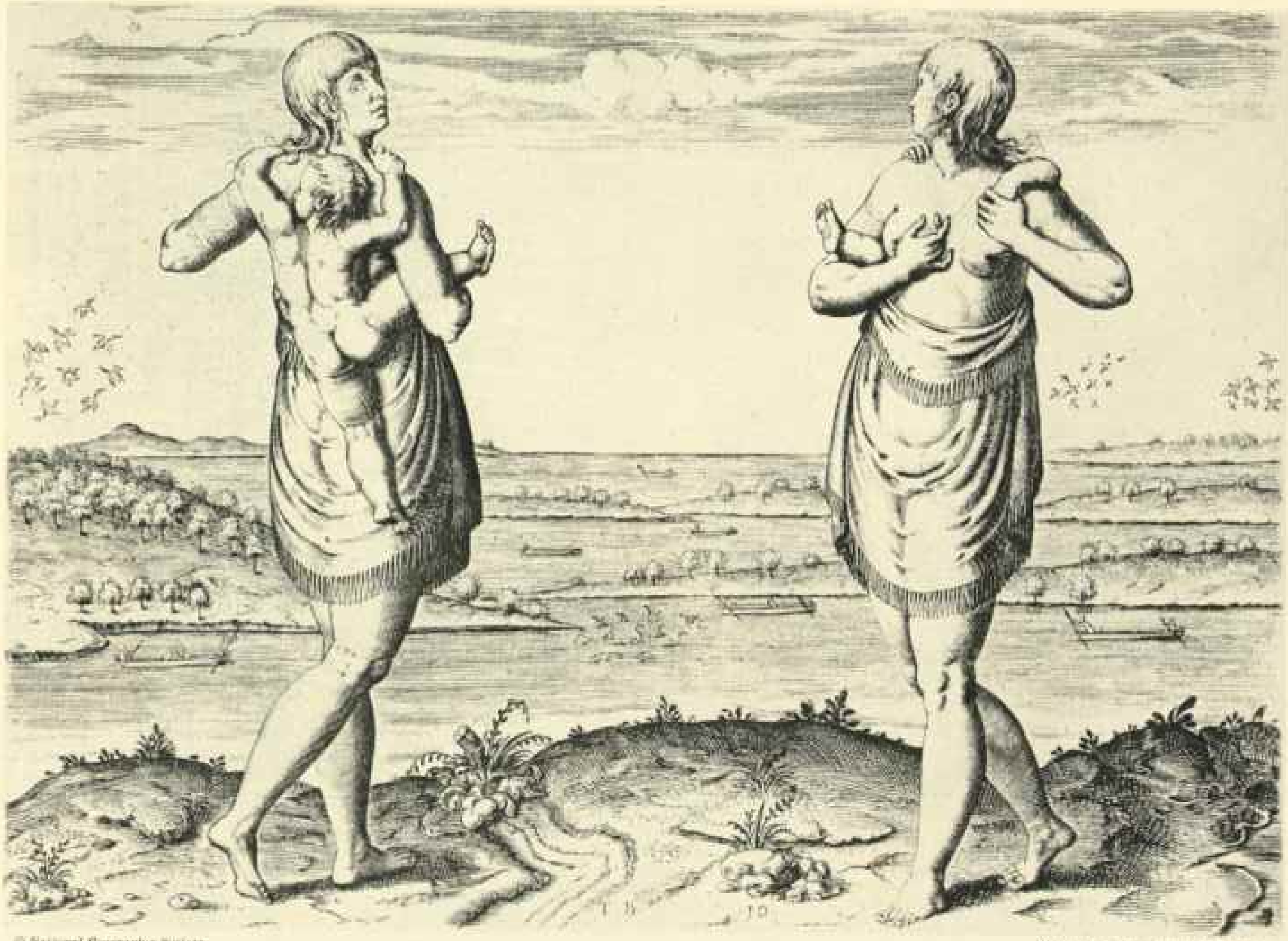
Indians dance around carved posts (Plates XIV, XV), feast in the village street (D), and shoot deer with bow and arrow. Crouching in a hut (F), a watchman "maketh continual cryes and noyse" to frighten marauding "fowles and beastes" away from ripening corn. Space was left between rows (H), "otherwise one stalke would choke the growthe of another." Pumpkins grow in garden (I). From the river (L) villagers obtained water.



© National Geographic Society — Engraving by Theodore de Bry, 1588

"The Towne of Pomeiooc . . . Compassed Abowt with Poles Stucke Faste in the Grownde"

Only the chief and his nobles occupied houses. Buildings were constructed of poles covered with mats which were turned up to admit light. The chief's dwelling is marked B. Opposite is the temple (A), "builded rownde and covered with skynne mattes." When towns were distant from streams, the Indians dug ponds for water (C). Feasts and celebrations were held in the middle of the village.



Engraving by Theodore de Bry, 1590

"Their Manner of Careynge Their Children and Attyre of the Cheiffe Ladyes of the Towne of Dasamonquepeuc"

These women differed from those of near-by Roanoke Island in that they wore no wreaths on their heads, nor did they paint their thighs. Their garments were of dressed skin. New World colonists found an abundance of wild fowl (background).

Engraving by Theodore de Bry, 1590

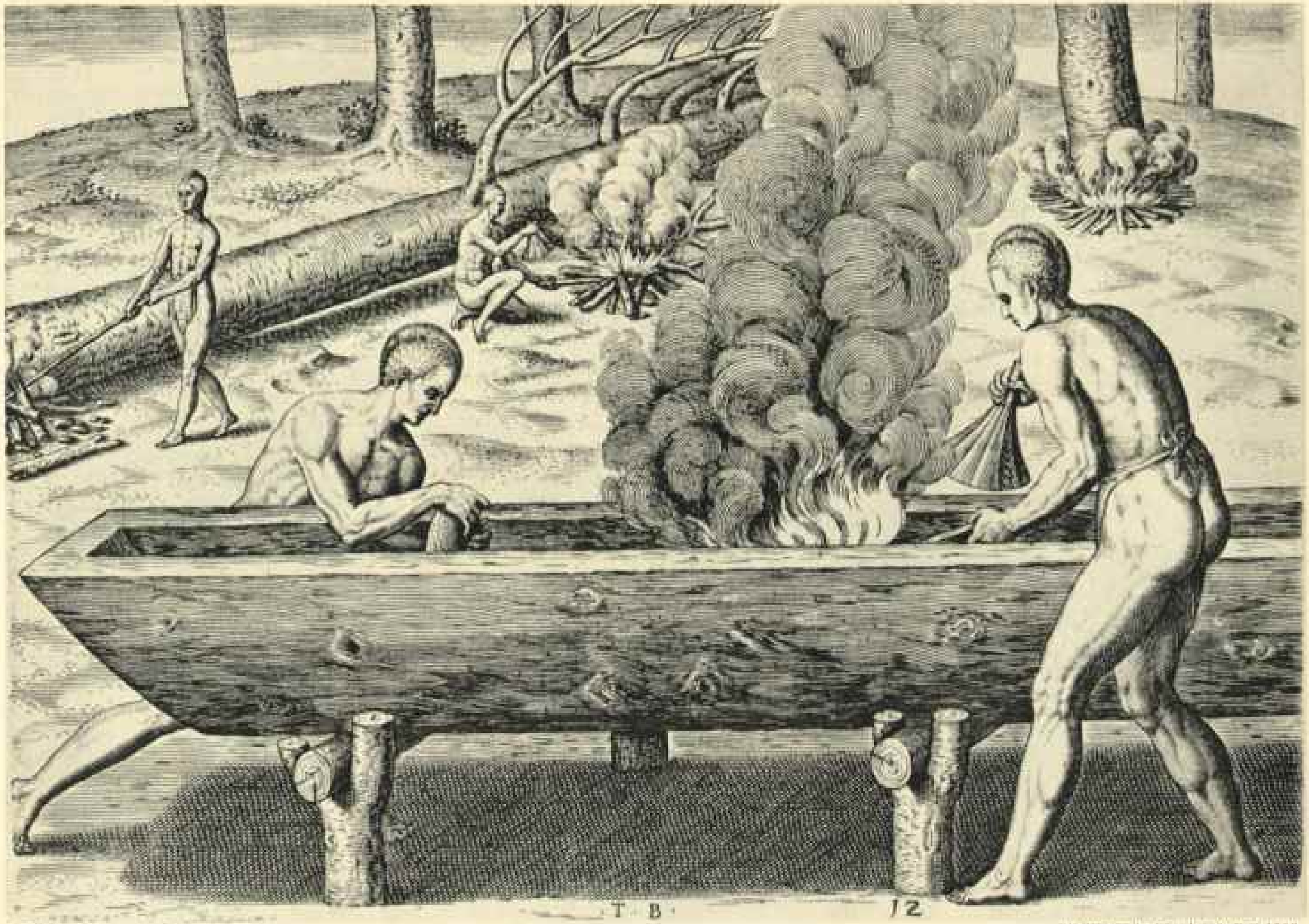
"Weroans or Great Lordes of Virginia Wear the Skinne of Some Beasts . . . the Tayle Hangeth Down Behynde"

Bodies were painted and bedecked with pearl necklaces and copper bracelets. Chests and stomachs were covered with spots where they had been bled when ill. With bows and arrows the Indians hunted game and defended themselves against enemies.

Engraving by Theodore de Bry, 1591

"Their Manner of Colletynge Golde in Streames Runnynge from the Apalatcy [Appalachian] Mountaynes"

The sands also yielded quantities of silver and "brass," the colonists reported. The Indians paddled canoes laden with treasure down the River of May (St. Johns) to trade with the Spaniards in Florida.



Engraving by Theodore de Bry, 1590

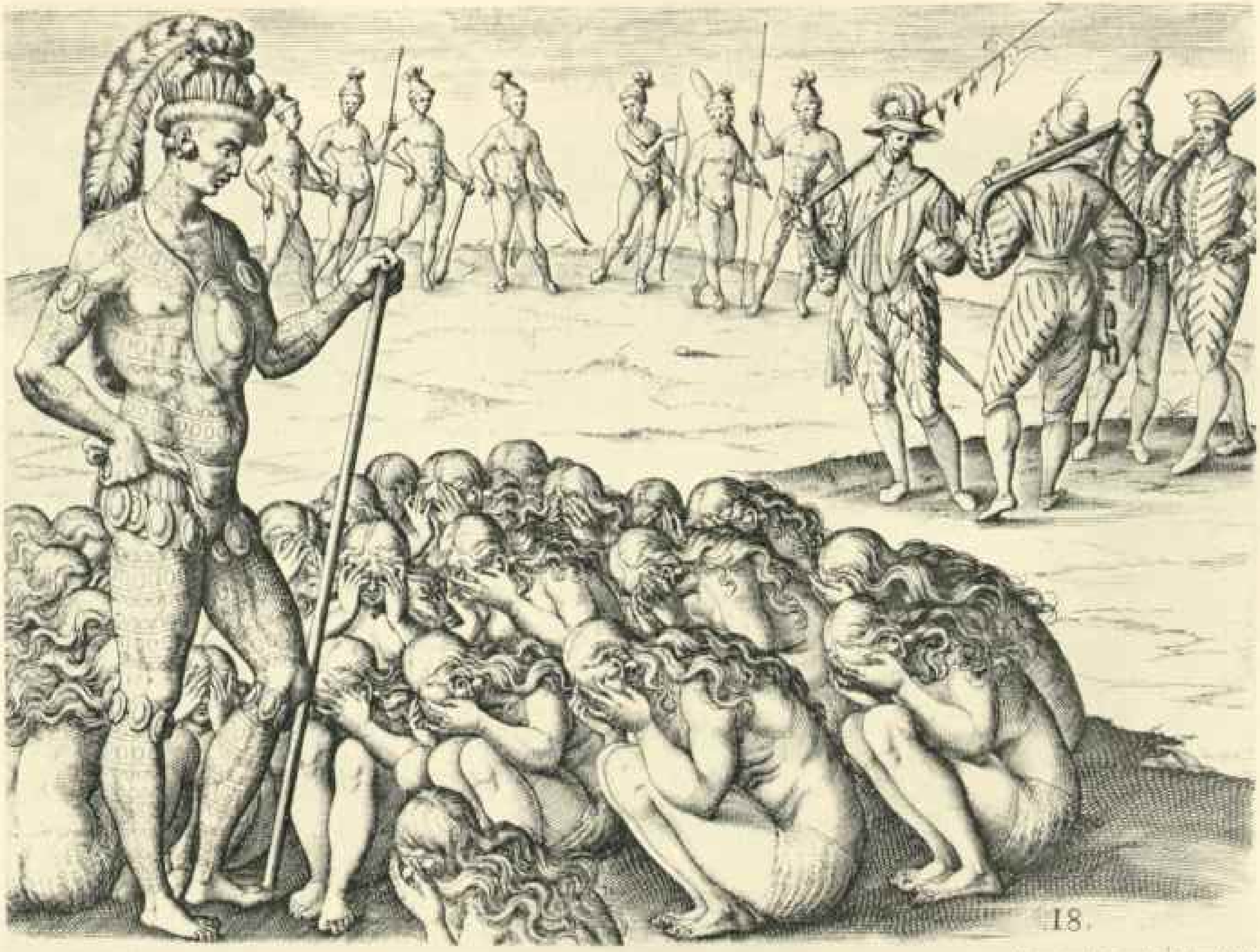
"The Manner of Makinge Their Boates in Virginia Is Verye Wonderfull"

Indians felled trees by building low fires close to the roots (upper right), then burned off tops and boughs (center background). Lacking iron tools, they hollowed out the trunks by burning and scraping with sharp shells.

Engraving by Theodore de Bry, 1591

"Industry of the Floridians in Storynge Their Croppes in the Publicke Granarie"

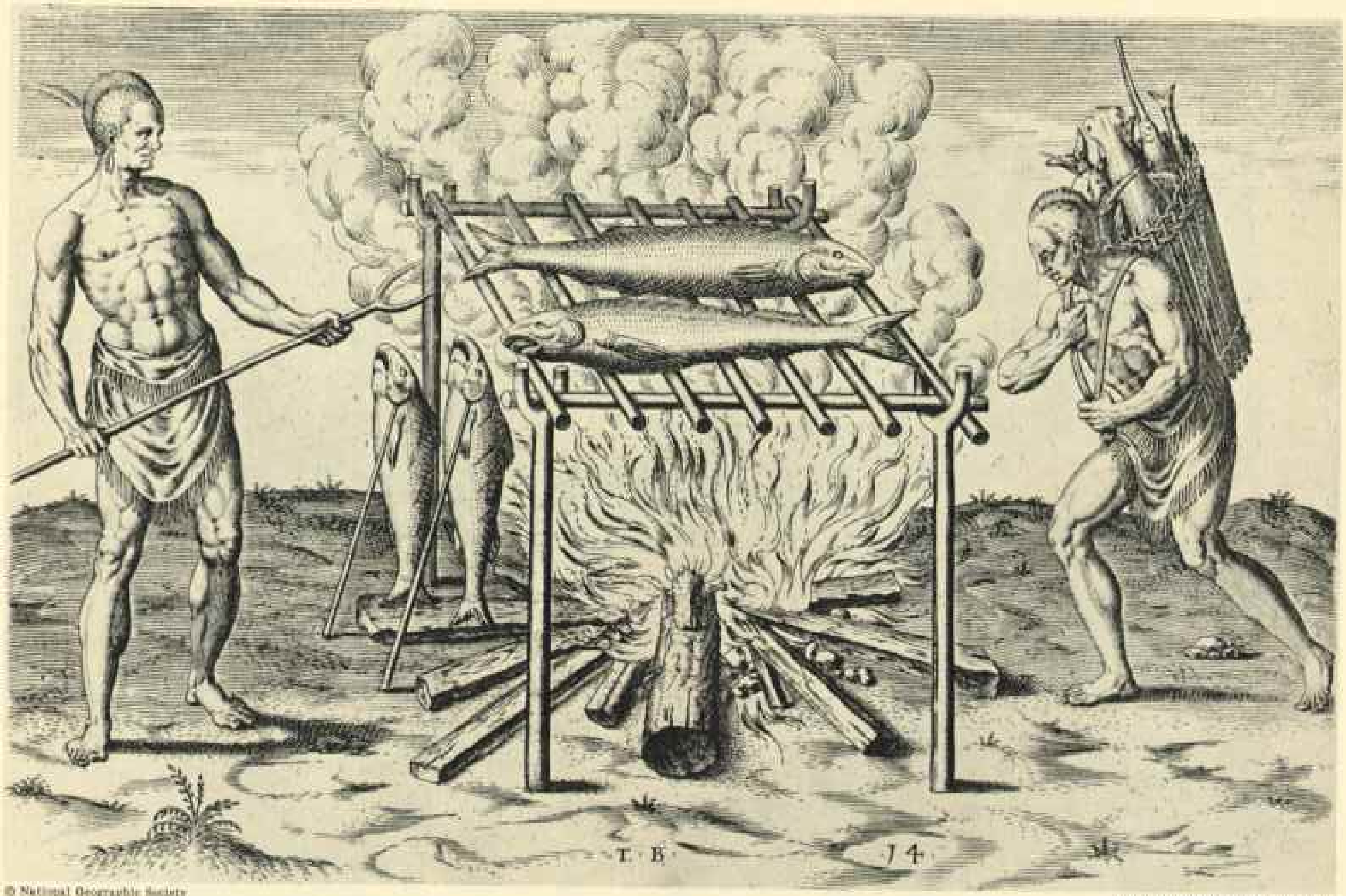
Twice a year natives of the New World loaded canoes with produce and carried it to storage houses built of earth and stone. Such structures usually were erected on shady sites to protect their contents from the sun's rays.



Engraving by Theodore de Bry, 1591

"The Chieffe Applyed to by Women Whose Husbandes Have Died in Warr or by Dysease"

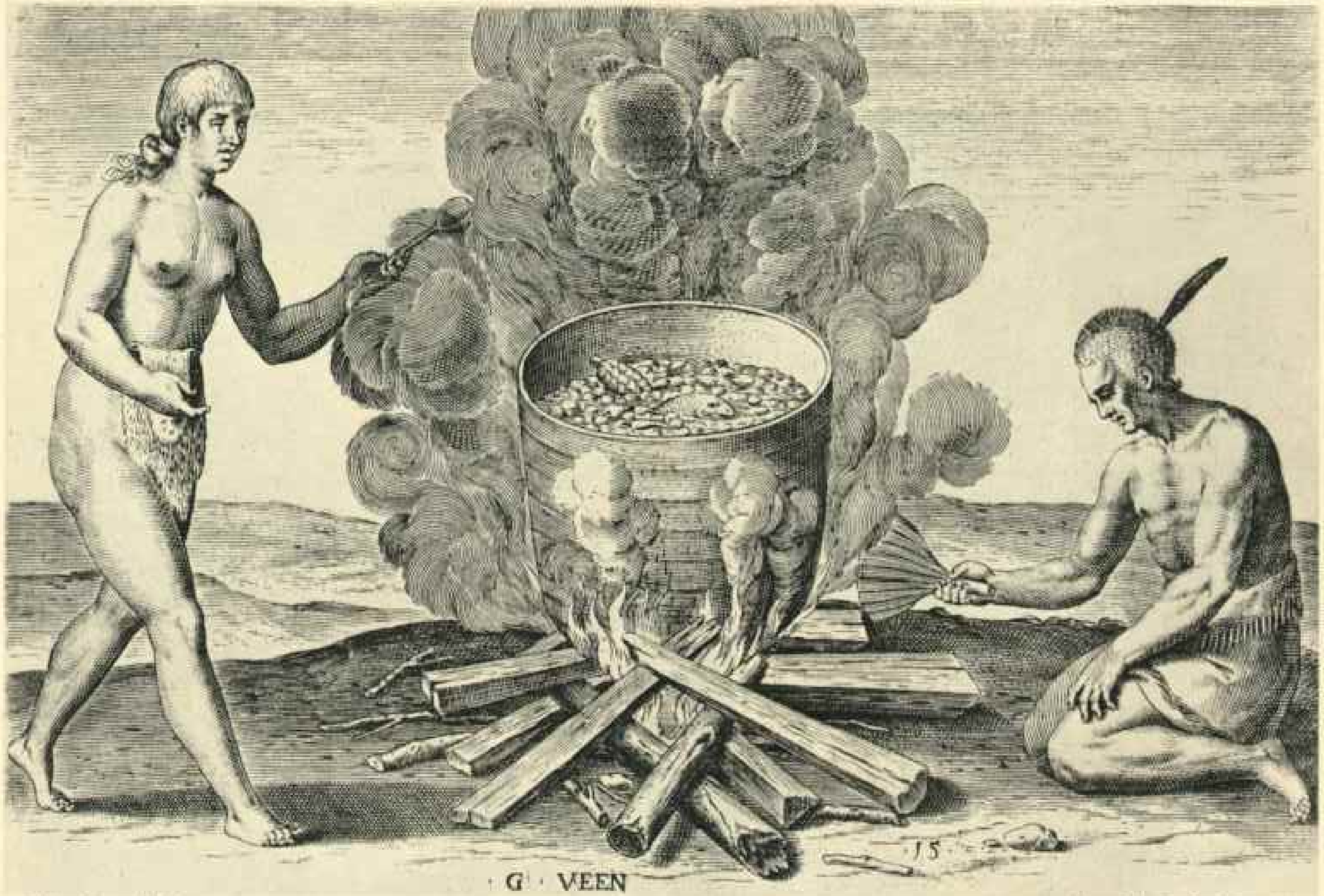
From the chief the widows received sympathy and permission to remarry after a proper period. Then they carried the fallen warriors' weapons to their graves. Colonists (right) are armed with muskets, sword, and halberd.



Engraving by Theodore de Bry, 1590

"Broylinge Their Fishe over the Flame . . . They Take Good Heed that They Bee Not Burntt"

Two shadlike fish sizzle atop a wooden grill supported by stakes; two more are cooked beside the fire. In the basket (right) a new catch includes a garfish and a small hammerhead shark. Virginia Indians ate their fish at once; those of Florida cured them for later use.



Engraving by Theodore de Bry, 1590

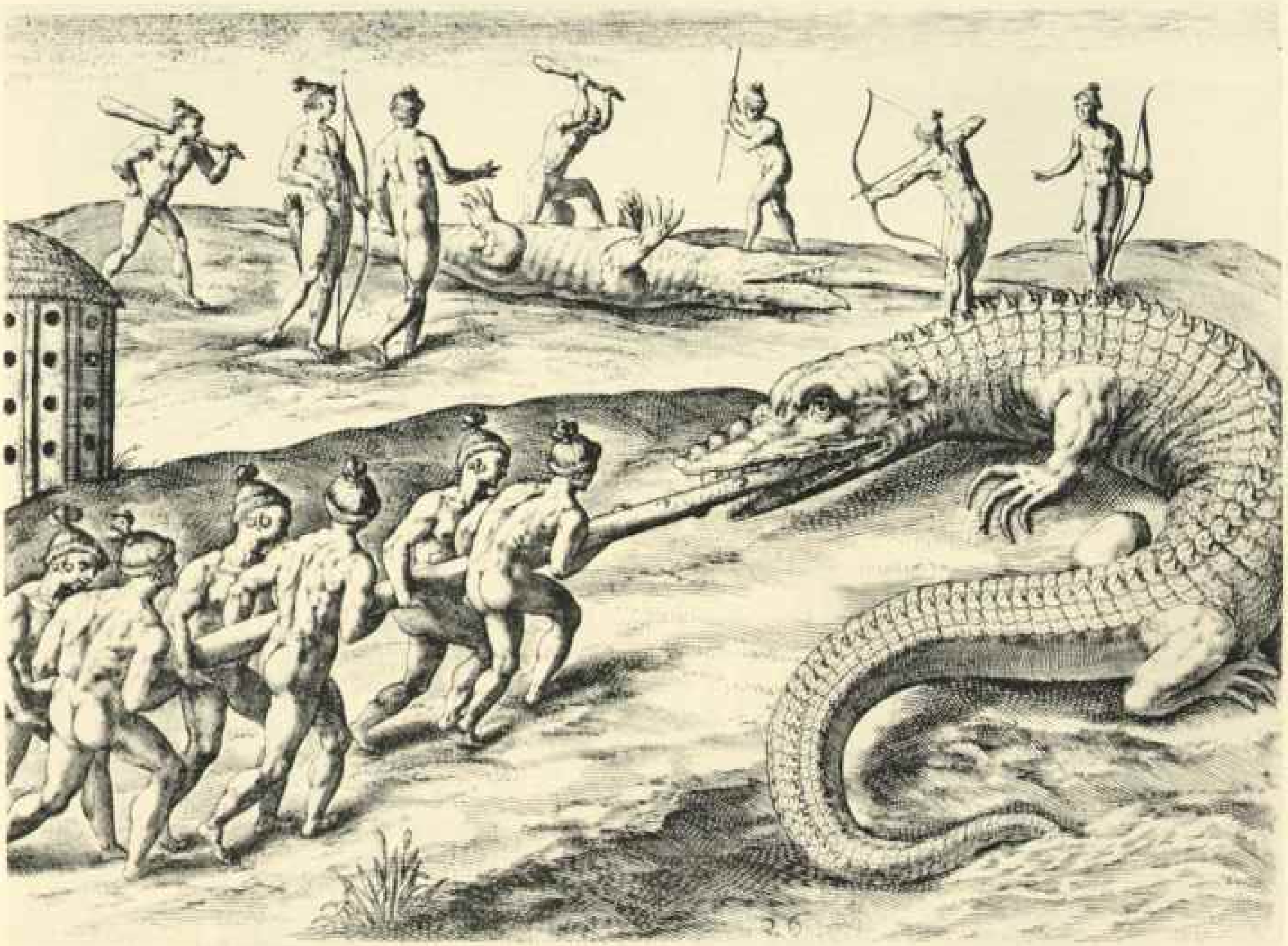
"Their Seetheynge of Their Meate in Earthen Pottes"

Fruit, meat, and fish were cooked together "as in a gallimaufry or olla-podrida [French or Spanish stews]." In his notes the artist suggested that the English might well emulate the Indians' moderate eating habits and thus "bee free from many kynes of diseasyes."

Engraving by Theodore de Bry, 1590

"The Conjurers Use Strange Gestures . . . and Be Verye Familiar with Devils"

A small black bird worn above one ear was the sorcerer's badge of office. Such men were described as "contrary to nature in their enchantments." They were believed to converse with devils and thus learn of their enemies' plans.



Engraving by Theodore de Bry, 1591

"Their Manner of Killynge Crocodrilles"

Shoving a pointed pole into a reptile's mouth, the Indians turned it over and attacked its soft underbelly. The artist probably referred to alligators, although crocodiles are known in Florida. In small huts (left), the Indians kept constant guard against the creatures.

"Att Their Great and Solemne Feastes . . They Dance and Sing"

Several times a year members of the Virginia Algonquian tribes gathered in one of their villages to spend hours singing and dancing, as illustrated here by John White. A great feast climaxed the festival.

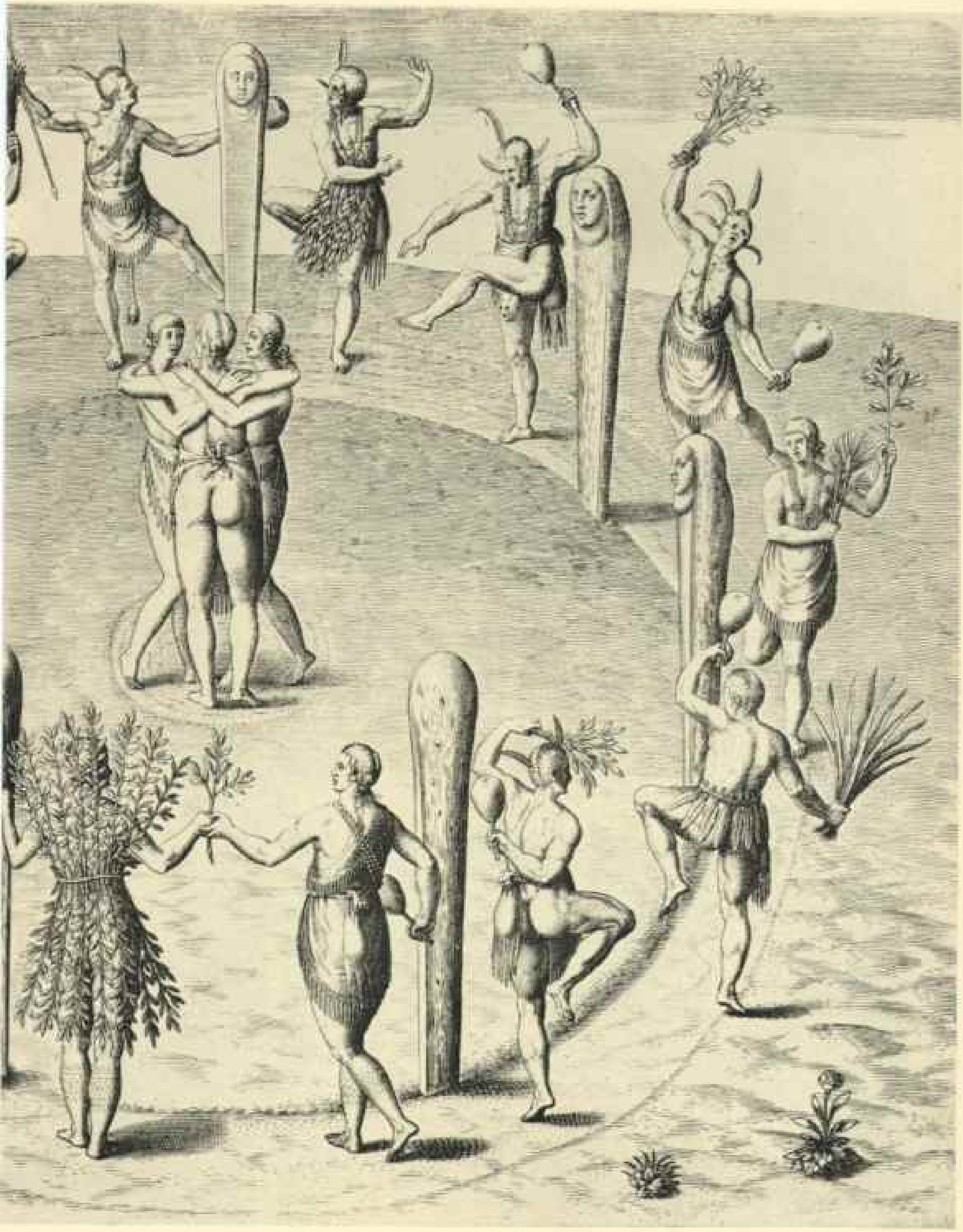
Since many of the Indians brandish or are adorned with parts of plants, most ethnologists agree that they were either praying for a bountiful harvest or giving thanks for crops already gathered. The same scene appears in the picture of the town of Secota (Plate II).

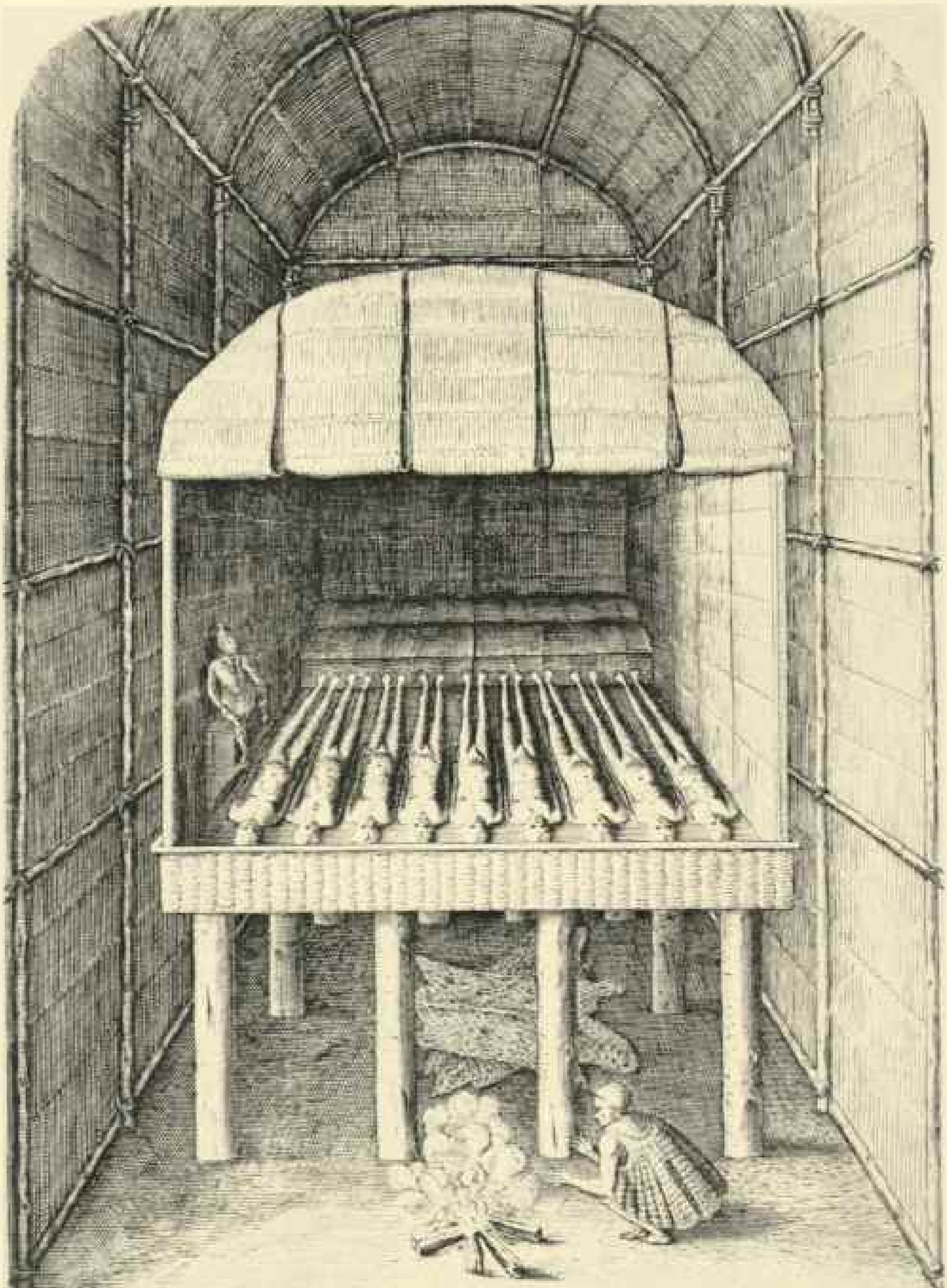
The festivities began after sunset, with the men "attyred in the most strange fashion they can devise, having certayne marks on the back to declare of what place they bee." The dry rattle of seeds or pebbles in gourds accompanied their singing and dancing. When dancers dropped out of the circle because of exhaustion, others took their places.

In the center of the ring enclosed by the carved posts stood "three of the fayrest Virgins of the companie," who embraced each other and turned around and around as the dance proceeded. Indian maidens customarily played important parts in crop festivals.

To White, the carved heads on the post resembled those of veiled nuns. They are assumed to represent minor deities.

Engraving by Theodore de Bry, 1590





 Engraving by Theodore de Bry, 1590

"The Tombes of the Weroans or Cheiffe Lordes"

Here John White gruesomely depicts the Indians' methods of embalming their deceased chiefs whom they venerated even after death. He reported how a leader's body was eviscerated and skinned; then the flesh was removed from the bones and dried in the sun. The skeleton, covered with its own tanned skin, was placed on a scaffold, beside an idol (left). The flesh was wrapped in mats and placed at the feet. The priest (foreground) kept constant vigil, praying for the souls of the departed.

Born Hunters, the Bird Dogs

By Roland Kilbon

THE spaniel, scrambling up the hillside, paused. In front of him, on the sunny side of a boulder, was the sandy depression in which, a moment before, a pheasant had been dusting itself. The scent of game came heavy to his nostrils.

After a moment of tension in which his eager tail flicked faster than ever, the dog plunged into the thicket where the bird had sought refuge at the first hint of alarm.

In an instant, with shrill squawks and rapidly beating wings, the pheasant broke into the air. The dog, at the far side of the brush, sat to watch it fly. There was a shot and the bird fluttered down.

At the command of the gunner the dog was off like a flash toward the point of fall. In a few moments he was back, sitting before his master, proudly looking up for the bird to be taken from his mouth.

Man and Dog an Age-old Team

Here was demonstrated, with 20th-century refinements, the joint effort which brought about an unusual partnership in the animal kingdom—that of man and dog.

Originally, the dog was a larger and more wolflike animal. The man, possibly clad in bear or deer skins, may have used a bow and arrow, a dart, or a sling. But the two were working together to provide something for the pot.

Then, as now, the dog was utilizing its superior sense of smell to locate and flush the game. The man contributed his weapons to bring down the quarry which the dog alone could not get. In partnership they assured each other of a meal.

In the prehistoric period when man and dog began working together, all were hunters. Today the number of dogs trained to hunt forms only a small proportion of the canine population.

Man, to suit his tastes and his mode of living, has reduced many breeds to a size which would have doomed them to speedy extinction in ages when an animal was the prey of any other larger or more crafty creature.

For all the tremendous changes which have taken place over the centuries, one fundamental factor in the original partnership remains. This is the satisfaction which both man and dog draw from their ability to work together.

It is all very well for poets and essayists to proclaim the comfort that comes from a cold nose thrust against one's hand when one is moody or discouraged. But any man who really has worked with his pet will testify that the resulting gratification far transcends the satisfaction of passive companionship.

Both man and dog are elated at the successful completion of any joint project, be it the performance of some simple parlor trick or the most taxing blind retrieve at a field trial.

This fact explains the tremendous growth of obedience trials in recent years. In these, dogs begin with such rudimentary things as learning to walk at heel and to sit when their handlers stop. They carry on through jumping and retrieving to such advanced tests as scent discrimination and, finally, tracking.

Nowadays there is scarcely a dog show in this country in which obedience trials do not have an important place. Usually they can be found by going to those rings around which the crowd is thickest.

Obedience is being widely taught by scout groups and, in large cities, by humane organizations which feel that the better behaved a dog becomes, the more acceptable he will be as an urbanite. This wide participation is not a sudden awakening of civic responsibility on the part of dog owners. It arises because obedience trials again bring into play the basic teamwork of man and dog.

Instinct Survives Breeding Changes

When Georgian's Betty, UD (that UD stands for "utility dog," the highest degree to be won in obedience), retrieves a dumbbell over a hurdle and, the exercise completed, jumps about her handler in pleasure, she exhibits the satisfaction which her ancestors felt ages ago when one of them brought to hand the game his master would share with him.

Betty is a little orange Pomeranian, bred so far down in size from her progenitors which roamed Europe's forests that she would be lost in the hunting field. The fact that she has been reduced to the status and stature of a toy has not dulled her inbred desire to be man's partner.

But on the hunting field this original relationship most clearly survives. There the dog seeks out game for the pot and brings it back.

One has only to watch the pride of any gun dog delivering a bird to know that here is the peak of canine satisfaction.

There are rich rewards, too, for the man who guides a young dog through the intricacies of field training.

Perry T. Jones

A Good Bird Dog Honors His Bracemate's Point

Here the pointer (Plate III), in the van, has scented the birds and has frozen to a point. His bracemate, an English setter (Plates I and II), honors his find by freezing, too. Both will hold steady until their handler arrives and they can be tested for steadiness to wing and shot (page 375).

On the day when the pup, steadied to wing and shot, brings its first bird to hand, its master feels a thrill which comes seldom in the average lifetime.

Field trials provide a competitive outlet for this relationship. They also furnish a yardstick for breeding.

In the field champion the hunting instinct, originally so keen in all dogs, has been little dulled by the effects of civilization.

When a man tells you his dog has the blood of a Comanche Frank, a Mary Montrose, or a Seaview Rex, you know that dog was born to hunt.

It may never attain the stature of these field-trial immortals, for few dogs do, but it will give a good account of itself if taken out after birds.

The Weimaraner, Born to Hunt

The extent to which the hunting instinct is bred into a dog is illustrated by the experience of a man in New England who acquired a Weimaraner pup. This German novelty (Plate XIII and pages 374, 398), used exclusively for hunting for some 300 years, only recently has been brought to this country.

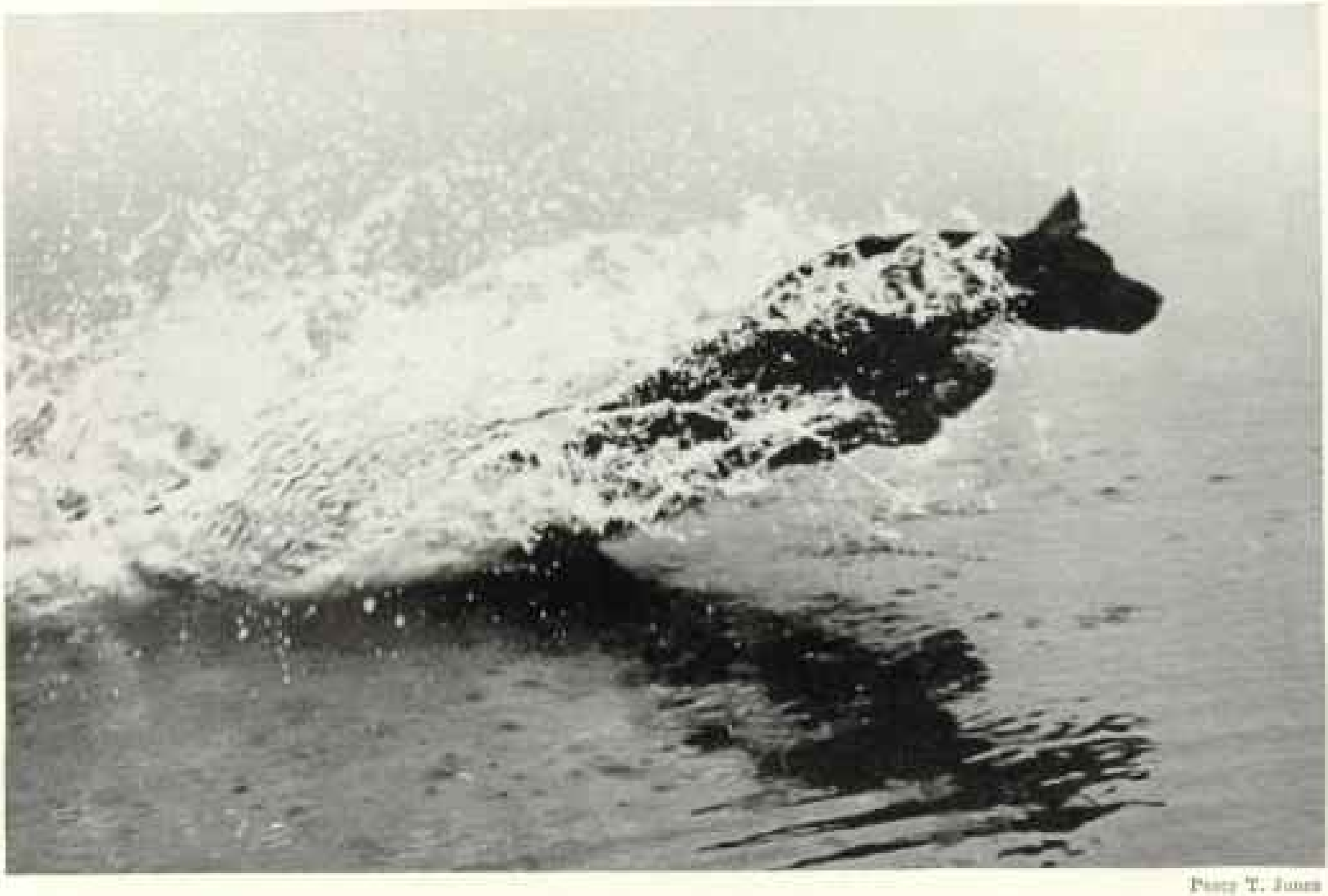
The New Englander was prepared to take with a liberal dose of salt all the things told him about the fine qualities of the breed. However, he was much attracted by the dog's appearance, and so decided to take him.

Writing in a recent issue of the news letter issued by the Weimaraner Club of America, the owner explained that, being busy with other things, he had no chance to train the dog. He did not take him into the field until he was 15 months old, and then decided to let the dog go along for company while he explored some likely cover on the last day of the woodcock season.

They had not gone 50 yards before the dog came to a perfect point. The skeptical hunter concluded that a field mouse had attracted the Weimaraner, but he walked in to investigate and flushed a woodcock, which he killed.

Just to see what the dog would do, he commanded, "Go get the dead bird!"

The dog quartered a bit, caught the scent of the bird, and pointed again. Then, when his master said nothing more, he circled the bird uncertainly, mouthed it a moment, picked it up, strutted back and forth with head held high, then sat down in front of his master and held up the game to be taken.



Percy T. Jones

In His Leap, the Labrador Retriever Shows Canine Determination at Its Peak

The eagerness with which he hits the water, the way he holds his head, denote his fixity of purpose. He is intent upon getting his duck! He marked its fall, and he needed no urging to set out when his leash was slipped, even though the water was frigid. Short, dense coat and thick, oily hide protect him (Plate XVI and page 398).

In the partridge season which followed, the dog had abundant chance to demonstrate that this was no fluke. With no further schooling, he turned out to be a dependable pointer and retriever.

He never pointed a dead bird again, but neither did he ever get over the habit of strutting back and forth a few times, bird in mouth, before coming in to make the delivery!

This eccentricity would certainly count against him in a trial, but his master wouldn't swap him for all the field champions in existence. They have worked out their own partnership afield.

Trained Dogs Aid Conservation

Field trials have an important function aside from demonstrating hunting qualities of the participants. It is their value as a school in which all sportsmen can learn what part a trained field dog plays in conservation.

The man with a good dog can fill his bag with the allotted number of birds much more quickly than the man who lacks the co-operation of a canine partner. Furthermore, he does this without leaving behind a number of crippled birds.

On the basis of questionnaires sent to duck hunters, the American Field reports that last year about 5,000,000 ducks were crippled and lost in a season during which about 19,000,000 were brought to bag. Hunters were almost unanimous in agreeing that the use of properly trained retrievers would have cut that figure tremendously.

All classes of game birds meet the same fate, so it is not surprising that conservationists wish there were some practical means by which every hunter could be required to take a well-schooled dog into the field with him.

Such a wish is unlikely ever to come true. But as field trials continue to spread, and more and more sportsmen see what the well-schooled shooting dog can do, the number of man-and-dog hunting partnerships increases.

The canine halves of these teams have three main functions—to find the birds, to get them into the air, and to bring them back after the hunter has brought them down.

While the average gun dog does all of these, special emphasis has been laid on different parts of the job for different breeds. In the pointing breeds, for instance, stress is laid

Herald Tribune—Ellis

"Go Find 'Em, Boy!" Peerless B'Gay Breaks Away at Command to Hunt in an Orange County, New York, Field Trial

No thoroughbred leaving the barrier shows more verve than a bird dog when the leash is slipped. Off like a streak, this English setter will give the judges' horses a workout until scent of game brings him to point. Long before hunters used shotguns, ancestors of the modern English setter located birds for hunters who carried nets. The dogs were taught to approach quietly, then "set"—sit or crouch—while the net was dropped over the birds.

Bud White from St. Louis Post-Dispatch

How about It, Judges? Whitebridge Wally, as Much at Home on Land as in Water, Completes a Quick Retrieve

This field-trial champion, a golden retriever (Plate X and page 375), shows flashing form in a trial near Bourbon, Missouri. Through the brush, at upper right, a group of handlers watches the steadiness of Wally's bracemate. Upland fowl thrive in Missouri's extensive woodlots and underbrush.

Perry T. Jones

Is He a Pointer or a Retriever?

Until the official status of the Weimaraner (Plate XIII), a newcomer to the United States, is settled, these dogs show their skill mostly in obedience trials. Here one of the breed retrieves a dumbbell over a hurdle, a standard obedience test. Of German origin, the Weimaraner has proved its worth as a hunting dog in this country (pages 370 and 398).

on locating the birds hiding in cover and on keeping them pinned down with a point until the hunter arrives.

In the nonslip retrievers (one whose leash is not slipped until he is about to be ordered out after the bird), the ability to bring back the bird rather than to locate or flush it is emphasized. Spaniels are expected to do all three things—locate the birds, get them off the ground, and fetch them after they have been shot.

Trials for the pointing breeds—commonly spoken of in a group as bird dogs—lead by far in number. Last year approximately 355 were held, with a total of 19,250 starters. This includes the trials held on the Canadian prairies where dogs which late in the winter vie for top honors at big meets in Mississippi and Tennessee receive their first workouts of the season in the preceding summer.

The pointer and setter folk hold what amounts to a grand circuit, starting on the prairies and working southward toward the goal of all top bird dogs, the National Championship at Grand Junction, Tennessee, in late February.

Many prominent trainers have their own camps in Manitoba to which they move in the spring with their young dogs which are prospects for the derby stakes later in the year, and also with their seasoned campaigners.

Prairie chickens, Hungarian partridges, and the other open field birds still are plentiful there, while modern farming, dooming the rail fences and hedgerows, has rendered them scarcer in more thickly populated sections.

Field trials have their sand lots, too, and on these, as in baseball, the big majority get a chance to participate. The average sportsman is bound to be thrilled by the speed, the stamina, the staunchness, and the scenting qualities of a field star, but he will realize that for a day's ramble in the fields such a dog would be as much out of place as Babe Ruth playing three-old-cat.

Such a hunter might burst with pride at owning the winner of the National, but as a hunting companion he probably would prefer a dog with a good enough nose and sufficient control to capture a stake at one of the many small trials held in all parts of the country.

In the parlance of field-trial folk, such

events are called one-course trials, because, since they are not held on big preserves, dogs in successive heats must cover the same ground. It is necessary to plant birds. If this were not done, the first dog down would have all the advantage and those coming later would be unlikely to find a bird.

Dogs Work in Pairs

In all trials, regardless of the breed being tested, it is customary to work the dogs in pairs, both to reduce the time required to give each dog a fair chance and to lessen the number of birds used.

The contestants, in pairs, work through a stretch of open country where the judges can observe their eagerness to hunt and their thoroughness in covering their ground. Then they are brought into the bird field where game is certain to be located.

This artificiality is not without its advantages. The spectator, without having to climb into a saddle to follow the judges, usually can find a point of vantage to see the bird field and part of the course. He also can experience the thrill of the breakaway—the moment when the contestants, fresh and eager to hunt, are cast off. No race horse leaving the barrier is away with more drive than the good pointer or setter when his handler slips the leash and orders him out (page 372).

The sedentary spectator, of course, misses some things. Not for him is the beautiful picture of the smooth-gaited dog, racing along, head high, to catch the faint scent wafted from the bird that may be hiding along a hedgerow. He cannot see the dog hesitate as it catches wind of a lark or, possibly, of a rabbit, and then race on.

Peter T. Jones

Stilrovin Nitro Express Proves He Has a Champion's Heart

The mesh fence with barbed-wire top might stop an ordinary dog, but not a golden retriever with this field-trial champion's determination. Readiness to overcome such obstacles in making a retrieve proves hunting quality.

One surprising thing about a good bird dog is the speed with which it comes to distinguish between all other wild things and the game birds it is seeking.

At the bird field, however, all can see what goes on. At the warning, "Here they come!" the spectators drop their conversation to watch the brace dash into the open.

Holding Point Tests Steadiness

The leading dog gets the scent first and freezes to a point, instantly followed by its bracemate, provided, of course, that the latter does not commit that cardinal sin of ignoring its partner's find (page 370). Once on point, they hold it until the handler comes up, gets

his command from the judges to flush the bird, and then fires a blank pistol cartridge to test the dogs' steadiness to shot.

Such a trial, of course, cannot test the contenders as thoroughly as one of the stakes held on so large a preserve that the dogs can be put down in hour-long heats without covering the same ground.

There the dogs may range far before the cry of "Point!" from the handler brings judges and gallery galloping up. The dog may have to hold its point for some time, so that steadiness and stamina as well as bird sense are severely tried.

Just how long a bird dog will hold a point has always been a moot question. I saw a limited test at an informal trial out on Long Island. A setter, let out of her master's car for exercise, caught the scent of birds in a crate waiting to be taken out for planting.

At once she froze to a point and refused to be distracted by the other dogs and the men moving about her.

At the urging of bystanders, her owner let her hold the point for minutes. She might have held it indefinitely, for all the evidence to the contrary. She hadn't budged when her master decided that she had had enough and called her to him.

This setter was a nondescript animal. She looked as if moths had been having a field day in her coat and she would not have gotten a second look from a judge at a bench show. But there was no gainsaying her proficiency in her own sphere of competition.

There may be some truth in that old tale of the lost dog whose master, months later, found a skeleton of a dog pointing to a skeleton of a bird.

Standards of Field Trial and Bench

Primary interest in hunting skill has widened a gap between field-trial enthusiasts and bench fanciers, especially in the pointing breeds. How dogs cover their ground and how they handle their birds, rather than how they measure up to a bench standard, are of main interest to the hunting fraternity.

This point of view was well exemplified by the accomplishments of a little English cocker spaniel, Druidaig Bess. Seemingly not much bigger than a peanut, and certain to be ignored by anyone seeking an ideal specimen of her breed, she was a most eager hunter.

Too small to follow the flight of her birds even from ordinary cover, she would sit erect on her haunches the minute the bird flushed so that she could mark its flight and fall. On the command to fetch she would be off like a flash and struggle back with a cock pheasant as big as she.

One judge who placed her over a number of much more impressive-looking dogs explained, when asked about it, "She'd have my bag full before the others knew what it was all about. She's a hunting fool if ever I saw one."

Bess has been gone for some years, but I can still see her in memory, sitting erect, quivering with excitement, her eyes fairly sparkling as she watched the flight of her bird.

Neither retriever nor spaniel trials are as common as those for the pointing varieties. There were 61 championship trials for retrievers in 1946 with a total of 1,816 competitors, and 21 official spaniel trials with some 500 entrants.

One Award in National Championship

In some respects, the retriever trials are the best organized of all. A national championship, held early in December, is limited to the 20 dogs which have made the best showing in the open all-age stakes at licensed trials in all parts of the country.

There are no second- or third-place awards in this stake, and the dog which emerges the winner is officially labeled the national champion retriever of the year.

The spaniel field-trial clubs are moving in the same direction, and this December, for the first time, will hold a national championship stake in the Midwest, although not with such strict qualifications as those which now surround the retriever championship.

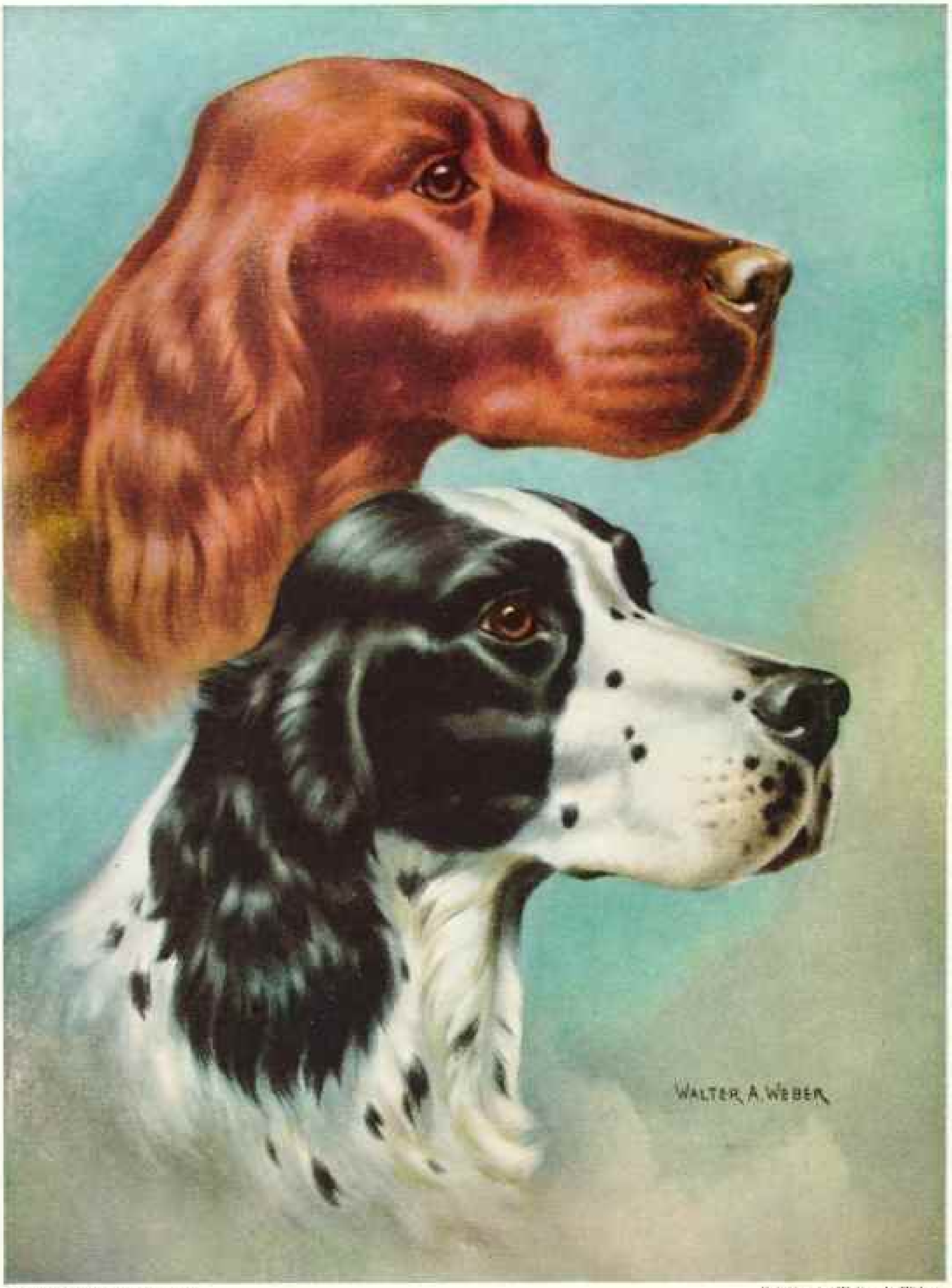
Trials for retrievers and spaniels differ from those for pointers and setters, chiefly in the fact that at the former the birds are killed and the dogs are required to bring them to hand.

Another difference is that, while pointers and setters are ranging far afield, gliding along hedgerows and freezing to a point when they find their quarry, the retrievers and spaniels are at all times under close control.

The retriever is not asked to locate the game. His job is to bring it to hand after it has been brought down. Accordingly, he does not go ahead of his handler and is classified as a nonslip retriever (page 374).

In this category come the Chesapeake Bay, curly-coated, flat-coated, golden and Labrador retrievers, and the Irish water spaniels (Plates IX, X, XIV, XV, and XVI).

Fanciers of the Weimaraner insist that their breed belongs here, too, but the American Kennel Club has held it to be a pointing species. As a result, the Weimaraners have



 Painting by Walter A. Weber

With Graceful Irish and English Setters, It's the Nose That Counts

Once they detect the presence of game, these hunters freeze to alert attention. A rich mahogany or chestnut hue is desirable for the rugged, long-lived Irishman. For show purposes, some white markings are permissible. English Setters are predominantly white, with well-scattered flecks of color preferred to heavy patches (Plate II).

Painting by Walter A. Weber

Camouflage, a Quail's Chief Defense, Fails When Keen-nosed English Setters Strike Its Scent

The bird huddles in the covert (lower right), hopeful that protective coloration will foil the enemy. Rigid from tip of nose to feathered tail, the three setters keep the quarry pinned to earth until their master arrives. Then the quail is flushed, to allow the sportsman a wing shot.

 Painting by Walter A. Weber

Pointers, Result of Centuries of Crossbreeding, Hunt with Flashy Speed and Superlative Staying Power

Greyhound, foxhound, and possibly bloodhound and spaniel blood were introduced into the old pointer strain to produce these lithe, muscular gun dogs, favorites of sportsmen everywhere. The original pointers, which appeared in England about 1650, were used to locate hares, which were then chased by greyhounds.

Painting by Walter A. Weber

Gordon Setters Are as Rugged as Their Native Scottish Moors

These members of the bird-dog aristocracy were named for the Duke of Gordon, reputed to have started the breed by crossing a black setter or "setting spaniel," with a black-and-tan collie. In the hunting field they cover ground slowly but surely and specialize on ruffed grouse and woodcock.

Painting by Walter A. Weber

"Handsome Is as Handsome Does," Say Irish Setter Fanciers

Canine beauty reaches its peak in the rangy silky-haired dogs from the Emerald Isle, but when there's arduous field work to be done they match all competitors. Mystery surrounds their origin; some believe they sprang from a combination of spaniels, pointers, English and Gordon setters. Their cheery disposition makes them perfect pets.

Painting by Walter A. Weber

Friendly American Cockers, Smallest of the Sporting Spaniels, Are This Country's Most Popular Dogs

Of 204,957 entries for 1946 in the American Kennel Club studbook, 73,671—or nearly four times as many as any other single breed—were American Cockers. For shows they have been divided into three color classes: black (upper left), parti-color (upper right), and "ascob," or any solid color other than black (center).

Painting by Walter A. Weber

Superior Weight and Abundant Energy Make English Springer Spaniels Ideal for Hunting in Rough Cover

Among the oldest of the spaniel varieties, these dogs were so named because they "spring" or drive pheasant, ruffed grouse, woodcock, and other game from their hiding places. They are also excellent water dogs and retrievers. A 17th-century print shows Springer Spaniels flushing birds for mounted hunters.

Longer Legs Give the English Cocker an Edge over His American Cousin

This dog has a longer muzzle to cope with the largest game birds. His head resembles that of a setter (Plates I, II, IV, V), in comparison with the American cocker's more rounded skull (Plate VI).

Painting by Walter A. Weber

Extra-heavy Coat Makes the Welsh Springer an All-weather Spaniel

More difficult to train, the Welshman lags behind other spaniels in popularity, and is rarely seen in the United States. This breed comes midway in size between English cocker and English springer.

 Painting by Walter A. Weber

Irish and American Water Spaniels Share an Enthusiasm for Wet Going

Both are fearless swimmers, at their best as retrievers of waterfowl. The topknotted Irishman (upper) is less useful in upland shooting; long hairs of his waterproof coat catch in briars. Tallest of the spaniels, he is loyal to those he knows but often forbidding to strangers. His American relative is more amiable.

Golden Retriever's Ancestors Guarded Sheep on the Caucasian Steppes

An English nobleman developed this breed from a troupe of Russian trackers which he bought from a circus in 1860. Crossing them with the bloodhound accentuated their keenness of scent.

© National Geographic Society — Paintings by Walter A. Weber

Sussex Spaniels, Built Close to the Ground, Are Determined Hunters

Seldom seen in America, these low-slung dogs are best adapted to sport in the English county whose name they bear. They often bark when on the scent, a serious fault in bird work.

An English Name Belies the Sedate Clumber Spaniel's French Origin

First dogs of this breed seen in England were sent to Clumber Park, the Duke of Newcastle's estate, by a French nobleman. There they were crossed with the basset hound, also from France.

Paintings by Walter A. Weber

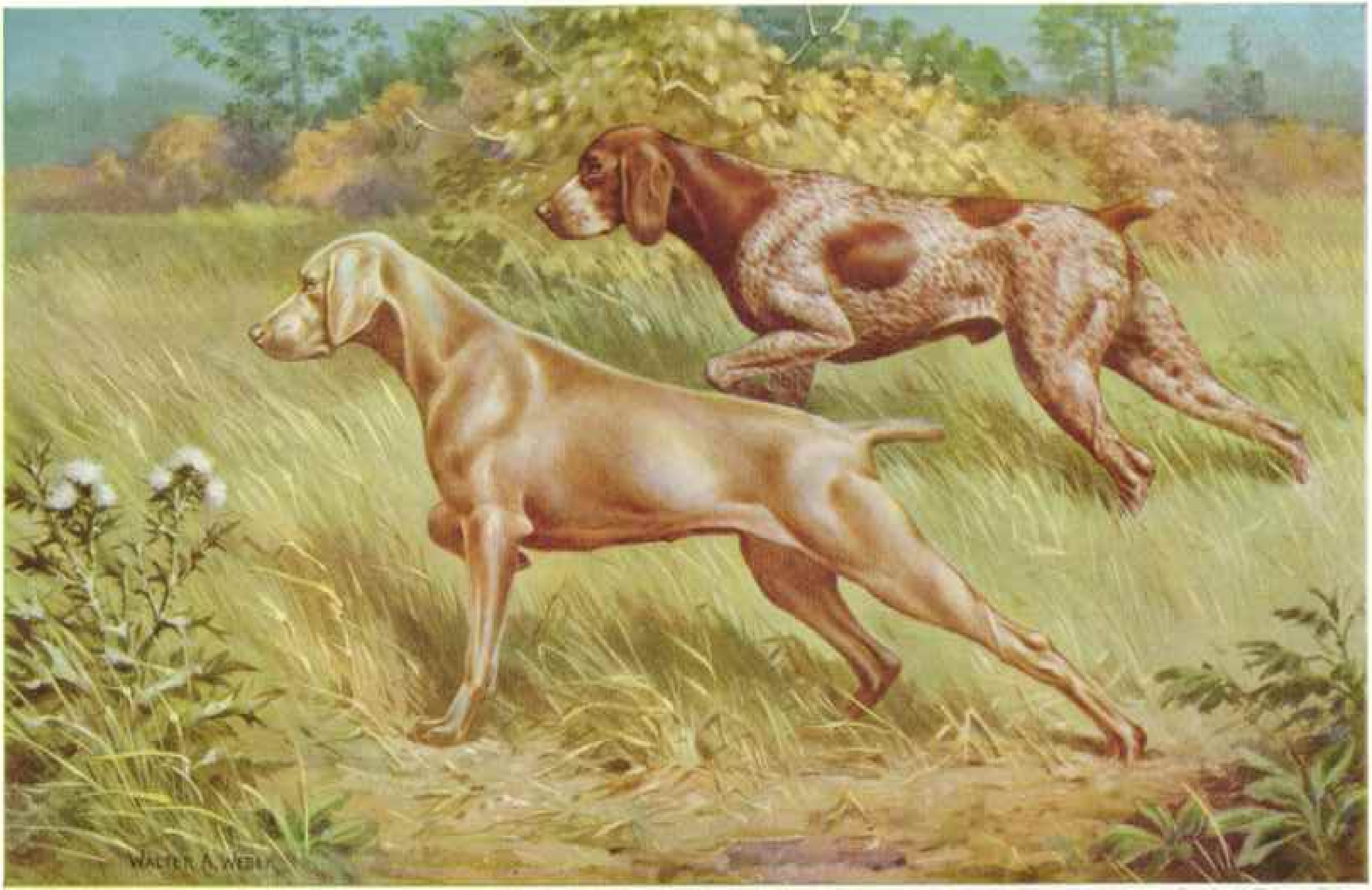
Wire-haired Pointing Griffon Caused a Father and Son to Quarrel

E. K. Korthals, a Netherlander, spent years developing this breed, and so displeased his father that he was obliged to leave home. His experiments, continued in Germany, finally produced a useful gun dog.

Painting by Walter A. Weber

Brittany Spaniels, Rangy and Powerful, Are Favorites with Hunters in New England and French Canada

One of the oldest hunting breeds, Brittany Spaniels resemble setters in general working style. Nearly a half century ago a French sportsman, Arthur Enaud, introduced the blood of pointers and other breeds to rescue the line from degeneration through many years of inbreeding.



 Painting by Walter A. Weber

Germany Contributes a Novelty, the Weimaraner, and an Old Stand-by, the Short-haired Pointer

Named for the Thuringian city which gave Germany its pre-Hitler republic, the Weimaraner (foreground) is new to most American bird-dog fanciers, although known in Europe for 300 years. Webbed feet and water-repellent coat make the German Short-haired Pointer a favorite with waterfowl hunters.

Painting by Walter A. Weber

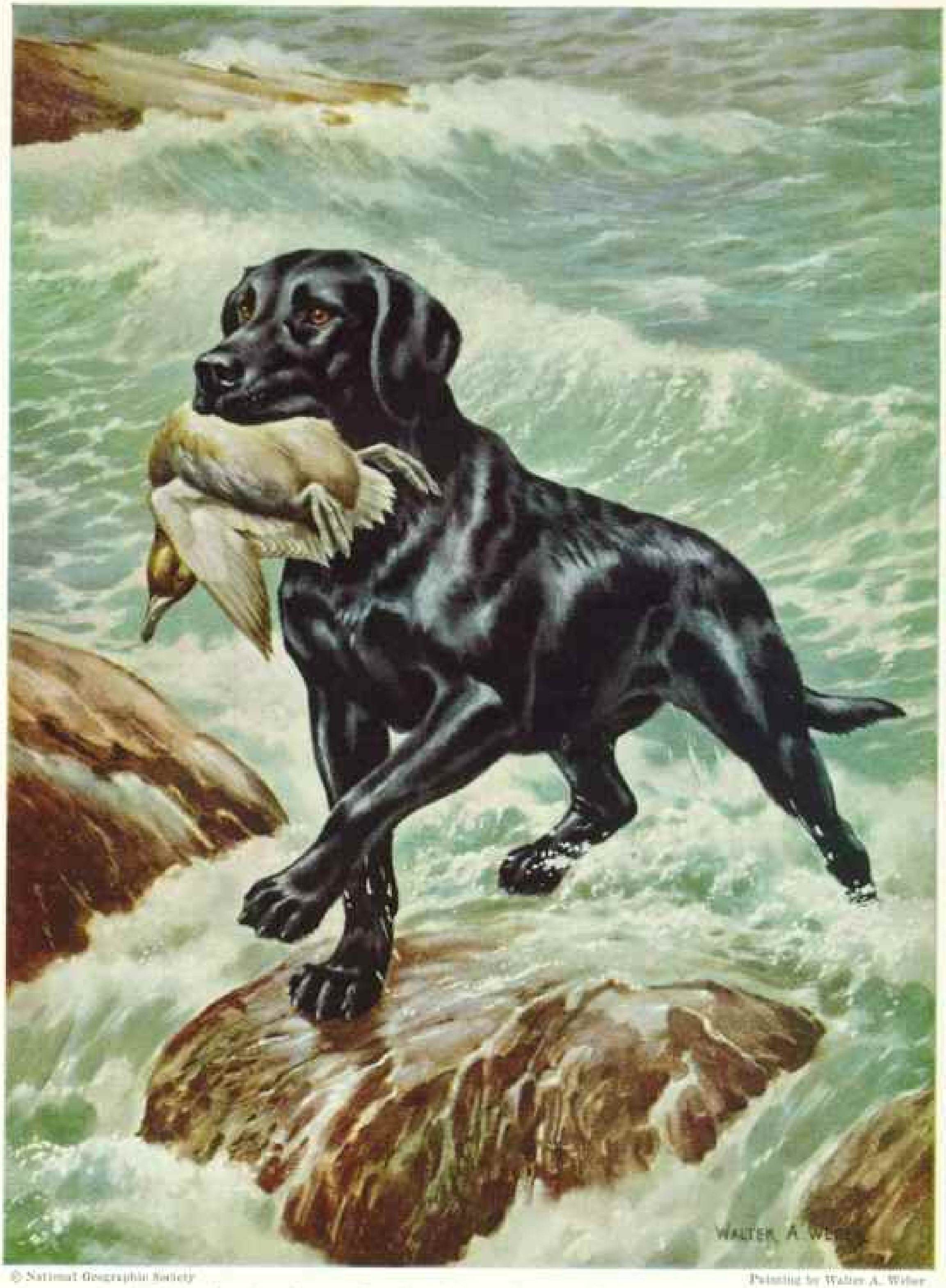
Equally at Home in Marsh and Upland Cover Are Curly-coated and Flat-coated Retrievers

"Curly" (left) owes his crisp, crinkled coat to crossing with the poodle, one-time retriever of France. His lineage also includes spaniel blood. This breed was popular in the United States until overshadowed by the Labrador (Plate XVI). Flat-coated Retrievers, common in England, are rare in America.

Painting by Walter A. Weber

Result of a Shipwreck Is the Chesapeake Bay Retriever, a Native American Sporting Dog

This breed has developed since 1807, when two Newfoundland puppies, brought to the Maryland coast in a disabled brig, were crossed with local retrievers. A dense undercoat protects the Chesapeake against severe weather. Reddish-tan outercoat blends with marshy cover. Some specimens have retrieved 500 ducks in a day.



Painting by Walter A. Weber

Labrador Retriever Gets Its Name from a Geographical Mix-up

Actually, this breed came from Newfoundland and was originally called the St. John's Newfoundland or St. John's Water Dog. Fishermen carried the first specimens to England, and in the early 19th century more were imported. Despite early attempts at interbreeding with other retrievers, the original strain was kept pure.

participated in few formal trials and have demonstrated their adaptability to training mostly by their work in obedience tests.

Since the dogs are not required to flush the game, judges of retriever trials enjoy broad latitude in planning the tests. These can be made progressively more difficult as the competition in a hot stake narrows down to a few dogs.

Judges can direct how far ahead of the dogs the birds are to be released and can govern, to some degree, the type of cover in which they are to be brought down for a land test, or how far out in the bay or stream they are to be dropped for water work.

In the final series of the 1945 national championship, the judges ordered a triple retrieve—two birds shot down in front of the decoys and the third dropped in high reeds about 150 yards away in the marsh.

The sensation of that meet was the manner in which F.T.Ch. Scoronine of Deer Creek, a Labrador, marked and remembered those falls. With a minimum of direction he got all three with a speed and dash none who saw him is likely to forget. There was no question in any mind that he remembered his falls perfectly.

The dog with such a memory of course has an advantage over other competitors. But the dog which lacks that faculty can offset it to some extent by the readiness with which it follows the directions of its handler.

Ordinarily, while retrieving one bird a dog will lose its marking on the other. Then it must rely on the man, turning at the sound of a whistle and promptly following the hand signals, left, right, or straight ahead, as the case may be.

Reason for "Blind Retrieve"

The man hunting waterfowl does not want to be sending his dog out continually, especially when the birds are coming in fast. This has led to the inclusion, in virtually every stake, of at least one difficult "blind retrieve." For this dead birds are planted, and the dog, which has had no opportunity to mark a fall, is sent after them.

In the course of such a test the retriever usually is required to cross one or more bodies of water and proceed some little distance ashore. Under such conditions, a dog which will not take direction readily from its handler is at a tremendous disadvantage.

The dog on a blind retrieve has no way of knowing whether it is seeking a duck floating on a wind-whipped bay or a pheasant in the brush ashore.

There are anxious moments for the handler and periods of intense interest for the spectators when a dog, forced to swim against wind and tide on such a quest, starts circling uncertainly before catching the handler's signal and plunging ahead to the opposite shore.

Once a good retriever knows that this is a land instead of a water test, it begins casting about for the scent, since, from the point where the dog is dispatched inland, the cover usually makes further hand direction impossible. Then there is more suspense until the dog, bird in mouth, reappears on the far shore and plunges in to bring the game to hand.

Retrievers Show Mettle in Water

Although, in the National Championship, land and water tests are evenly divided—there are five of each—the straight water work, it always seems to me, shows the retrievers at their best.

On a cold autumn day, when the spectators huddle in their warmest hunting clothes, it is thrilling to watch a good retriever unhesitatingly plunge into icy water after a brace of ducks.

Ordinarily, one duck presents no great difficulty. The dog, from the blind, has marked it and goes directly after it. Getting the second is something else, especially if, as is often the case, wind and tide have carried it some distance from the original fall.

Then the dog may be called upon to swim a long distance in a chop that often will break over its head, especially when it is returning upwind with the duck in its mouth.

If, at the end of such a test, the dog can deliver the bird smartly to the hand of its owner, shake itself, and wag its tail in appreciation of a job well done, he or she is worthy of being classed with champions.

Sometimes, since the best of gunners are not infallible, the duck will have been merely winged and hence able to swim strongly. This can work to the advantage of the dog, since a bird that is moving is easier to spot than one floating dead. But the retriever is in for a race that can be both taxing and spectacular.

I recall one contest in which the bird was fully capable of swimming and diving but not of flying. It would go down almost as the dog was on it and then reappear a bit later behind the dog or far to one side. It was a grueling contest for the dog.

That he won is one reason why conservationists contend that a dependable retriever should always be used, especially in hunting waterfowl.

While all trials have their special elements

Peter T. Jones

Briars Which Tear at Dog and Bird Alike Can't Stop His Retrieve

Ability to crash through punishing cover puts the English springer spaniel (Plate VII) high in favor for upland hunting in the United States.

of appeal, I admit partiality to those for spaniels. This is solely because they most closely approximate conditions encountered in a day's hunting.

Although these trials are open to all spaniels except the water spaniels, tested as retrievers, and the Brittany (Plate XII), whose tests are like those for bird dogs, they have come to be pretty well monopolized by the springers.

Springer vs. Cocker

For the type of cover found in upland hunting in the United States, the springer, with its greater bulk, is regarded by many as a better bet than the cocker. This, however, is an impression which the cocker spaniel fanciers are striving to overcome. The American Spaniel Club is supporting a move to get more cockers into the field.

One of the most consistent trial performers I ever saw, F.T.Ch. Cinar Spot of Earlsmoor, was an English cocker (Plate VIII), longer in leg and muzzle than his American cousin.

At the first trial where Spottie appeared in the all-age stake for cockers, we thought a springer had got into the event by mistake. He hurdled bushes and bunch grass through which a cocker would have had to weave its way.

Last autumn, at the age of ten, he was still showing the same fire and drive which in the intervening years had won him such high honors.

A veteran trial spaniel will quarter back and forth, covering a rectangular piece of ground approximately fifty yards in front of, and on either side of, its handler. At its master's order it will plunge into a thicket where a bird might be hiding, even though an almost impenetrable wall of briars is in its way.

When with cries of alarm and whirring wings a pheasant breaks into the air, the dog will sit to mark its flight and fall. Then,

Percy T. Jones

Proud of a Job Well Done, the Cocker Awaits His Handler in Approved Form

In a finished field-trial performance, this English-type spaniel has flushed the pheasant, marked its fall, and made the retrieve. Now he will wait quietly until the judge orders his handler to take the bird.

on a command to fetch, it will dash out and bring the bird back.

As in all other trials, the spaniel must honor its bracemate's work, no matter what the temptation. He or she may have been on the point of flushing its own bird when called to halt because of the successful flush by its bracemate. And the dog must remain steady even when, as was the case in one stake last autumn, the bird shot for its bracemate fell not more than a dozen feet from its own nose.

The flush had been made from a thick clump of bayberry, and the bracemate, with no chance to mark the flight or fall, had some difficulty in taking direction and had to cast about where the other dog was sitting.

Throughout that ordeal, with a pheasant lying temptingly under his eye, the first dog remained steady, although quivering with excitement. It was a performance which gave the tempted dog a better rating in the judge's book than the one doing the hunting.

Steadiness, as long as it does not arise from laziness, is a great attribute in a spaniel. Its natural instinct—inherent in most dogs—is to pursue at once the bird it has flushed.

The dog which breaks into a wild dash after a bird can strip the whole course ahead of him of its game and leave it barren for the next contender. Although this is a cardinal sin in a field-trial dog, I have seen the best of them commit it.

Fleet Too Hasty

I recall one time when the greatest springer it was ever my privilege to watch, F.T.Ch. Fleet of Falcon Hill, was so overwhelmed by the instinct to get his bird at once that he broke like a puppy. His crash into a clump of cover sent a big cock pheasant whirring out the other side.

Up to then, his capture of the spaniel event of the year, the open all-age at Fishers Island, New York, had seemed a cinch.

As in retriever trials, nothing so tests the merits of a spaniel as a bird which has been winged, rather than killed, and has thus become a runner, able to get away from the spot where it was brought down.

This tests not only the dog but the handler's faith in him or her, since the handler ordinarily has no way of knowing that the bird is not where it landed. If he loses faith in his canine partner and tries to call the dog back to the spot where he thinks the bird is, the retrieve may never be made.

I recall one instance where a bird was brought down in some marsh grass at the edge of a road. A moment later, in sight of dog and handler, a bird scurried across the road into some brush near where the pheasant had been brought down. When the dog reached the spot, he scented the running bird, hesitated a moment, then started on toward the fall.

Instead of letting him go, the handler turned him on the trail of the runner. Several times the dog tried to come back, but each time he was ordered off to the right.

Finally the judges directed that he be taken up, and the hunt proceeded down the road. There, almost in sight at the edge of the grass, was the dead bird which the dog would have brought back quickly if the handler had not been sure that he knew more about the situation than the dog did.

Cinar's Soot Keeps His Head Down

One of the most spectacular performances I ever watched developed out of the pursuit of a runner.

A pheasant, flushed by a little black English cocker, Cinar's Soot, was brought down on a steep hillside. It had been winged, but it could run as fast as ever.

The dog picked up the trail at the point where the bird had fallen and began a chase, every detail of which was visible to the gallery. The pheasant zigzagged back and forth up the hill, wisely moving downwind away from the dog.

At times the bird was not more than a dozen feet above the dog. If only he had looked up, he could not have missed seeing his prey. His friends in the gallery almost prayed that he would lift his eyes. But he was on a job, not sight-seeing. That job called for him to keep his keen nose to the fresh track.

It would be pleasant to be able to report that Soot made the retrieve. None doubted that he could have done it, but to meet the time schedule of the trial he was called up after the bird had got over the top of the hill, and a gamekeeper was sent after it.

A similar episode with a happier conclusion occurred one autumn in the Valley Forge trial at Fort Washington, Pennsylvania. There a pheasant, flushed on the crest of a hill which provided a grandstand for the gallery, came down at the edge of the woods in the valley.

The bird proved a strong runner, and the cover was not so heavy that the spectators could not watch as it zigzagged back and forth among the trees, trying to shake off the persistent trailer.

The dog—a springer whose name, if memory serves correctly, was Pheasant Run Jill—went directly to the fall and picked up the fresh scent. Like little Soot, she kept her nose faithfully on the trail when, if she had stopped to look about, she might have seen the quarry.

She did a beautiful piece of tracking and finally came up with her bird. It was one of those fortunate breaks—a chance to show persistence and keenness of scent in full sight of spectators and judges—which sometimes decide close contests.

Since, in any hunting, water may present a problem, the spaniel trials, too, have their water tests. These, however, are merely to prove that a dog will not hesitate to enter water when necessary; so there is nothing complicated about them.

As a shot is fired, a bird is thrown into the water and the dog is ordered to make the retrieve. A dog which refuses to make the swim cannot qualify for a field title.

One of the great appeals of field trials is that participation need not involve much expense. There are, of course, those who have invested huge sums in building up kennels of top dogs under the care of expert professionals. But they are few compared with the persons with one or two dogs which they have bred and trained themselves.

Sudden Sue Trained on Pigeons

A sensation of last autumn's spaniel trials was a springer named Sudden Sue. Her owner is a mechanic who had trained her himself in his own back yard. Unable to afford live birds on which to teach her retrieving, he schooled her on pigeons, which, thanks to modern refrigeration, he could use over and over.

To get the money necessary for a trip east to compete in the big stakes there, after he had scored impressive victories in the Midwest, he worked overtime shifts at the factory.

His reward was a beautiful collection of silver trophies, topped by that one which goes with winning the national amateur stake of

the English Springer Spaniel Field Trial Association, the blue-ribbon event of spaniel competition held each autumn at Fishers Island.

To be sure, this Cinderella touch is not encountered every day, but it happens often enough to emphasize the democracy of field trials. Hunting clothes in themselves are leveling, since weather-resisting qualities rather than any style or cut interest their wearers.

Then, too, at a trial, participants and members of the gallery have one thing in common—all are dog lovers and most of them are dog owners.

Whether the background is the fresh green of spring or the brilliant crimson and gold of autumn, it is not surprising that field trials hold a special place in the hearts of many people.

Georgia Knothard

This Cocker Puppy Knows a Wet Nose Is a Keen Nose

Still a long way from the hunting field, he instinctively wets his in anticipation. But the wide popularity of friendly little cocker spaniels as children's pets may result in a stay-at-home career for him. He may never go a-hunting after all.

Detailed descriptions of eighteen breeds of field dogs appeared with the article, "Field Dogs in Action," by Freeman Lloyd, published in the January, 1937, issue of the NATIONAL GEOGRAPHIC MAGAZINE.

Since then, two other breeds have gained established places for themselves in the United States—the American Water Spaniel and the Weimaraner.

The American Water Spaniel

Although not given official recognition by the American Kennel Club until 1940, the American Water Spaniel (Plate IX) has been a popular hunting dog for years, especially in New England and the Middle West.

What kept the breed out of the official studbook was the fact that its owners were interested in the dog as a companion in the field and not as a bench-show competitor.

This American's origin is obscure, but coat, color, and liking for water indicate a generous proportion of Irish water spaniel in its blood.

Slightly smaller than the springer spaniel and larger than the cocker, the breed lacks the pronounced stop and domed skull of the American cocker.

The coat, a solid dark chocolate or liver, is closely curled to give protection against the coldest water or most punishing cover. Like the Irish water spaniel, the American carries a full tail—other spaniels have theirs cropped short—but it should be well feathered, not ratlike.

An eager hunter, this dog springs its game, as do the other field spaniels.

Basil White from St. Louis Post-Dispatch

Field Trial Champion Shed of Arden, Labrador Retriever, Shows His Mettle

Here at a Bourbon, Missouri, field trial, his eyes were fastened on the duck the instant it began to fall. In this calm water he can keep it in sight as it floats. In rough tidal currents he might temporarily lose track of his quarry. Then he would look back to his handler for signals to help him relocate the bird.

The Weimaraner

Like many of the "made in Germany" breeds, the Weimaraner (Plate XIII and page 374) is based on the Schweisshunde, a solid-colored bloodhound.

The breed was developed by nobles of the court of Weimar who wanted a distinctive variety of sporting dog for their game preserves. It reached its present refinement about 140 years ago, but was so closely held that it was unknown outside of its native duchy. It was not entered at bench shows or field trials, and a vote of three members of the Weimaraner Club was sufficient to prevent any outsider from acquiring one of the dogs.

First to Import Breed

In 1929, Howard Knight, a sportsman from Providence, Rhode Island, was admitted into the club, and thus for the first time Weimaraners came into American hands. He brought the first pair to this country and subsequently imported six others which became the foundation stock here.

Probably the most striking thing about the Weimaraner is its coat of solid color, ranging from silver gray to silver taupe and looking like fine velour.

The eyes, blue-gray or amber, changing in different light or when the pupils are dilated, add much to its attractiveness. The tail, cropped to the length of 1½ inches within three days of whelping, is approximately six inches long at maturity.

From its bloodhound ancestors the Weimaraner retains a keenness of scent that makes the breed especially good in tracking, locating, or retrieving game.

Writing under the name of Arthur Roland, the author of this article has been the Kennel Editor of the New York Sun for more than twenty years.

Split-second Time Runs Today's World

By F. Barrows Colton and Catherine Bell Palmer

EVERY night when the sky is clear, high on a hill above Washington, D. C., an astronomer takes a look at the stars to see if the Nation's clocks are right.

His job is to check just how fast the earth is turning. From that turning the whole world gets its time.

Our giant planet of solid rock, with its thin skin of continents and oceans, weighing well over six sextillion tons, turns at a speed that varies less than the works of the best clock ever made.

On his lonely vigil while the Nation's Capital sleeps, the astronomer times this speed of turning. His is the most crucial timekeeping job done anywhere, for the turning earth is the master clock by which all other clocks are set. It is accurate to within one part in 30 million.

This nightly task of timing the earth's rotation is carried out at the U. S. Naval Observatory, official keeper of the Nation's time.

Astronomer Rides Merry-go-round Earth

Think of the earth as a giant merry-go-round, spinning around in space out among the stars. Riding around on it, you pass by the same point every time it completes a turn.

As the astronomer rides around on the earth, he notes what time he passes directly under a certain star. Carrying him on around as it turns, the rotating earth brings him back the next night to the same position once more, and he notes again what time he passes under that same star.

The interval between any two times when the astronomer passes under that star is always the same within an extremely tiny fraction of a second.

By this standard the Naval Observatory regulates its radio time signals, sent out every two hours on the odd hour and heard all over the United States and the world. Those signals are accurate to within 8/1000 of a second. They are set, as near as is humanly possible, by the time of the earth's turning.

A Signal Every Second

All the world lives by this "earth time," which astronomers call star time or sidereal time. It is the most nearly accurate time available. No clock or watch can match the precision with which the turning earth brings that astronomer and his telescope back under the same star night after night, through the years and centuries, always "on the dot."

But in today's split-second world, accurate time-*telling* is not enough. Time-*measuring* is equally important.

To provide an accurate *measure* of time, the National Bureau of Standards broadcasts another and far more frequent time signal that goes out each second (omitting the 59th of each minute), all day and all night, a continuous "tick-tick-tick."

That signal provides a "yardstick of time." It is just as essential in today's world as the accurate telling of time. Very short intervals of time, tiny fractions of a second, are used in numerous ways, from calibrating parking meters so that you get exactly one hour for your nickel, to measuring the water under a ship's keel by timing an echo returning from the bottom.

With its "signal-every-second" the Bureau of Standards provides a "standard second," accurate to one part in 1,000,000, just as it also makes available the standard foot, the standard meter, the standard pound, and the standard gallon.

That time yardstick is coordinated closely with the Observatory's time signals, and so is based, too, on the master time of the earth's turning. Scientists and engineers use it constantly to check their time-measuring devices.

Astronomers, probing out into the unimaginable depths of space, measure the universe with time—in years, "light years," the distance that light, flashing along at 186,000 miles per second, travels in a year. That comes out at six trillion miles, but so vast is the universe that the most distant galaxies of stars so far found are 500 million light years away.*

Light from the Distant Past

And with this light, coming to us from such incredible distances, we literally turn time backward and see into the past. For we see the more distant stars not as they are now but as they were long ago when the light from them now reaching us first started on its way. Light from some very distant stars began its journey before the human race existed on earth. It brings to our eyes today the images of those stars as they looked then.

Today's world moves literally on split-second timing.

*See, in the National Geographic Magazine, "Heavens Above," by Donald H. Menzel, July, 1943; "Interviewing the Stars," by William Joseph Showalter, January, 1935; "News of the Universe," July, 1939, and "New Frontier in the Sky," September, 1946, both by F. Barrows Colton.

Staff Photographer Robert F. Sisson

The Summons That Came Too Soon

Alarm attachments to clocks are about as old as the clocks themselves. Clocks in the 13th century, without face or hands, struck the hours on bells (page 420).

Every day now scientists divide seconds into as many as a million equal parts in timing the speed of a shell fired from a cannon, or the speed of a radar beam bouncing back from a ship or plane or hurricane.

Your electric clock is run by current that vibrates 60 times a second. If it varies from that, your clock is wrong.

Even the modern watch is accurate to an extent undreamed of by the early makers of watches and clocks. Today's average watch does not vary by more than 10 or 12 seconds a day. A good watch has a hairspring that vibrates 18,000 times an hour. If it is off schedule by as few as 10 beats, the watch will gain or lose nearly a minute a day.

Latest available estimates indicate that perhaps 70 million Americans own watches, one for every two people in the country. That alone is a good indication of how important time has become in modern civilization.

To furnish accurate time for all those watches—and nobody knows how many clocks—the U. S. Naval Observatory maintains elaborate equipment and a large staff of astronomers and technicians.

Essentially, their job is to check the time when an astronomer, riding around on the turning earth, passes under a certain star each night. Originally that was the way it actually was done. Lying on his back, the astronomer looked upward through a telescope that pointed vertically at the zenith, the point directly overhead in the sky.

Across the center of the telescope's end was stretched a fine hair. As the earth turned, a certain star would come into view in the telescope. When it was right on the hair line, the astronomer would press an electrical key, marking the exact time. On the next night he would do it again, and the interval between was one 24-hour day by star time.

Photographing Time—by the Stars

Today it's done with even greater precision. What the astronomer really does is to see how star time compares with the average time of the Observatory's master clocks. Instead of peering at a star through the telescope, he takes four photographs of the star. About 80 stars are used for the purpose on various nights.

Two pictures are taken at 45 and 15 seconds before the star is due to reach the zenith, and two at 15 and 45 seconds after it is due to have passed. An electrical device records the exact times when these pictures are taken according to Observatory clock time. Then,

by careful measurements on the plates, it can be determined whether the star reached the zenith when the master clocks said it should.

If there is any difference, the time of sending out the radio time signals is corrected to coincide with the earth's turning. For instance, if the master clocks say the star should reach the zenith at exactly 11 p. m., but it actually arrives at 1/100th of a second before 11, then the clocks are that much wrong, and the next time signal is sent 1/100th of a second sooner than it otherwise would be.

Of the Observatory's seven master clocks, three are run by pendulums and four by vibrating crystals. The Observatory's time signal is based on crystal clocks only, since they are the most accurate.

The master clocks are always "wrong," for once started going they are never reset. To do so would only increase their errors. But it does not matter that they are wrong, since the astronomers always know just how fast or slow they are. Their error is allowed for in sending out the time signals.

Even with their constant error, those master clocks are far more nearly accurate than the average good clock or watch that keeps time satisfactorily for you and me.

To keep them so exact, the clocks are protected from all outside disturbances. The pendulum clocks tick off their time in an insulated vault 30 feet under ground, away from vibrations and changing temperatures. Each pendulum swings in a vacuum, in a case from which the air has been pumped out, for air resistance would gradually slow down their time of swing. Each pendulum swings in a different direction, too, so that the vibration of one will not affect another.

Pendulums Viewed Through Periscope

In the vault also temperature is kept constantly within a fraction of a degree of 85 Fahrenheit, for changes in heat and cold could also vary the pendulums' swing. No one ever enters this vault except to make infrequent repairs, and the swinging pendulums are watched through a periscope from above ground. The pendulum clocks are no longer used in timekeeping. They are now employed in observations for determining positions of stars, since time enters into these calculations.

Vibrating crystals that run the other master clocks are only slightly larger than an air-mail stamp. They are sealed inside vacuum tubes like those in your radio, so that they vibrate in a vacuum. Air resistance would slow down their vibration just as it would a pendulum's swing. They too are kept at a temperature that varies no more than 1/100th of a degree.

Electric current keeps the crystals vibrating, and once started they vibrate continuously at the same frequency, 100,000 times per second. Clocks run by the vibrating crystals are more nearly accurate than the pendulum clocks, because the crystals are not affected by variation in the pull of gravity, which causes slight irregularities in the swinging pendulums, even in the underground vault.

Even a change in the level of the water table in the ground will make enough change in gravity's pull to alter the rate of a pendulum's swing.

Besides these seven master clocks of its own, the Naval Observatory also uses the master clocks of the Bureau of Standards to help regulate the accuracy of its time signals. These clocks also are crystal-controlled.

Mother Earth Slowing Down

But absolutely accurate time is a hard thing to achieve, for Mother Earth herself is not a perfect timekeeper. Though the time of the earth's rotation is the basis for our time, even that varies slightly. Records show that its rotation apparently speeds up occasionally, then slows down a little.

From 1680 to 1800 the earth lost about 27/100 of a second in that period of 120 years. From 1800 to 1900 it gained slightly more than 30/100 of a second. From 1900 to 1920 it lost a bit again. Since 1920 it has been gaining once more. Nobody knows why.

Moreover, despite these periodic gains and losses, the earth clock is gradually running down like any other. In the long run it is turning more slowly all the time, losing about 1/1000 of a second in 100 years. Astronomers know this from records of old eclipses as far back as Babylonian times. That has no effect on us laymen, but it is important to astronomers, who think in eons of time.

Friction of the tides against the bottoms of the shallower seas is the main force that is gradually slowing the earth down. Another is any shifting of materials from one place on the earth to another, which disturbs its balance slightly. The Mississippi River, transferring millions of tons of silt from the northern United States to the Gulf of Mexico, farther from the center of the earth, slows down the rotation of the earth a little.

You could even say that the construction of the Empire State Building, in which materials were taken from below the earth's surface and placed on top of it, caused an infinitesimal slowing down of the earth's rotation. All that makes it at least a little more difficult for the Naval Observatory astronomers to keep accurate time.

Staff Photographer Robert F. Sisson

Dots on a Moving Paper Keep Time Signals Accurate

On this strip at the National Bureau of Standards an electric spark records at intervals the seconds pulses of seven of the Bureau's master clocks and the Naval Observatory time signal. The spark burns a tiny hole and melts the paraffin coating to make a visible mark. Distance between the dots shows how much the clocks differ. From this record, corrections are made to increase accuracy of both the Naval Observatory time signal and the Bureau's once-a-second signal used in precise scientific time measurements (page 399).

Time runs today's world in innumerable and amazing different ways. Modern civilization could not operate if we suddenly were unable to measure time. All kinds of things depend on knowing not only what time it is but on knowing just how long a second is. All over the Nation and the world scientists and engineers time things by the Government time signals, both the Naval Observatory's two-hourly signal and the Bureau of Standards' once-a-second tick (page 399).

That "wirephoto" picture in your newspaper, showing a riot in far-off India or a royal wedding in London, could not be sent without split-second timing.

Timing for Pictures and Power

A picture to be "telegraphed" is placed on a revolving roller. Highlights and shadows in it are transformed into varying electric impulses that flash to the receiving end. There the impulses are translated into light of varying brightness that exposes a negative mounted on another revolving roller.

Both rollers, though thousands of miles apart, must turn at exactly the same speed or the picture will be blurred. To keep the rollers synchronized, their times of rotation are checked with the time signals (page 412).

All over the eastern United States, lines of electric power companies are interconnected, so that one can draw power from another at times of heavy demand for electricity. All those power currents operate on an alternating current frequency of 60 cycles per second. If one company's current varies from this, it cannot be used by another; so power engineers check their current frequencies against the time signals.

When you turn to your favorite radio program, you turn your dial to 630, or 1,260, or 1,500 as the case may be. Those figures stand for kilocycles, or thousands of cycles per second, the frequency assigned to that station. Each station must keep on its own frequency and not overlap with another.

To preserve the accuracy of those frequencies, both the stations themselves and the monitoring stations of the Federal Communications Commission check them against

standard frequencies broadcast by the Bureau of Standards.

In some types of radio receivers, quartz crystals vibrating at different frequencies separate the wave lengths of different stations, so you can tune to the one you wish to hear without interference from the others.

In the telephone system, where many conversations travel together over the same wire or cable, each at its own frequency, crystals vibrating at these different frequencies separate out the different conversations on the receiving end so you hear only the one you want. Vibrations of those crystals are timed by standard frequencies.*

When a radio program is put on a national network, clocks in all the stations from coast to coast must agree, so that all will receive and send out the program exactly on the second.

Shutters of some cameras are timed down to 1/1000 of a second or less. One high-speed camera used in photographing the human vocal cords in action takes as many as 8,000 pictures in one second.

X-ray pictures taken in one-millionth of a second are now possible, to reveal what is happening inside machines operating at very high speed.

A ship captain, steering toward a strange coast after losing his bearings in the fog, sees a lighthouse flashing its beam at regular intervals. Timing the flashes, he notes that they come, say, every five seconds, and that the beam revolves in 120. This tells him at once what light it is.

Many lighthouses all over the world thus identify themselves with codes keyed to time.

Rewound in Reverse, This Mainspring Will Increase in Strength

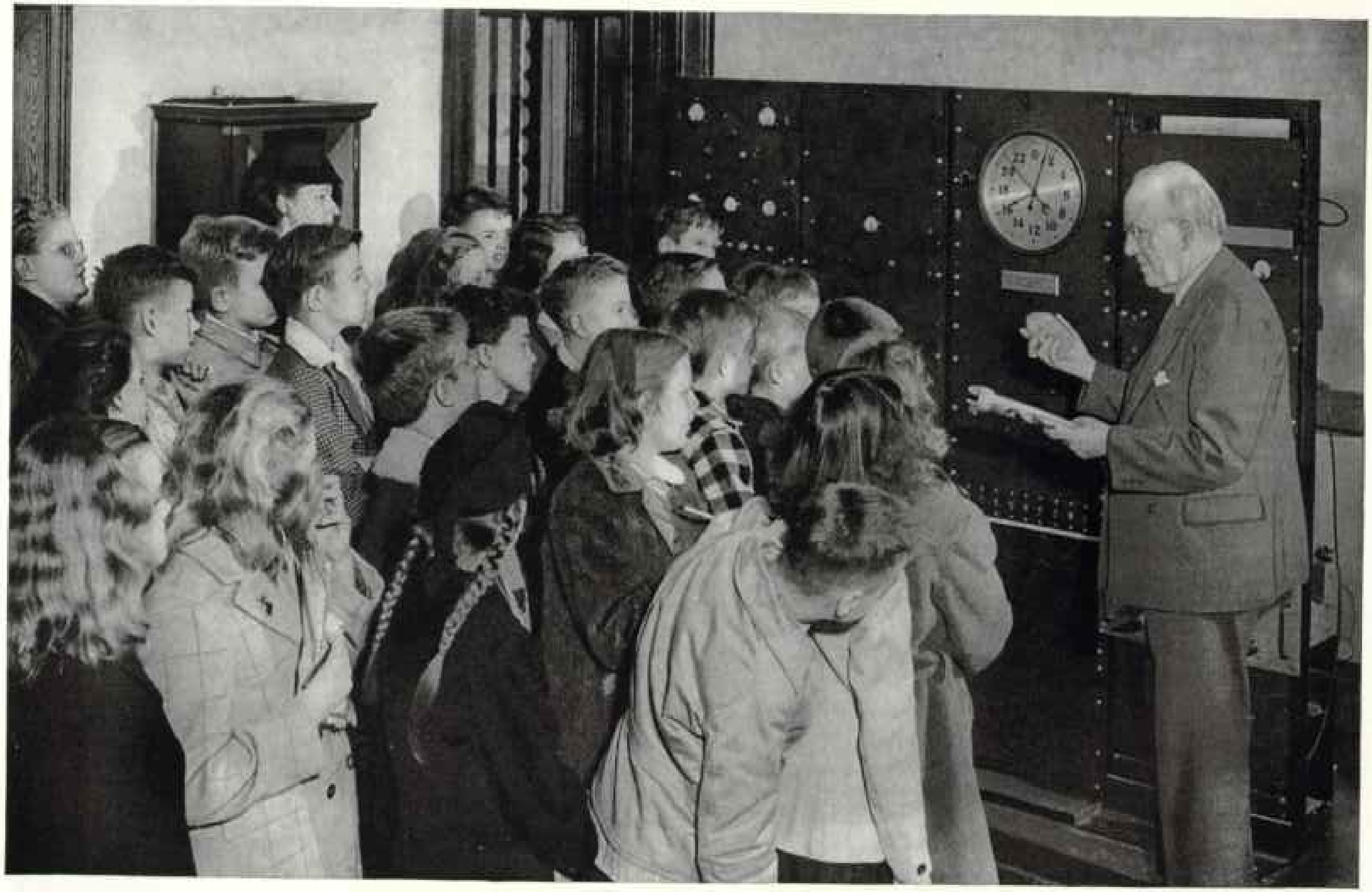
After being coiled in one direction and heat-treated, mainsprings made of a new alloy used in Elgin watches (pages 414 and 428) are rewound in the opposite direction on this machine, to improve their strength, or torque. The new alloy, containing eight different substances, is declared to be nonmagnetic and more resistant to stress than steel.

Radar sets depend on very accurate timing to show the distance of an object which the radar beam picks up. The fraction of a second it takes for the radar pulse to flash out and echo back from a ship, a plane, or an iceberg indicates how far away that object is.

Measuring Millionths of a Second

In war the range of guns can be set by radar. It takes only 1/10,000,000 of a second for a radar wave to travel to an object 50 feet

*See, in the NATIONAL GEOGRAPHIC MAGAZINE, "Miracle of Talking by Telephone," October, 1937, and "Miracle Men of the Telephone," March, 1947, both by F. Barrows Colton; and "Prehistoric Telephone Days," by Alexander Graham Bell, March, 1922.



Staff Photographer J. Baylor Roberts

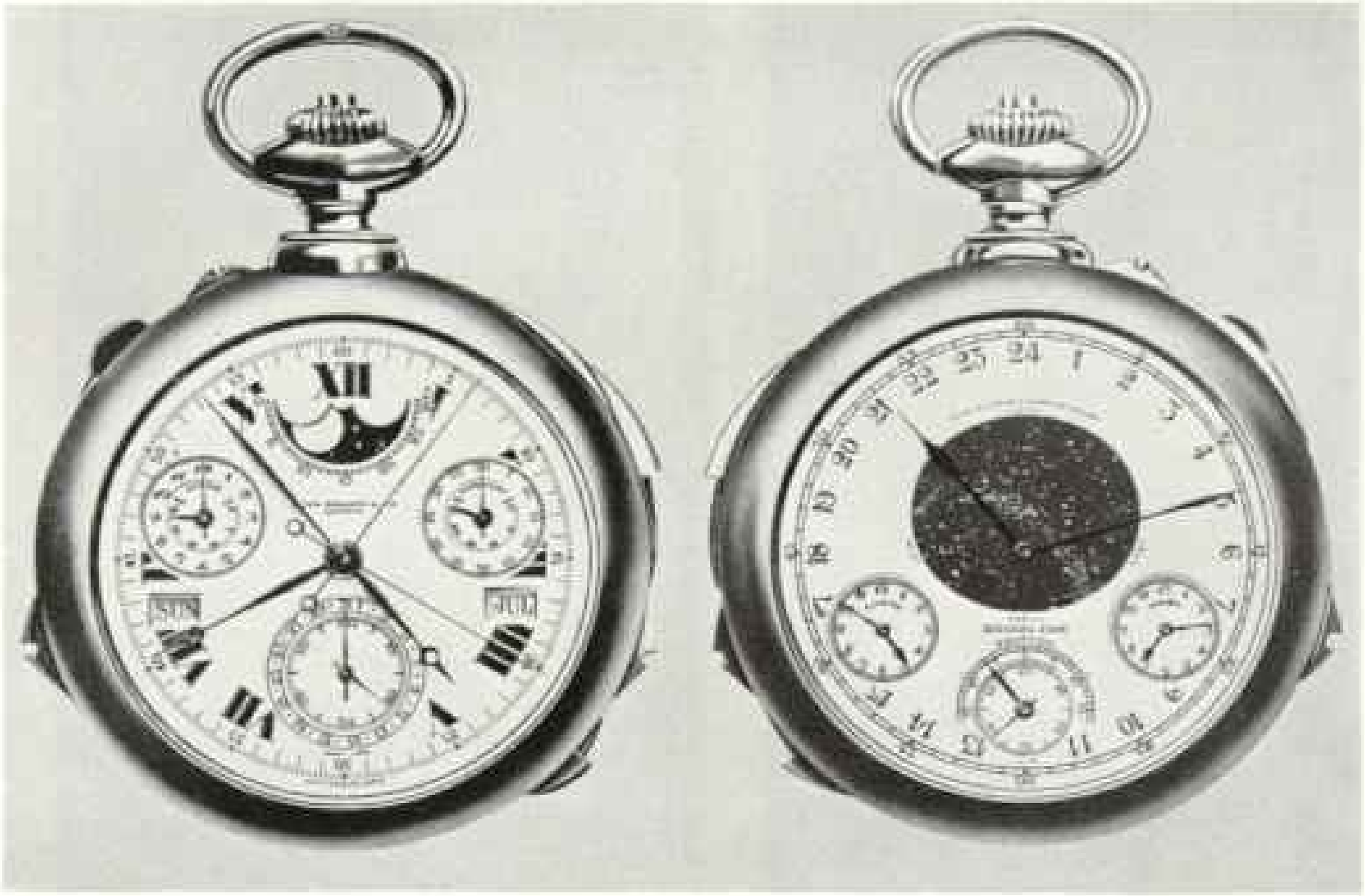
School Children See One of the Master Clocks That Help Keep the Nation Running on Time

Visiting the U. S. Naval Observatory, they hear an explanation of one of the four clocks regulated by quartz crystals vibrating with extremely high accuracy (page 401). The clocks control the Naval Observatory radio time signals sent out all over the world, which are accurate to within 8/1000 of a second.

Staff Photographer Robert F. Sisson

Radio's Sign Language for Timing a Broadcast Employs These Standard Hand Signals

Left to right (upper): Stand by; You're on; Speed up; Stretch, or slow down. Lower: Two-minute signal; One minute to go; Cut; On the nose.



From Henri Hein Watch Agency, Inc.

Time Is Only One of Many Things This Two-faced Watch Tells

The dial on the left gives the time of day in split seconds, the day of the week, the month, moon's phases, and amount of time left before the watch must be wound. It strikes quarter, half, and hour chimes. The other dial indicates time of sunrise and sunset, sidereal time (time according to position of stars), and the equation of time (difference between sidereal and standard time). White dots on the black field indicate position of stars over New York City according to season. It took five years to make this instrument.

away and back, but radar can measure it.

By the same principle, the depth of water under a ship's keel can be measured in a fraction of a second by timing the echo of a high-pitched sound sent down to the bottom and back. Knowing the speed of sound in water, 4,938 feet a second, a skipper can tell within a fraction of an inch how deep the water is.

Tiny fractions of a second also are the key to the working of Loran (Long-range Navigation), a system developed during World War II for enabling ships and planes to fix their positions accurately at sea or in the air (page 412).

With Loran, a navigator of a ship or plane determines his position from the difference in the time of arrival of radio signals from two different pairs of radio-sending stations on shore. The difference in their time of arrival is measured in millionths of a second.

Eclipse Study Requires Timing

In far-away Brazil in May of this year, scientists of the Army Air Forces-National Geographic Society solar eclipse expedition listened to the Navy time signals to check their chronometers (page 295).*

Oil and other minerals are located by variations in the pull of gravity, measured by time.

In measuring the force of gravity the time of swing of special pendulums is very precisely measured.

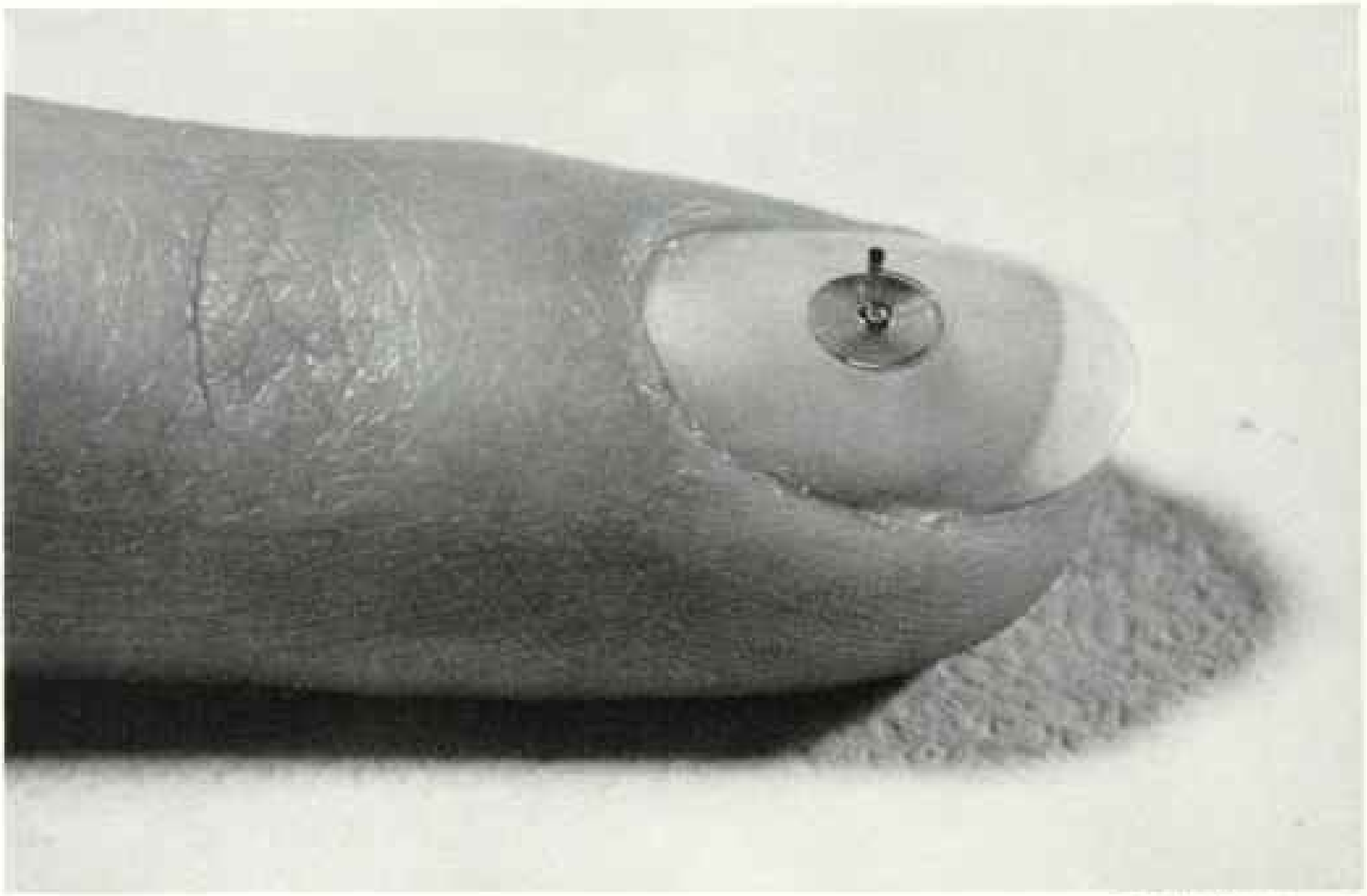
To determine the slight variations of gravity at different points on the earth, which gives objects slightly different weights at, say, the Equator and the Poles, a pendulum's swing is timed with an accuracy of better than one part in a million.

The Way the Earth Is Weighed

Another gravity measurement, to find the attraction that two bodies, such as the earth and the moon, exert on each other, also is made by timing a pendulum's swing. From this it is possible to figure the weight of the earth, which is about six sextillion, 600 quintillion short tons.

Even music is measured by time. A musical note of any particular pitch represents so many vibrations per second of a violin string, a

* See, in the National Geographic Magazine, "Eclipse Hunting in Brazil's Ranchland," by F. Barrows Colton, page 285 of this issue.



Hamilton Watch Company

This Tiny Hairspring Controls the "Heartbeat" of a Watch

Vibrating 18,000 times an hour, it governs the swing of the balance wheel in a lady's watch. The balance wheel in turn controls the action of the mainspring on the intricate cogwheel mechanism. Less than ½ the diameter of an average human hair, the hairspring is made of rustproof Elinvar, a nickel-steel alloy.

drumhead, or the air column in the tube of a trumpet or tuba. The more vibrations per second, the higher the pitch.

To help musicians and musical instrument manufacturers tune their instruments accurately, the Bureau of Standards broadcasts a continuous musical note precisely tuned to A above middle C. It is produced by dividing down the vibrations of a crystal oscillating at 100,000 cycles per second to 440 cycles per second.

This note is the Nation's "standard of pitch." You can get it any time on a short-wave radio and use it to tune your piano, violin, or trombone.

Government surveys, which form the basis for all property lines, depend on very accurate measurement of latitude and longitude. To measure longitude you need to know the correct time to a small fraction of a second. Longitude is distance measured east or west of the Greenwich meridian, an imaginary line that runs through the original site of Britain's Royal Observatory at Greenwich. (The Observatory is now being moved to Sussex because smoke of factories made observations difficult.)

Distance from the Greenwich meridian is measured not in miles but in time—in hours, minutes, seconds, and fractions of seconds. To get it, you have to know the exact time on the Greenwich meridian and the exact time where you are. The difference between the two is your longitude. For example, if it is 12 noon in Greenwich and 7 a. m. at New York City, the longitude of New York is 5 hours west.

On maps, longitude is indicated in degrees, one hour being equivalent to 15 degrees. Government surveys are made to an accuracy of 1/100 of a second in longitude.

Without a chronometer, which is really a clock that tells very accurate time, no ship could navigate accurately.

From the chronometer the ship's navigator can determine the correct time at Greenwich. Then by observing the positions of certain stars and checking with official navigation tables he can easily determine his ship's position (pages 408 and 428).

Congress Turned Time Backward

Congress sometimes used to turn time backward in order to transact its business "on time." Formerly, when sessions ended at midnight on March 4, by the clock in the Senate

Staff Photographer J. Baylor Roberts

Carefully Regulated Chronometers Guide U. S. Navy Ships on the Seven Seas

In the instrument shop of the U. S. Naval Observatory hundreds of the precision timekeeping instruments await issue to naval vessels. An employee records data on the way an instrument varies in rate with temperature changes. A chronometer is a highly accurate timepiece which indicates Greenwich time, used in calculating a ship's position (page 407). In the foreground are watches which also are used by navigators.

or House Chamber, if all the scheduled business could not be finished in the normal time remaining, the clock was turned back as much as necessary.

Geologists, measuring the age of rock strata in the earth, use a ready-made "clock" installed in the rocks by Nature herself. It keeps extremely accurate time. This "clock" consists of radium and other radioactive minerals, which gradually disintegrate and change eventually into lead at a constant, unvarying speed.

If you find a deposit of radium in a layer of rock, you will always find with it a deposit of lead, resulting from the disintegration of some of the radium.

Measuring the amounts of lead and radium, you can tell how much radium was there in the first place, since originally all the lead was radium, too. Knowing the speed at which radium turns into lead, you then can figure how long it took for the original radium to change into that much lead. That shows how long ago the process began, and therefore how old the rock layer is. By this method the ages of some rocks have been found to be from 400 to nearly 2,000 million years.

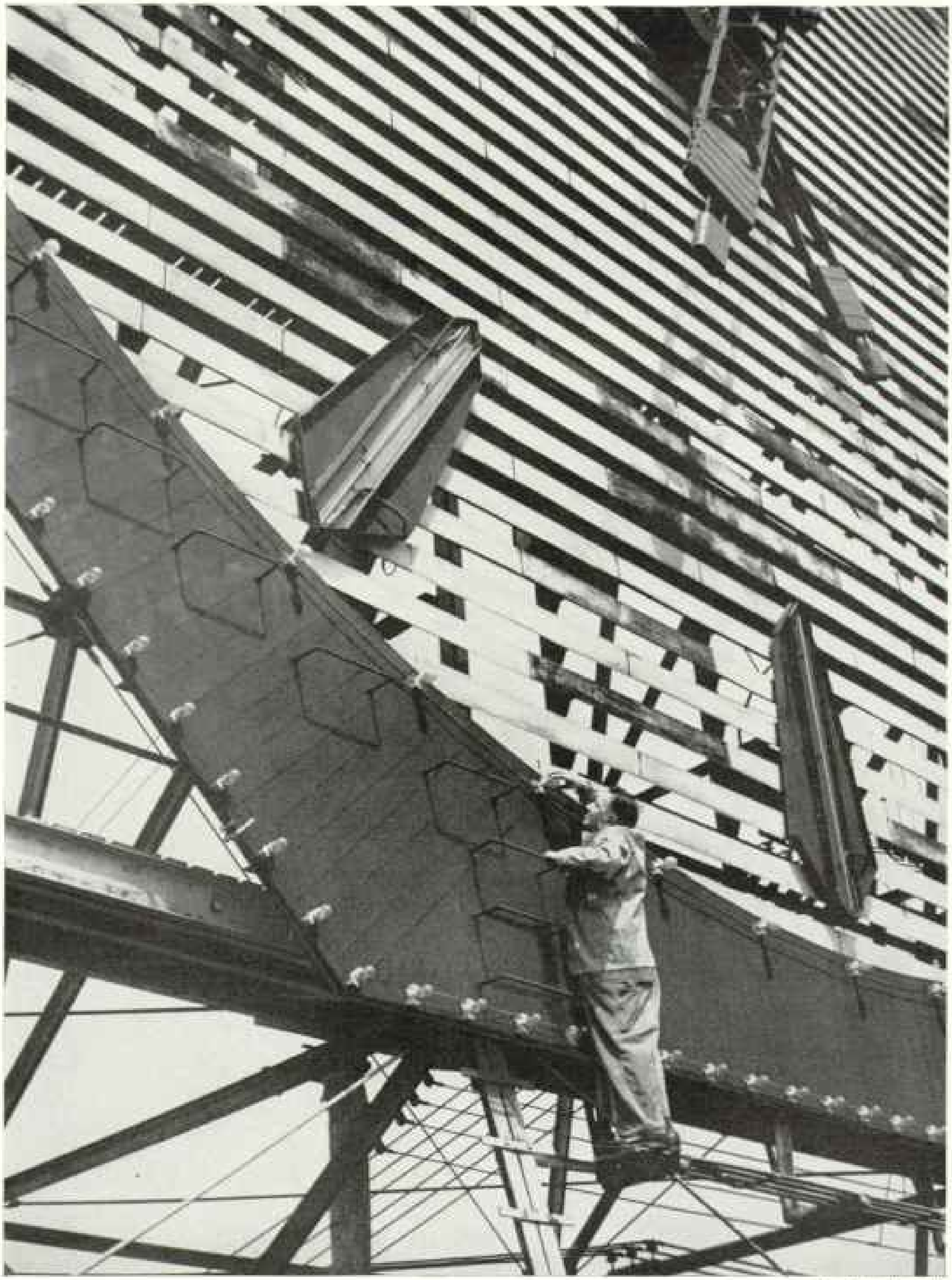
But we're chiefly interested in the time we live by, standard time, divided into hours and minutes. An hour is a man-made thing, just one-twenty-fourth part of the time it takes for the earth to make one complete turn.

Who decided to divide up that time of turning of the earth into 24 hours instead of 20 or 36 or 10, nobody knows. It doesn't

Staff Photographer Robert F. Sisson

Just Before the Train Leaves, Conductor and Engineer Compare Watches

This is a last-minute ritual on all American railroads. Only watches which have been examined and certified by company inspectors are used. They are checked against standard clocks and must keep accurate time within 30 seconds a week. Railroads instituted standard time for the United States in 1883 (page 411).



Newark Sunday Call

A New Bulb Joins 344 More to Light the Face of the World's Largest Clock

Atop the Colgate-Palmolive-Peet Company plant in Jersey City, New Jersey, the dial, 50 feet in diameter, can be seen for miles in New York Harbor. The black, coffin-shaped, five-minute markers to the left and right of the custodian are seven feet high. The minute hand travels almost three-quarters of a mile a day (page 425).

matter now, because everybody is used to the 24-hour system.

Nor do we need to worry about the fact that actually our hours are gradually growing longer. As the turning of the earth keeps slowing down, the day keeps getting a little longer, and so each 1/24th of it, each hour, keeps getting a little longer, too. But the change is so slight in even a thousand years that it's of little consequence.

Today the world runs on standard time, but it hasn't been running that way long. Some people now living, born before 1883, can remember when the United States, and in fact all the world, had no such thing as standard time. Most localities used local time, told by the sun or the local town clock. Such local time varied 4.5 seconds for each mile east or west.

That worked all right when travel was no faster than a horse could walk or trot. But when railroads, with high-speed travel, began to spread everywhere, confusion resulted. Different railroads operated schedules on different times, usually that of large cities where they had terminals. At one period about 100 different standards of time were in use by American railroads.

Staff Photographer W. Robert Moore

It's Coffee Time in Brazil by the Coffee-maker Clock

This antique automatic timepiece, now in a museum in Belo Horizonte, did more than keep time. It could be set to light the alcohol burner at the proper moment and turn it off when the coffee was done.

Finally, at a conference of all the railroads it was decided to divide the United States into four time zones, with all trains operating in each zone using the same standard of time. Cities and towns in each time zone adopted standard time also, although standard time was not enacted into law in the United States until 1918.

When the change-over took place officially, on November 18, 1883, there was great excitement. Some skeptics said the whole thing was a gigantic plot by the watchmakers to get everybody's watches out of kilter and thereby make more business for themselves!

Wrong Time Caused Railroad Wrecks

Even after standard time zones were established, some trouble was caused by trainmen's watches being inaccurate occasionally. One wreck in 1891 was caused by an error in a watch carried by one of the engineers of the two trains.

After that a system was devised whereby inspectors were appointed to check standard clocks on railroads and to supervise designated railroad men's watches at stated intervals so that these watches and clocks would run within 30 seconds of correct time a week. All engineers and conductors are required to check

From Pan American World Airways

With Loran, He Can "See" and Measure Lightning-fast Electrical Impulses

This Pan American World Airways navigator looks through the scope of the Loran (coined from Long-range Navigation) to fix his position. He does this by measuring the difference in time between arrival of radio signals sent from different Loran transmitting stations. Loran also is used in ship navigation (page 406).

Staff Photographer Robert F. Sisson

Split-second Timing Is Required to Flash a Wirephoto Across the Country

The cylinder on this Associated Press wirephoto machine and the one on the receiver, though thousands of miles apart, must revolve at the same speed or the picture will be blurred. To keep the two cylinders synchronized, the times of rotation are checked with time signals (page 402).

their watches daily against a standard clock and with each other (page 409).

In 1884 an International Meridian Conference met and extended standard time to the entire earth. The world was divided into 24 time zones, each approximately 15 degrees, or 1/24th of a circle in width. Standard time in each zone varied by one hour from the next, either one hour earlier or one hour later than the time at Greenwich, England, which was taken as the zero point.

Thus when it is 12 noon at Greenwich, it is 11 a. m. in the next zone to the west and 1 p. m. in the next zone to the east. This is because the earth turns from west to east, and as we travel along with it we come toward the sun in the morning, pass under it at noon, and move on away from it in the afternoon. Dawn, noon, and sunset move around the earth as it turns.

Wide World from Photo Ass'n

By This Clock Parisians Have Told Time for More than 580 Years

Made by Henry De Vick in 1364 for Charles V of France, it was more ornamental than accurate. It told only the hour and was sometimes off two hours a day. The old-timer looks down from the Palais de Justice, Paris.

In Jules Verne's famous novel, *Tour of the World in 80 Days*, the hero bet £20,000 that he could travel around the earth in that time. He thought he had lost the bet because he did not get back to London until what he believed was the day after the time limit set. But then his servant reminded him that in crossing the Pacific he had crossed the international date line, and in so doing had gained a day, so that he arrived in time to win the bet after all!

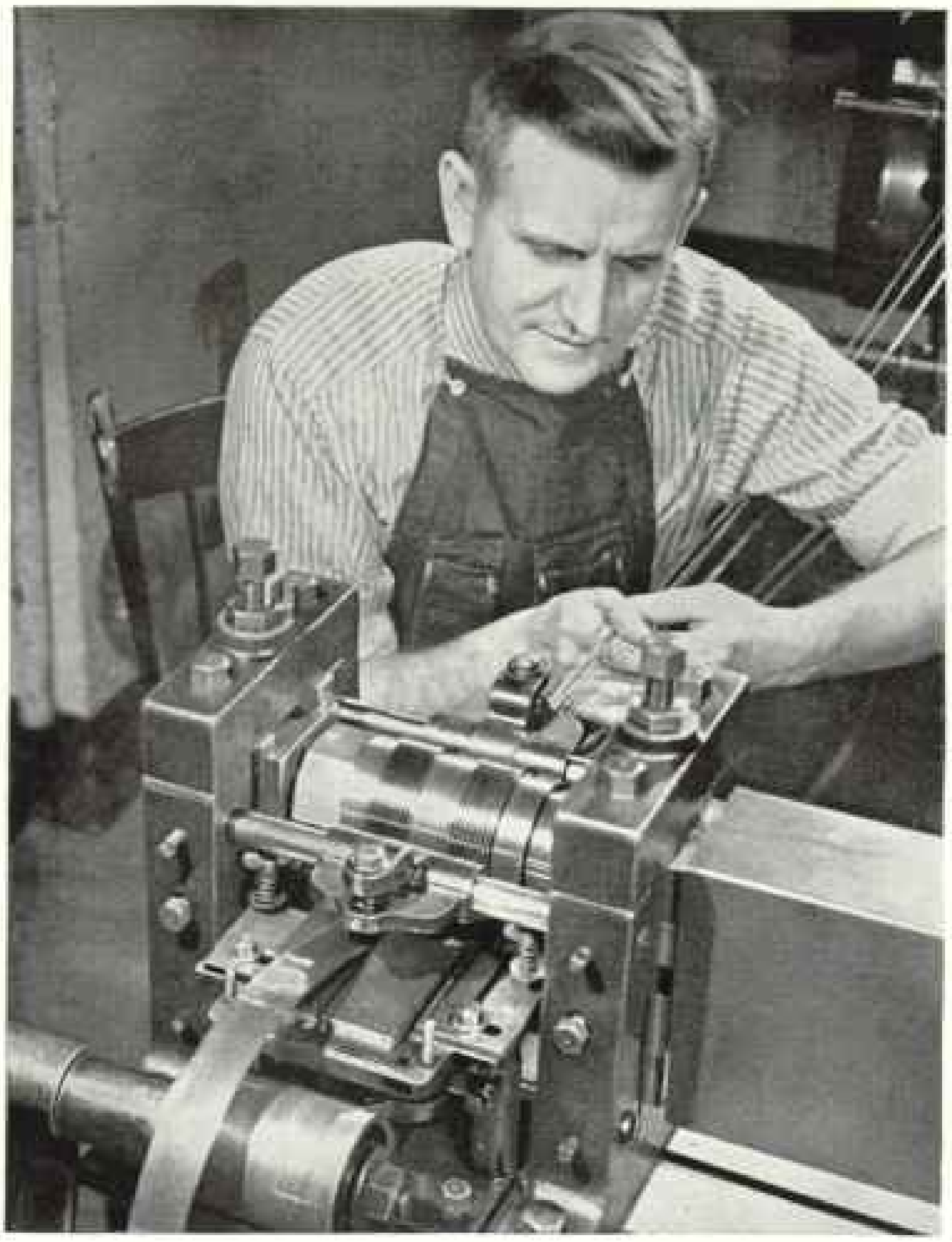
That international date line, established in 1884, is an imaginary line drawn north and south through the Pacific Ocean, 180°, or halfway, around the earth from the Greenwich meridian. Actually, it deviates here and there from the 180th meridian so as not to divide various island groups. It is placed there so as not to inconvenience anyone, for that is the place where, as you go around the earth, you change not only from one hour to another but from one day to another.

Anyone traveling eastward across the Pacific thus lives today over again, and anyone going west skips tomorrow, or, in other words, goes from today to day-after-tomorrow.

You can best see why the international date line is necessary if you think of two men starting out from Greenwich and traveling east and west.

The man going east, to keep on standard time, must set his watch ahead one hour each time he passes into another time zone until he reaches the 180th meridian, where the time is 12 hours later than at Greenwich.

Therefore, when it's 7 p. m. on October 15



He Slices a Band of Elgiloy into Watch Mainsprings

Elgiloy is the Elgin National Watch Company's new mainspring alloy, so tough that it resists the action of powerful acids. Immersed in a 10-percent salt-brine solution for more than 500 hours, these mainsprings showed no sign of rust. The machine cuts the band (entering at bottom) into exact mainspring widths.

at Greenwich, it will be 12 hours later, or 7 a. m. the following day, October 16, at the 180th meridian.

Meanwhile, the other man, traveling westward, to keep himself on standard time has to set his watch *back* an hour every time he passes through another time zone. When he reaches the 180th meridian his watch will show that the time is 12 hours earlier than at Greenwich. If it is 7 p. m. at Greenwich October 15, his watch will say that it is 7 a. m., October 15, the same day. The two men, having traveled the same distance but in opposite directions, find they disagree by one day as to what day it is.

So, to keep things straight it is agreed that anyone going east across the international date line repeats one day. If you cross the line eastward on Saturday, the next day is not Sunday; it is Saturday again. You have to live through another Saturday before you get to Sunday. But if you're going westward, and you cross the line on Saturday, the next day is not Sunday, but Monday! You lose Sunday altogether.

That worried one pious lady so much that she wrote to the Naval Observatory about it. Planning a trip across the Pacific, going westward, she found that the steamer was scheduled to cross the date line so as to miss Sunday. Would it be proper for her, as a Christian woman, she asked, thus to lose a Sunday and the opportunity to go to church?

Lost—Eleven Days

Losing time has bothered other people, too. In 1752, when the present calendar was adopted in England, 11 days were dropped and the date set ahead from September 3 to September 14. Angry mobs stoned the carriage of the Prime Minister who had announced the change, shouting, "Give us back our eleven days!"

Actually, of course, nobody lost any time. Everybody simply lived 11 days longer by the new calendar than he would have by the old.

Calendar trouble is still with us. It all started because the year is measured by the time of the earth's rotation around the sun, and the month by rotation of the moon around the earth. The earth takes 365¼ days to go around the sun, and the moon goes around the earth in 29½ days.

You can't fit the 29½ into the 365¼ and come out even. You have to add a day or two to some months and have a leap year

with an extra day in it every so often, as we do by having February 29 only once every four years.

Early calendar makers did a bad job trying to match up the months with the year, until by Julius Caesar's time the calendar was running two months ahead. Fall began in the summer, and winter in the fall. Caesar fixed it in 46 B. C. by lengthening that year enough to bring things back on schedule. But he miscalculated slightly and by 1582 his calendar had gained 10 days.

Then Pope Gregory XIII decreed that October 5 should become October 15, and put us on a schedule that we still follow today, though England and other Protestant countries of Europe did not adopt it until almost two centuries later.

Many people still are not satisfied with the calendar, since months vary in length and holidays sometimes fall on Sunday. Before Congress today is a bill for adoption of the World Calendar, which rearranges the 12 months into equal quarters of 91 days each. The first month in each quarter would have 31 days; the other two, 30.

The year would have 364 days, with an extra day at the end called "Year-End World Holiday"; "Leap-Year World Holiday" would follow June 30 every fourth year. Each year and each quarter would start on Sunday and end on Saturday. Fixed holidays would fall on the same day of the week every year.

Already approved by 15 nations, the World Calendar is being considered by the United Nations and the Inter-American Economic and Social Councils.

Daylight saving, by setting clocks ahead in summer to give city dwellers one more hour of daylight at the end of the day, has led to some peculiar situations.

Hamilton Watch Company

The Statue of Liberty Might Use This in a Wrist Watch!

Made of transparent plastic, the model of a balance staff and its jewel bearing is 100 times actual size. The balance staff, which carries the balance wheel and the balance (or hairspring), pivots on jewels. Sapphires and rubies serve in a watch as a ball or roller bearing does in an automobile. Harder than metal, jewels reduce friction and maintain regularity of running (page 427).

Quirks of Daylight Saving

It resulted in two systems of timekeeping on opposite sides of a street in Delmar, Delaware, where the Maryland-Delaware State line runs down the middle of State Street. On the side in Delaware, which used daylight time in the summer of 1946, it was 11 a. m., when on the other side, in Maryland, which stuck to standard time, it was 10 a. m.!

One woman in another town, confused by daylight time, started feeding her baby a few minutes later after noon each day, with the

Staff Photographer Robert F. Sisson

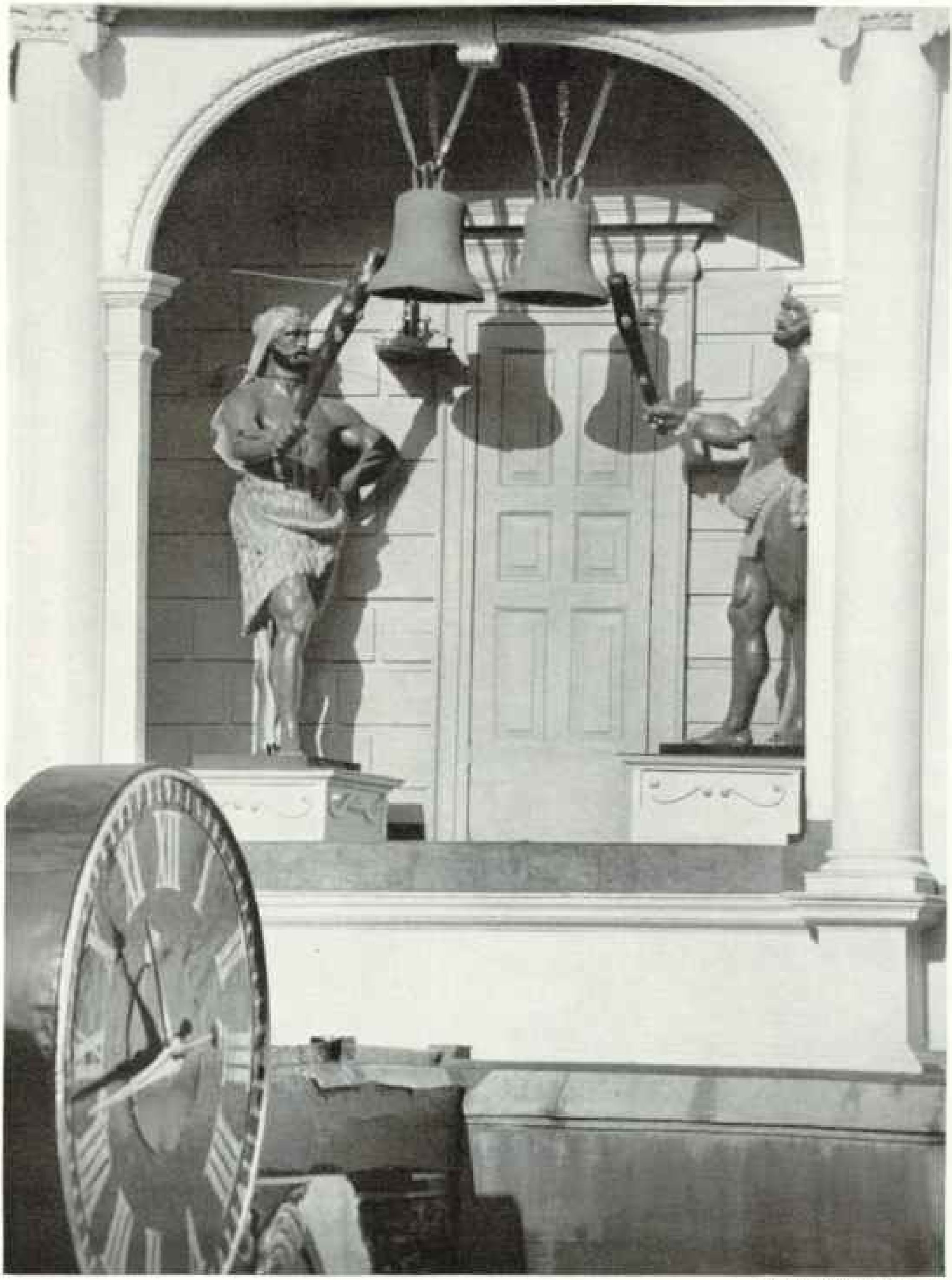
"I'll Meet You at the Clock"—New York Commuters' Rendezvous in Grand Central Station

The four-faced timepiece atop the information booth is one of 60 clocks visible to the public in the station. All are checked daily against time signals from the Naval Observatory, Washington, D. C.

Staff Photographer Robert F. Sisson

Disabled Veterans Learn Watch Repairing by Studying the Enlarged Anatomy of a Watch

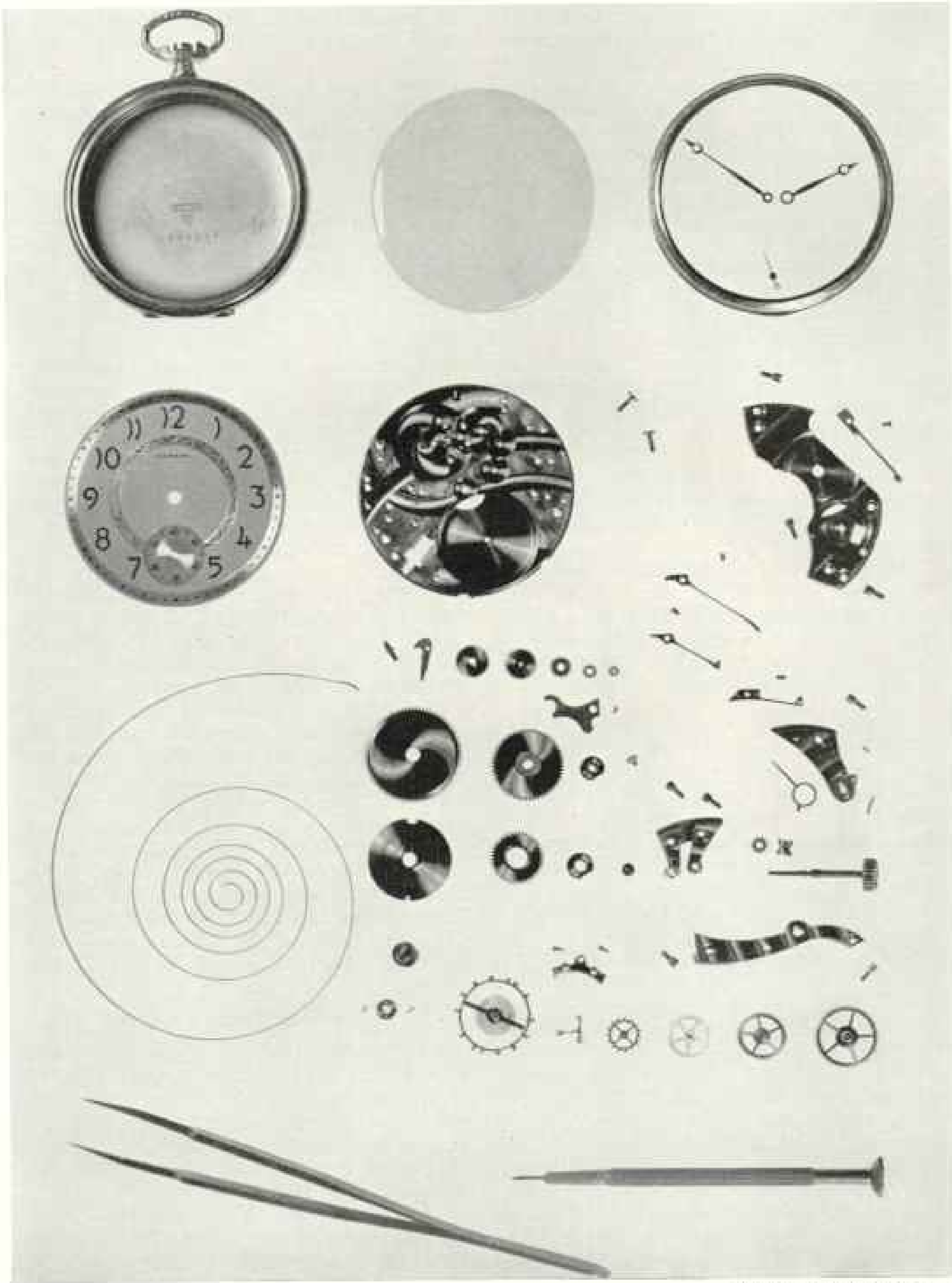
At the Joseph Bulova School of Watchmaking, Woodside, Long Island, New York, one year's training turns wounded veterans into skilled watch repairers. Jobs in the watchmaking industry await graduates.



General Photographic Agency

Life-sized Figures with Clubs Sound Each Quarter Hour in London's Fleet Street

The 17th-century clock and its wooden bell ringers were removed from St. Dunstan's-in-the-West Church when the building was torn down in 1830, then restored to the new church over 100 years later in 1935. Figures are variously identified as Hercules, "savages," and Gog and Magog. Blitz bombings left them undamaged.



Staff Photographer Robert F. Sisson

Could You Put These Parts Back in the Watch and Not Have Any Left Over?

This timepiece has 100 parts; some have more. Four principal parts that made the modern watch possible include the mainspring (large coil at left) and, left to right in bottom row: jewel, hairspring (attached to balance wheel), and escapement (tiny lever and toothed wheel). Tweezers and screwdriver are watchmakers' tools.

idea that when the change-over to daylight time was made the baby would still be eating at noon, daylight time. When the change came she found that the baby was eating not at 12 but at 2 p. m.! She should have started feeding him a few minutes earlier each day.

But our primitive ancestors never worried about daylight saving, to say nothing of minutes and seconds. How time-telling and timepieces have developed through the centuries is a fascinating story.

A stake driven into the ground told all the time primitive peoples needed to know. Time was measured by the shadow cast by the stake. Thus the sundial was born.

In the Bible, you will recall, "And Isaiah the prophet cried unto the Lord: and he brought the shadow ten degrees backward, by which it had gone down in the dial of Ahaz" (II Kings 20: 11).

Shakespeare refers to a pocket sundial, the great-grandparent of the modern watch, in *As You Like It*, when Jacques says, "He drew a dial from his poke."

Herodotus tells us the sundial came from Babylonia. Used in the valleys of the Tigris and Euphrates as early as 2,000 B. C., knowledge of it spread to all parts of the world, to India, China, Egypt, and Palestine, and eventually to Greece and Rome.

The Greeks Had a Cure for Long Speeches

The ancient Greeks, to time the speeches of their orators, used the water clock, which told time by the interval it took for water to drop from one receptacle into another. They had a word for it, *clepsydra*, from the Greek words, *to steal* and *water*. It was also probably known to the Egyptians.

An improvement on the sundial because it told time on rainy days, the clepsydra introduced a new conception of time. Unlike the sundial, which told *when*, the clepsydra marked *how long*.

Pliny the Elder says in his *Naturalis Historia* that the clepsydra was introduced into Rome in 159 B.C. The simplest form of clepsydra, and perhaps the earliest, consisted of a vessel of water with a small hole in the bottom. Filled up to a certain mark, the water escaped out of the hole in approximately the same intervals of time.

Referring to a tiresome speaker who repeatedly moistened his throat from a cup of water during his lengthy speech, Martial, the Latin poet, suggested sardonically that it would be an equal relief to him and to his audience if the speaker were to drink from the clepsydra instead.

Next, the inventive mind of man produced the hourglass, or sandglass, which would not freeze, would not spill over, and did not need refilling.

From the 16th century on, the hourglass was frequently used in churches to limit the length of sermons. Many a time when his hour had run out, the preacher turned the glass over!

Hour and half-hour glasses were in use in the British Navy as late as 1839. And until recently the British House of Commons used a two-minute glass in the preliminary to a "division," which is a method of voting.

Pious King Alfred of England, seeking to divide his day into equal parts for prayer, work, and rest, told time with six candles, each 12 inches long, which burned at the rate of 20 minutes an inch. One candle lasted four hours; six, 24 hours.

Finding that the candles' burning time varied if there was a draft in the room, he had cases for them made of horn, scraped thin. In early English this case was called a "lanthorn" and from it we get our word "lantern."

On the Palais de Justice in Paris is a clock made in 1364 for Charles V of France (page 413). Like most early clocks, it had only one hand, the hour hand. And sometimes it was off by as much as two hours!

Had you lived in the Middle Ages, especially if near a monastery, you would have told the time from monastery bells. Monks were the timekeepers then, just as priests were in Babylonia, and since time-telling was important to them, many worked to make better timepieces.

The bell was an important part of these early timekeepers. The word "clock" really signifies bell, and comes from the Middle English *clok*, the Middle Dutch *clocke*, the Old French *cloche*, the German *glocke*, the Medieval Latin *clocca*, and the Old English *cluicge*.

The First True Clocks

The first true clocks, in the modern sense, of which we have accurate records appeared in the 14th century. Earlier ones had neither hands nor face and told time merely by striking the hour. Bells were struck by hammers held in the hands of little figures of men and women, called "jacks-o'-the-clock."

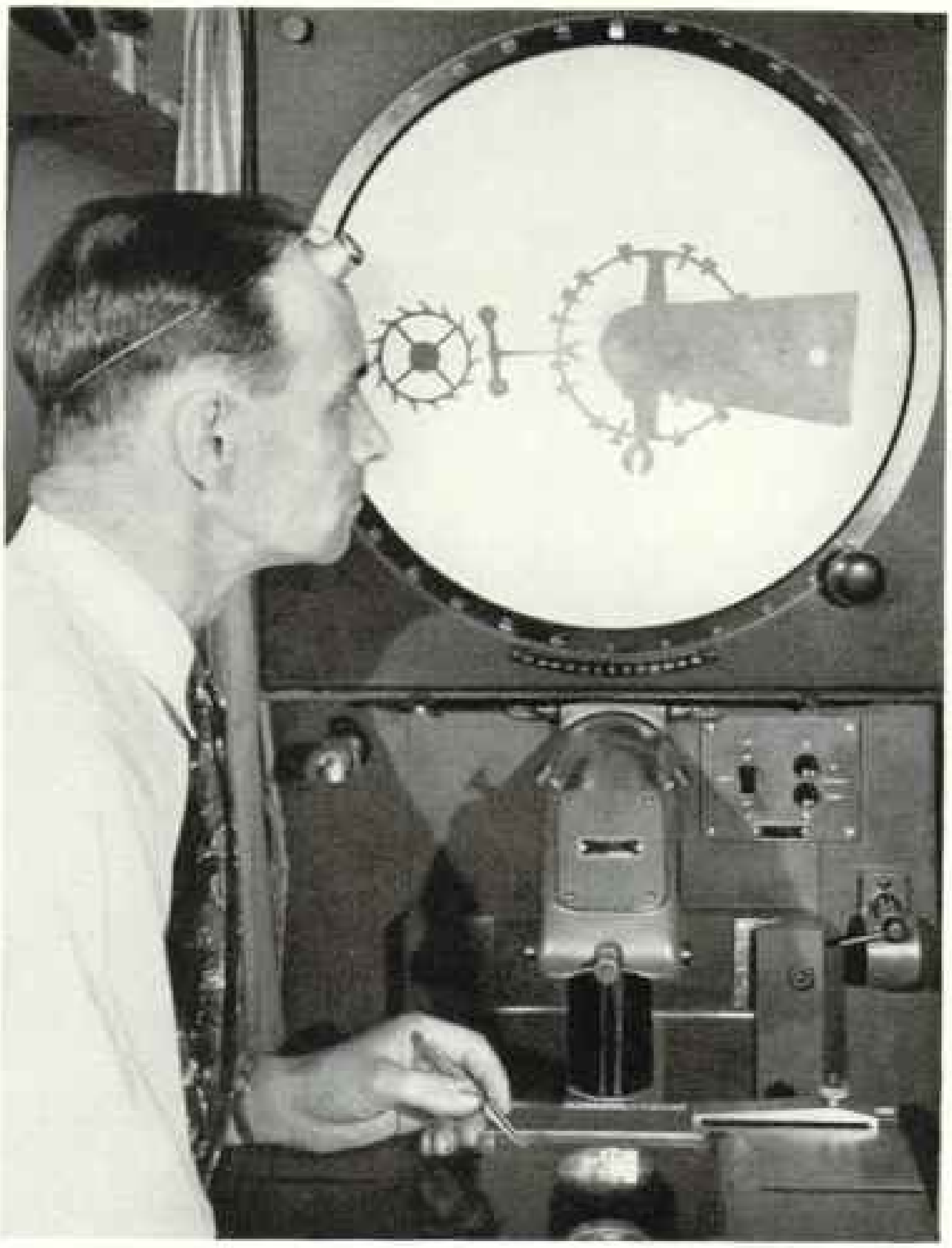
About 1335 an English monk constructed the first clock that approached a weight-driven clock, as we think of it. Equipped with new works, it is still in an old chapel at Wells Cathedral, England.

Peter Henlein, or Hele, a locksmith of Nürnberg, Germany, invented the mainspring about 1504. In the Moyer Fleisher collection of

© Donald McLeish

Bears March, a Cock Crows, and Bells Ring to Tell Hours on Bern's 16th-century Clock

Large dial of Zeitglockenturm (clock tower) in the Swiss capital tells time. Bears and cock perform at right of small dial (above gate) that shows day and month. "Jacks" (mechanical figures) strike hours on bells in cupola. Atop the Zähringer fountain an armored bear carries a banner with the coat of arms of Bern's founders.



Camera Associates

Tiny Clock Parts, Magnified, Are Checked for Flaws

Placed in a projector, they are enlarged to ten times actual size for inspection at the Seth Thomas Clock Company, Thomaston, Connecticut (page 425). Burs or other imperfections would appear as shadows on the screen. From left to right the parts are: escape wheel, lever, balance wheel with hairspring coiled within it, and balance bridge. Below, to right of the inspector's tweezers, are the actual clock parts.

watches in Memorial Hall, Philadelphia, is the clock-watch believed to have been made by Peter Henlein and to be the oldest portable clock-watch in existence (page 424).

This was the first attempt to get the works of a clock down to a portable size. Almost as big as a "Baby Ben," this clock-watch weighs about half a pound. Its drum-shaped case is $2\frac{5}{16}$ inches in diameter and one inch thick.

The early clock-watch of 1500 developed into the pocket watch in about one century. At first it became smaller with rounded edges, then elongated or oval-shaped, known as the "Nürnberg egg," then ornate and of many shapes. Many were in the form of books, animals, fruit, stars, flowers, insects, crosses, cockleshells, skulls, and padlocks.

Remember, in Dickens's *Dombey and Son*, the "accurate" time of Cap'n Cuttle's watch? On presenting his big silver watch to Walter, he said, "Put it back half an hour every morning, and about another quarter toward the afternoon, and it's a watch that'll do you credit."

Jewels, Hairsprings, and Balance Wheels

Queen Elizabeth and her court selected watches to match their various costumes. Striving to make up for a lack of precision, watchmakers of that period created lavishly ornamental watches. Worn on a chain or ribbon around the neck, they were largely for display. Works and dial were protected within cases of repoussé chased gold, silver, and brass, tortoise shell, shagreen, and painted enamel.

About 1675 the "father of English watchmaking," Thomas Tompion, perfected the balance or hairspring, which improved the accuracy of watches so much that within five years they were on the market with minute hands. Thirty years later, Nicholas Facio, Swiss watchmaker, patented the use of jewels for bearings in watches, reducing friction and increasing regularity (pages 415, 427).

An outstanding improvement in the accuracy of the watch, the compensated balance wheel, still an essential part today, was contributed in the early 1700's by George Graham, another English watchmaker.

Ninety years after Tompion's perfection of the hairspring, Thomas Mudge, a third Eng-

lish watchmaker, invented the detached lever escapement, a type of controlling mechanism of a watch, which in improved form is today the escapement of the majority of watches.

About the time Sir Walter Raleigh ranked high in Queen Elizabeth's favor, a youth of 17 stood one day in the Cathedral of Pisa, watching the swinging to and fro of a lamp suspended by a long chain.

By checking against his pulse rate, this lad noticed, so the story goes, that no matter how wide the arc, the swing was accomplished in exactly the same time. Thus Galileo discovered the principle of the pendulum.

Not until 1657 did Christiaan Huygens, a Dutch scientist, introduce the pendulum into clock mechanism. That improved the accuracy of clocks so much that the minute hand became the rule rather than the exception.

Watches were not usually carried in the pocket for more than a century after the mainspring was invented. Larger ones were kept on tables and smaller ones held by a chain around the neck or suspended from a chatelaine, an ornamental clasp, at the waist.

Staff Photographer Robert F. Sisson

When Will This Bank Vault Open? It's a Question of Time!

If the business day ends at 2:30 p. m., he sets the clocks to open the massive steel doors in 18 hours, at 8:30 the next morning. These four clocks, at Riggs National Bank, Washington, D. C., can be set as far ahead as 72 hours. At week ends the clocks are set at 3 p. m. Friday to open the big depositary in 65½ hours, at 8:30 Monday morning.

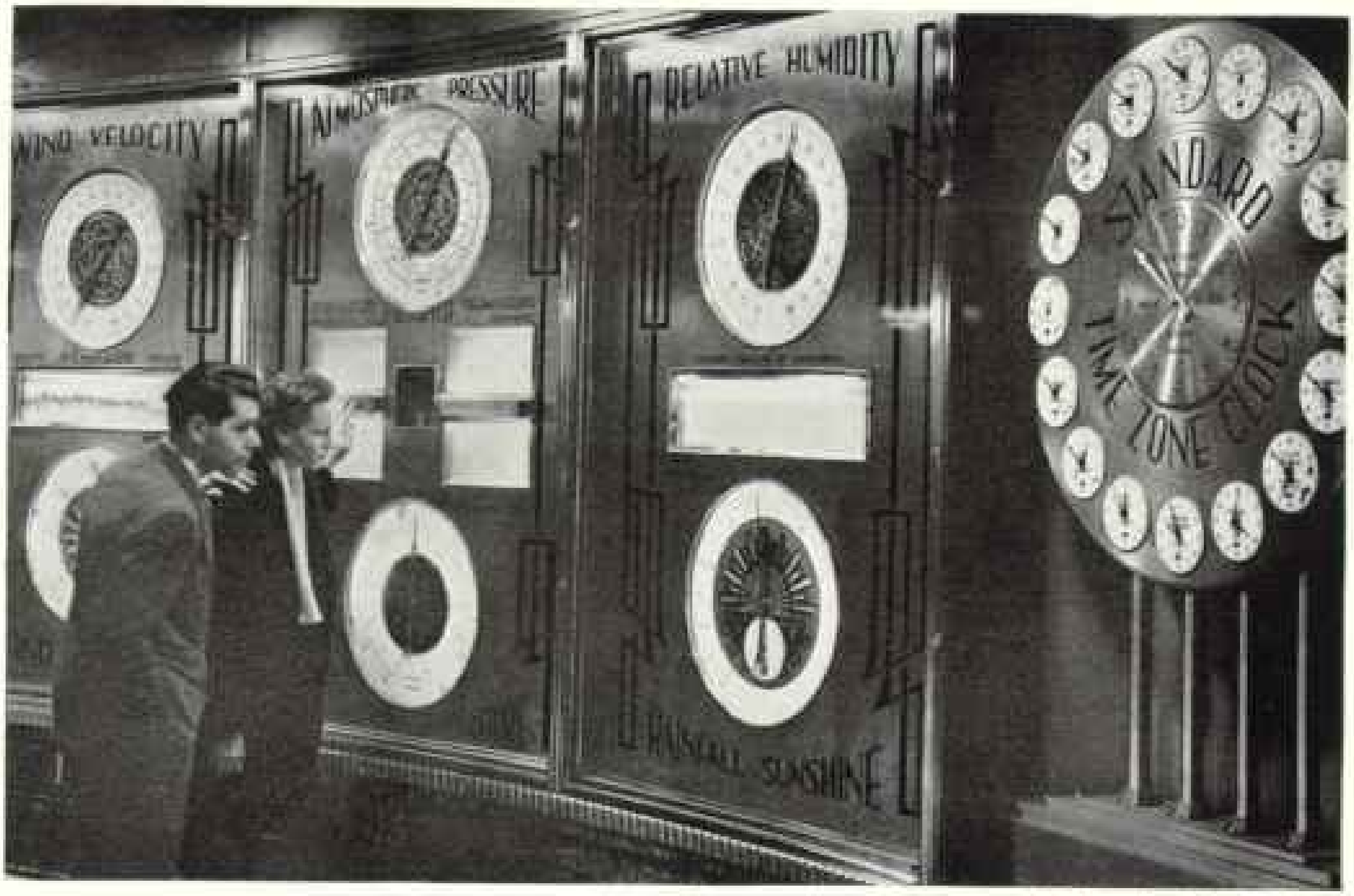
Chronometers Helped Explore the World

As clockmaking improved, leading governments of Europe offered rewards for a chronometer sufficiently accurate to determine longitude at sea. In England, Parliament in 1714 offered $100,000 for a timekeeper which, throughout a voyage to the West Indies, would give longitude within 30 miles. This meant it must keep time accurately within a minute a month, or two seconds a day.

John Harrison, English clockmaker, won the prize with his marine chronometer of 1761. Its accuracy enabled man to navigate trackless waters with certainty of position and encouraged sailors to explore the seas all over the earth (page 428).

Clockmaking in America developed in a new way. In Europe, clockmakers evolved from priests and astronomers, blacksmiths, locksmiths, and jewelers, but early American clockmakers were carpenters; hence the works of many early American clocks were of wood, fashioned with hand tools.

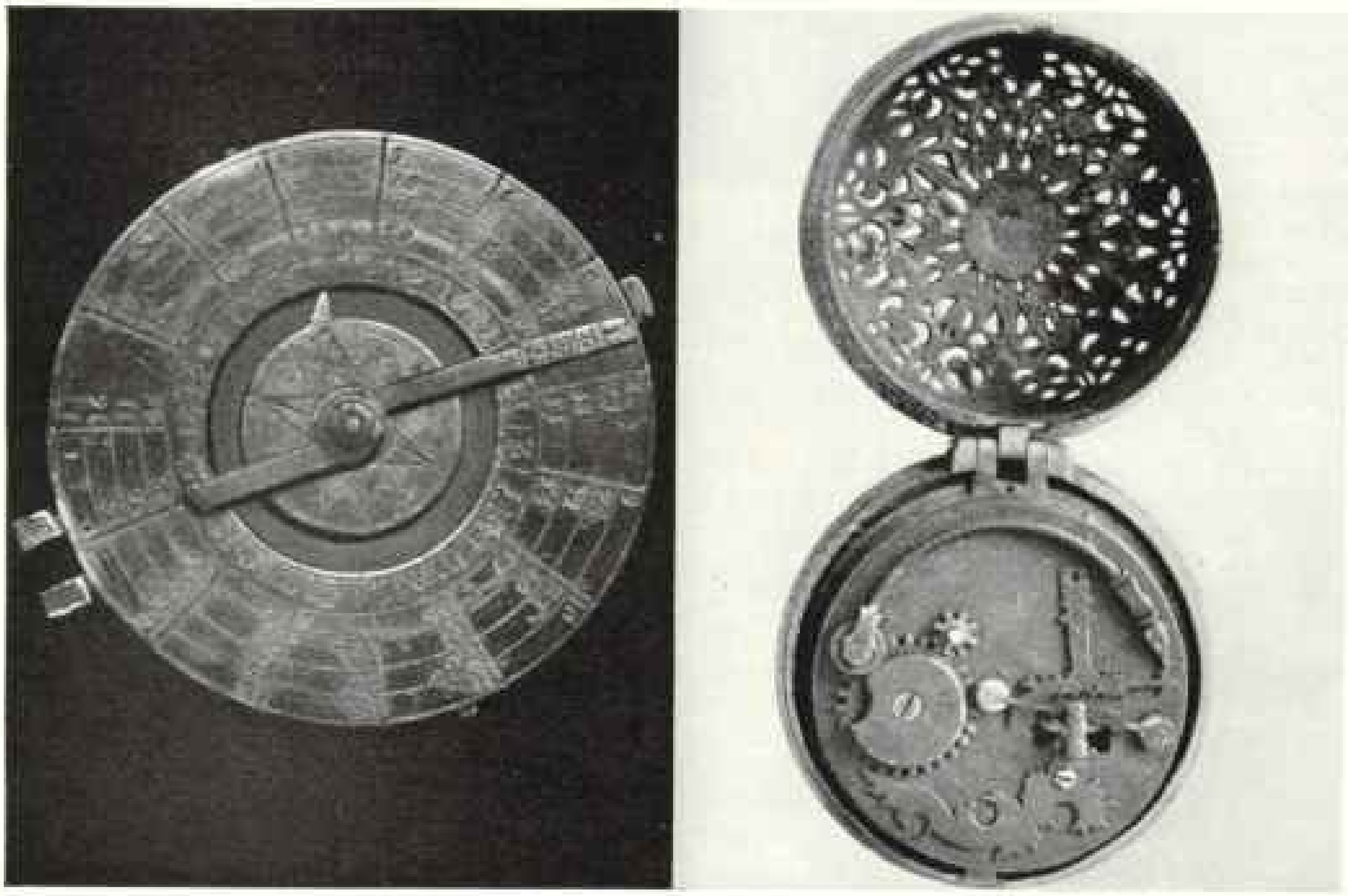
Most of the early clocks made in America were grandfather clocks. After the Revolution, demand for cheap clocks grew, and before



Staff Photographer Robert F. Sisson

Here You Can Check Time All over the World, and the Local Weather as Well!

In the lobby of the Daily News Building, New York City, the large clock (right) gives New York standard time; smaller ones show comparable time in 16 of the 24 time zones of the world. The clocks are connected by direct wire to Western Union, which checks their accuracy against time signals from the U. S. Naval Observatory, Washington, D. C. Weather gauges, left.



Mower Fletcher Collection of Watches

This Earliest Known Clock-watch Was Fashioned of Iron by Hand (page 420)

1800 cheaper rather than better clocks were prevalent.

It was customary to buy the works from a clockmaker and to have a local cabinetmaker make the case. Sometimes the works were hung on the wall without a case. These dust collectors were known as "wag-on-the-wall" clocks.

An outstanding Connecticut clockmaker, Eli Terry, pioneered in using machinery for quantity production of clocks and established the use of interchangeable parts in clock manufacturing.* Terry obtained one of the first clock patents ever granted in the United States with his now famous "pillar and scroll" shelf clock, a radical departure from the long-case clock.

Often Terry traveled on horseback, carrying as many clocks as he could. When the weather looked threatening, the story goes, he would leave a clock at a farmer's house with the understanding that he'd return for it in a few days. Often, when he came back, the farmer had grown so accustomed to the clock that he didn't want to part with it, and a sale was made.

In partnership with Seth Thomas and Silas Hoadley, Terry contracted to make 4,000 clocks. Friends and neighbors alike shook their heads and warned him solemnly, "You are losing your mind, Eli. The first thing you know, the country will be so full of clocks that there will be no market for them." But Terry completed the order within three years.

Seth Thomas, Terry's onetime partner, bought him out in 1813 and began business at Plymouth Hollow (now Thomaston), Connecticut. Here in 1853 he formed the Seth Thomas Clock Company, still outstanding in the clock-making field (page 422).

The World's Biggest Clock

Largest clock in the world, erected over the works of the Colgate-Palmolive-Peet Company, in Jersey City, New Jersey, was made by the Seth Thomas people in 1927. The dial, plainly visible for miles in New York Harbor, is 50 feet in diameter. The minute hand is 27¼ feet long and weighs 2,200 pounds. The tip of the hand travels 31 inches a minute, or 500 times the distance between two minute marks on an ordinary watch (page 410).

Two other Connecticut sons, Joseph Ives and Chauncey Jerome, pioneered in the production of rolled-brass clocks, which lowered the cost and accelerated manufacture. Jerome

*See "Connecticut, Product of Ingenuity," by Leo A. Borah, National Geographic Magazine, September, 1938.

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Lights Go On Again—All over Big Ben

London's famous Westminster Clock takes its name from the 13½-ton hour bell, whose sonorous voice is broadcast each New Year's Eve. When blitz bombings shattered one of the clock's four glass faces, Big Ben's heart didn't skip a beat; later, a workman's hammer, wedged in the works, stopped its tick. Each dial is 23 feet in diameter.

Staff Photographer Robert F. Sisson

"The World's Most Accurate Public Clock" Keeps Time for Lower Broadway

A New York City policeman checks his watch with the clock in the window of the American Telephone and Telegraph Building, 195 Broadway. Secret of its accuracy is the steady electrical current controlled by quartz-crystal oscillators at the Bell Telephone Laboratories. Synchronized every 15 seconds with the Time Bureau of the New York Telephone Company and checked frequently every day against time signals from the U. S. Naval Observatory at Washington, its time never varies more than a twentieth of a second. Eight smaller clocks in the window (four shown) give time in distant cities.

invented the one-day brass clock which drove out the old wood clocks.

Jerome sent a consignment of brass clocks to England. His invoice was so low that customs authorities seized the lot, charging him with undervaluation. The penalty, under the revenue laws of England, was confiscation of the shipment and payment of the invoice plus 10 percent. Jerome shipped another lot of clocks, and again the English paid the invoice plus 10 percent.

Jerome was delighted to find such an easy cash customer, willing to pay 10 percent over the invoice and not charge a commission for the sale. He sent a whole shipload of clocks. But customs authorities awoke to the fact that the English Government was losing money and they passed the shipment.

Pioneers in the establishment of the first watch factory were two Massachusetts boys, Aaron Lufkin Dennison, and Edward Howard, who conceived the idea of making watches by automatic machinery and on the plan of interchangeable parts, as Eli Terry had done with clocks (page 425).

Their factory, later known as the Waltham Watch Company, was the first in the world in which all parts of a watch were made by machinery under the same roof. Its success revolutionized the methods of watchmaking not only in America but also, to a less degree, in all parts of the world.

The name of the company passed into literature when Emerson, describing a successful type of man, said, "He is put together like a Waltham watch."

Touring a watch factory such as those of the Hamilton or Elgin Watch Companies, one realizes what Christopher Morley meant when he said, "I defy anyone to go through a watch

Staff Photographer Robert F. Sisson

Here Four Generations of Clockwise Jensens Have Kept Up with the Times

Clocks from all parts of the world have found their way to the shop on New York City's water front. Some are for repair. The Jensens' collection tells the history of timekeeping from cumbersome two-century-old wooden clocks to water-thin modern watches that split seconds.

factory and not get a little bit addled."

Look at some of these facts and figures:

The hairspring of a lady's wrist watch is less than 1/3 the diameter of an average human hair (page 407).

The standard unit of measure in a watch is 1/10,000 of an inch. This means that each one of the 100 or more parts when tested must meet this accuracy.

Some watch gear teeth are no wider than a human hair. The pallet arbor, or shaft, a part of the escapement, is so small you could put 4,000 of them on a dime. One watch screw is 18/1000 of an inch long and the same in width. You could put 20,000 of them in a thimble. The largest screw used in one well-known type of watch is only 55/1000 of an inch thick.

To weigh the tiny screws put in the edge of a watch balance wheel to poise its weight, a scale is used that is so sensitive it will record the weight of a pencil mark on a piece of paper.

Expansion and contraction of the hairspring caused by heat of summer and cold of winter is measured down to millionths of an inch by another instrument used in watch factories.

Temperature Changes Affect Watches

Though all good watches are tested in six positions, face up, face down, and with the "12" up, down, and turned halfway to the left and right, changes of position do make watches vary. For that reason, wrist watches usually are the least accurate.

Changes in temperature and atmospheric pressure will cause a watch to vary as much as seven or eight seconds a day, fast or slow.

You speak of a 17- or a 21-jewel watch, but do you know why jewels are used in a watch?

They bear the same relation to a watch as a ball or roller bearing does to an automobile. Sapphires and rubies are bearings for the revolving pivots in your watch because they are much harder than metal. The use of jewels

reduces friction and maintains the regularity of the running of the watch.

Timing of watches used to be limited to checking the fastest-moving hand on the dial. With the Hamilton Watch Company's "time-microscope," the balance wheel of the watch is observed.

At accurate split-second intervals a revolving reflector flashes a light on the watch's balance wheel, and if its speed is the same as the reflector's the arm looks stationary.

An important recent development in watchmaking is a new metal alloy for watch mainsprings, an outgrowth of research by Elgin National Watch Company scientists (pages 403, 414).

Half of all watch-movement repairs are traceable to mainspring trouble, it is estimated. The mainspring may break because of rust or may "set," which means it acquires a permanent deformation that results in loss of power. The new Elgin alloy is rustproof and is far less liable to "set," and so maintains its original driving strength indefinitely.

To show how tough are mainsprings made of this new alloy, Elgin scientists immersed a watch movement in a bath of heated aqua regia, a highly destructive acid. In a few minutes all the watch parts were completely dissolved except the jewels and the new alloy mainspring! They emerged undamaged.

You've heard the legend, perhaps, that an epidemic of broken watch mainsprings often follows a violent thunderstorm. The reason for it, say Elgin engineers, is that the air is very humid during a thunderstorm. The drop in temperature that usually follows the storm may condense some of this moisture on the mainspring. This may produce a spot of rust which will often cause the spring to break within a few hours.

Speaking of springs, the best time to wind your watch is in the morning. The reason is that most people get up at the same time, no matter when they go to bed. Thus if wound in the morning your watch will be wound at the same time every day. Moreover, a morning winding ensures that the spring will be tightest, and therefore your watch will keep the most accurate time during the day hours when you look at it most.

Few people realize that changes in temperature and atmospheric pressure cause a watch to "breathe." During the day, when a lady wears her wrist watch, the heat of her wrist will cause the air inside to expand and some of it will be forced out. At night, when she takes it off and places it on her dressing table, it grows cooler and the air contracts. Some air then is drawn inside, and may bring with it a bit of her face or dusting powder, which can cause trouble. Likewise, the alcohol fumes from milady's perfume or toilet water can be drawn inside in the same way, thinning the oil and causing it to spread away from points requiring lubrication.

Up to the outbreak of World War II, Europe was the main source of supply of chronometers used on ships. When the Germans invaded France this source was cut off, just when the expanding navies of Britain and the United States needed great numbers of chronometers (page 408).

Hamilton Watch engineers undertook to make chronometers by mass production, something never done before, since tolerances of chronometer parts are as fine as 1/100,000 of an inch. Two years later, Hamilton was producing more chronometers in a month than had been made in a year in all the world before the war. Elgin also made chronometers.

Watches Once Were Luxuries

Even toward the close of the 19th century, when demands of punctuality touched almost everyone, watches were regarded as luxuries.

Then the Waterbury Watch Company produced, in 1880, a watch which sold for $4. It had only 58 parts, and the whole movement, carrying the hour hand with it, turned around once every hour. The spring was nine feet long and required almost unlimited winding.

Some people held the corrugated stem against the side of a fence and made the watch wind by running along the fence's length! It was the subject of jokes; minstrels opened their performance by saying, "We come from Waterbury, the land of eternal spring."

In 1892 the Ingersoll brothers pushed the sale of inexpensive watches. Contracting for several thousand from the Waterbury Clock Company, a different firm, they listed them in mail-order catalogues to sell for $1. The Ingersoll watch became known as "the watch that made the dollar famous."

Will there ever be a clock that keeps perfect time? From the heart of the atom, so much in the news these days, we may get the answer. Someday we may use atoms to measure time, because they have within them very sharp and precise frequencies of oscillation, a scientist has discovered. You could adjust a vibrating crystal to vibrate at the same rate as the atoms of some pure element.

An electronic device could be designed always to make the crystal keep the same rate as the atom. Then the crystal's vibrations could be used to run a clock. Such an atom-controlled clock would keep more nearly accurate time than the turning earth itself!

NATIONAL GEOGRAPHIC SOCIETY

ORGANIZED FOR "THE INCREASE AND DIFFUSION OF GEOGRAPHIC KNOWLEDGE"

To carry out the purposes for which it was founded fifty-nine years ago, the National Geographic Society publishes this Magazine monthly. All receipts are invested in The Magazine itself or expended directly to promote geographic knowledge.

Articles and photographs are desired. For material The Magazine uses, generous remuneration is made.

In addition to the editorial and photographic surveys constantly being made, The Society has sponsored more than 100 scientific expeditions, some of which required years of field work to achieve their objectives.

The Society's notable expeditions have pushed back the historic horizons of the southwestern United States to a period nearly eight centuries before Columbus crossed the Atlantic. By dating the ruins of the vast communal dwellings in that region, The Society's researches solved secrets that had puzzled historians for three hundred years.

In Mexico, The Society and the Smithsonian Institution, January 16, 1930, discovered the oldest work of man in the Americas for which we have a date. This slab of stone is engraved in Mayan characters with a date which means November 4, 291 B. C. (Spinden Correlation). It antedates by 260 years anything heretofore dated in America, and reveals a great center of early American culture, previously unknown.

On November 11, 1935, in a flight sponsored jointly by the National Geographic Society and the U. S. Army Air Corps, the world's largest balloon, *Explorer II*, ascended to the world altitude record of 72,395 feet. Capt. Albert W. Stevens and Capt. Orvil A. Anderson took aloft in the gondola nearly a ton of scientific instruments, and obtained results of extraordinary value.

The National Geographic Society–U. S. Navy Expedition camped on desert Canton Island in mid-Pacific and successfully photographed and observed the solar eclipse of 1937. The Society has taken part in many projects to increase knowledge of the sun.

The Society cooperated with Dr. William Beebe in deep-sea explorations off Bermuda, during which a world record depth of 3,028 feet was attained.

The Society granted $25,000, and in addition $75,000 was given by individual members, to the Government when the congressional appropriation for the purpose was insufficient, and the finest of the giant sequoia trees in the Giant Forest of Sequoia National Park of California were thereby saved for the American people.

One of the world's largest icefields and glacial systems outside the polar regions was discovered in Alaska and Yukon by Bradford Washburn while exploring for The Society and the Harvard Institute of Exploration, 1938.

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DICTAPHONE

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Actual color photograph of 1947 Studebaker Regal De Luxe land Cruiser

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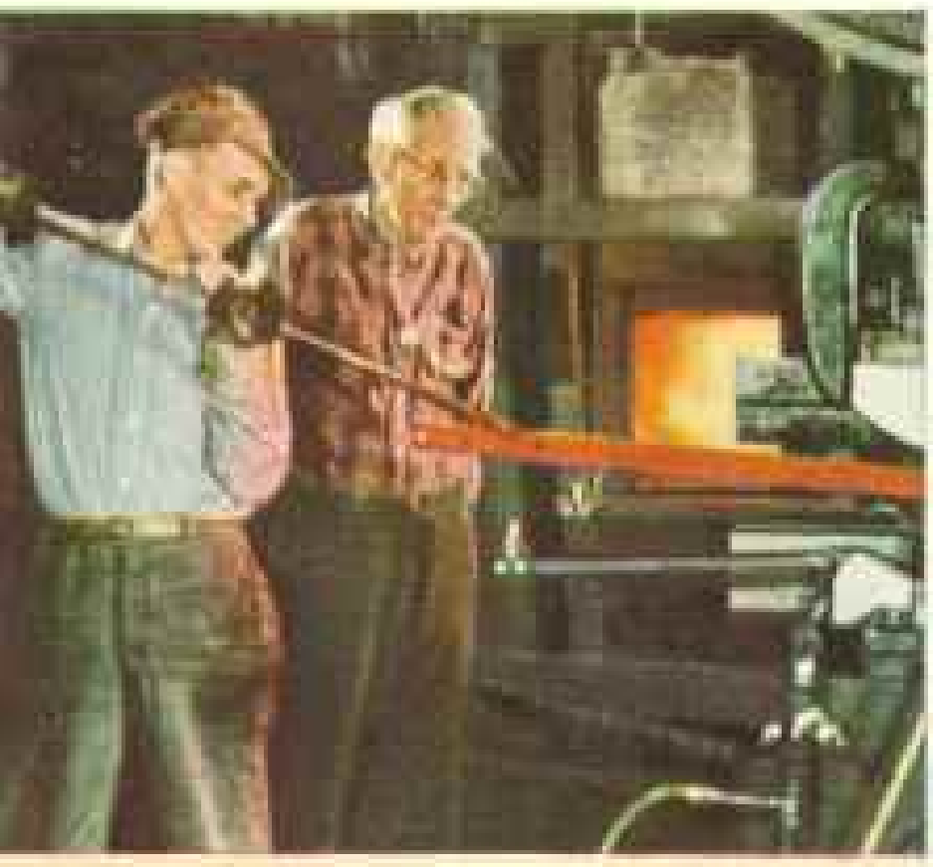

Man of conscience as well as competence build long life into every Studebaker— The Studebaker craftsmen pictured are the Millers—S. R. and N. T. A 63-year-old father and 40-year-old son, they're old-timers on their Studebaker jobs. For over 95 years, there has been a steady sequence of these father-and-son teams at Studebaker.

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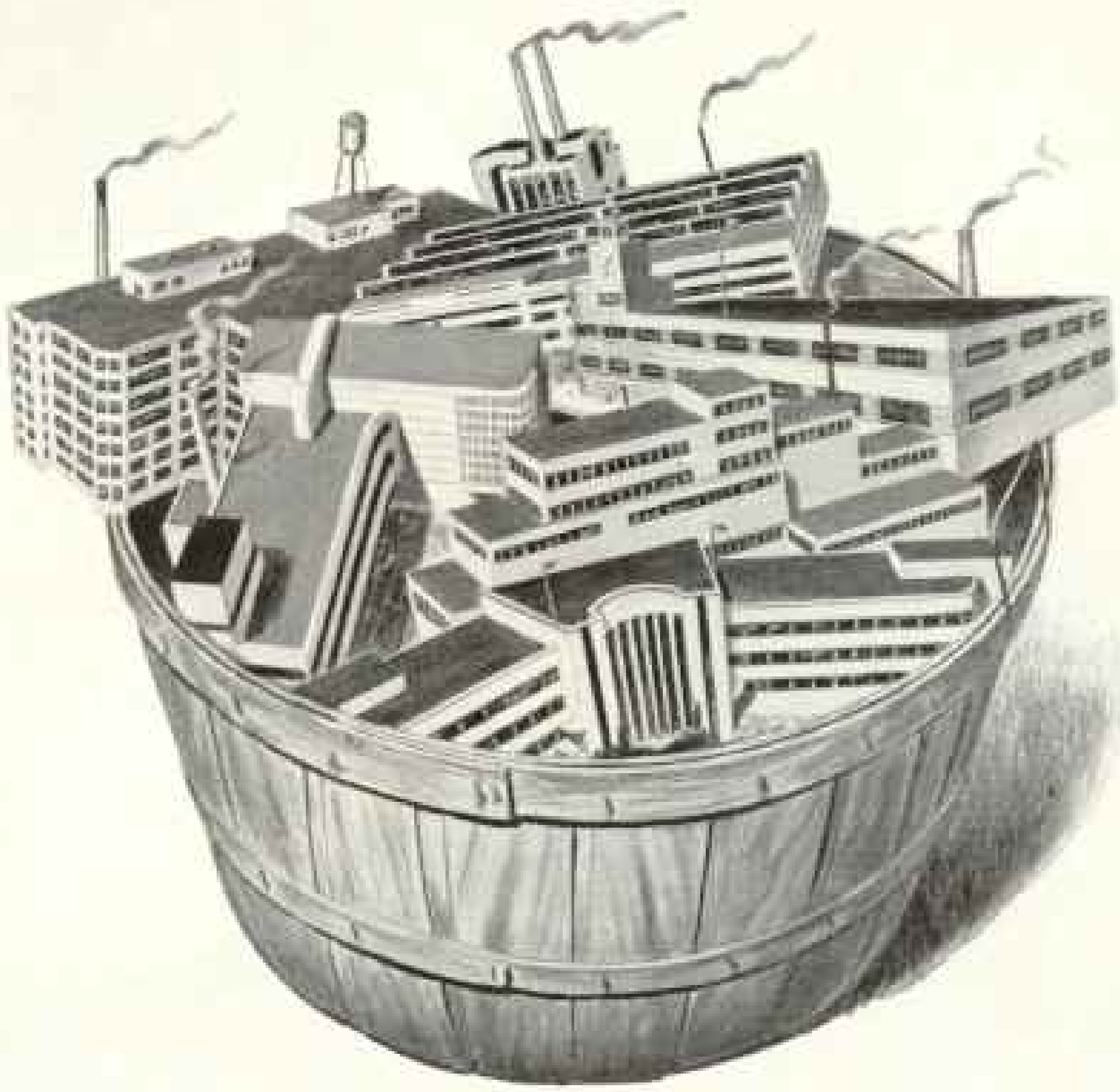

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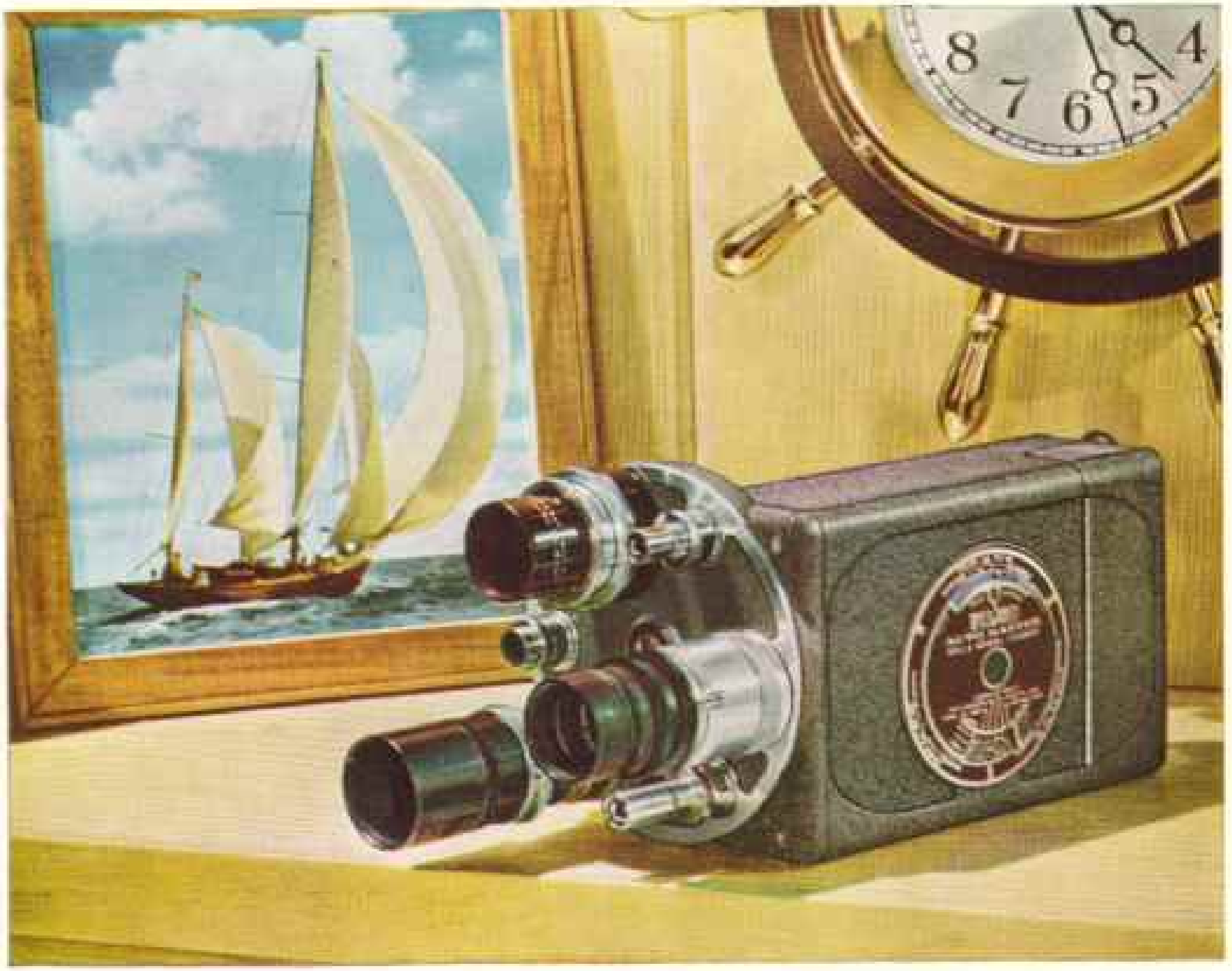

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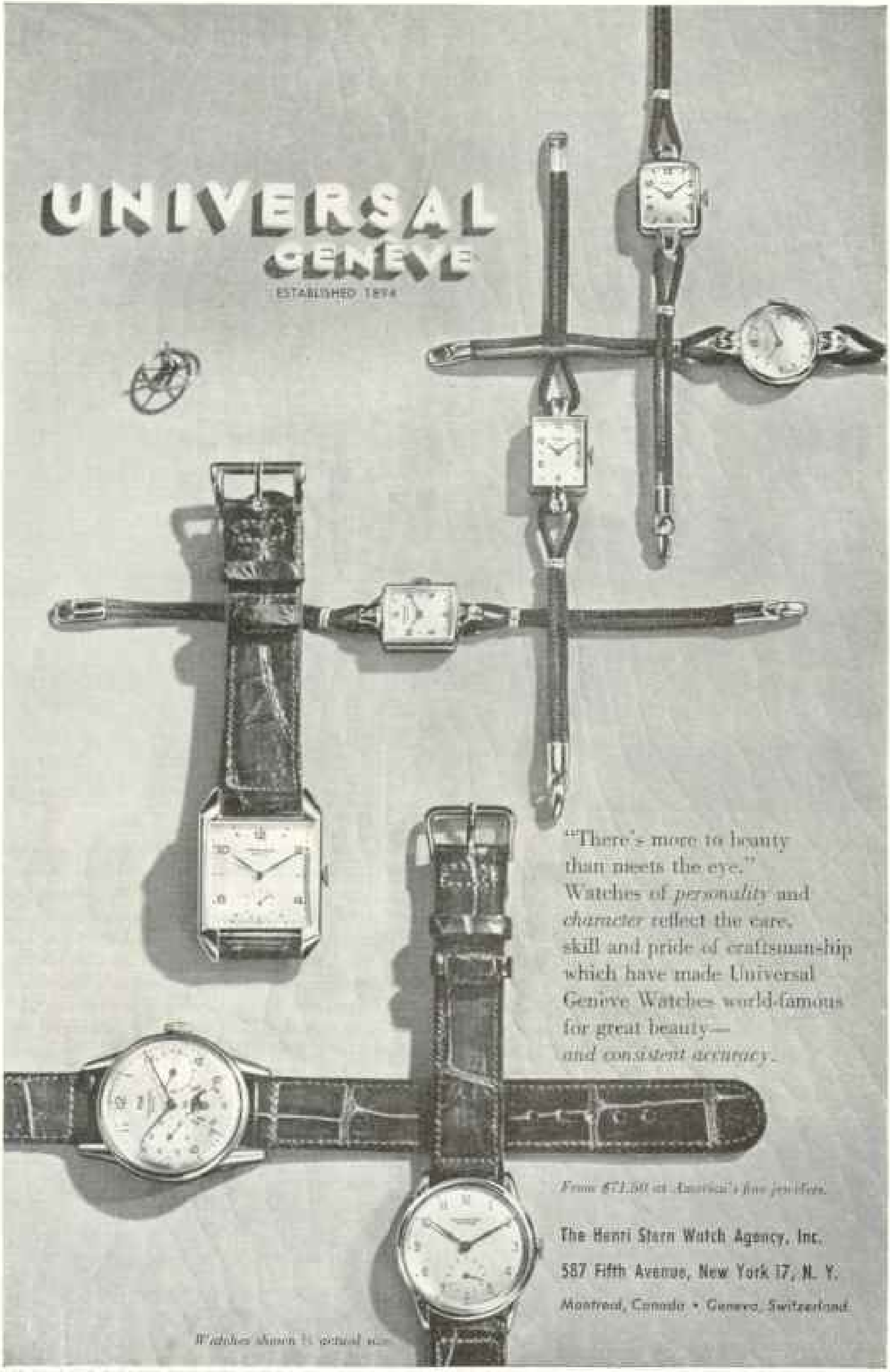

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Only constant vigilance  can hold these gains. Recently, when diphtheria immunization was neglected in some parts of the country, cases in those sections began increasing.

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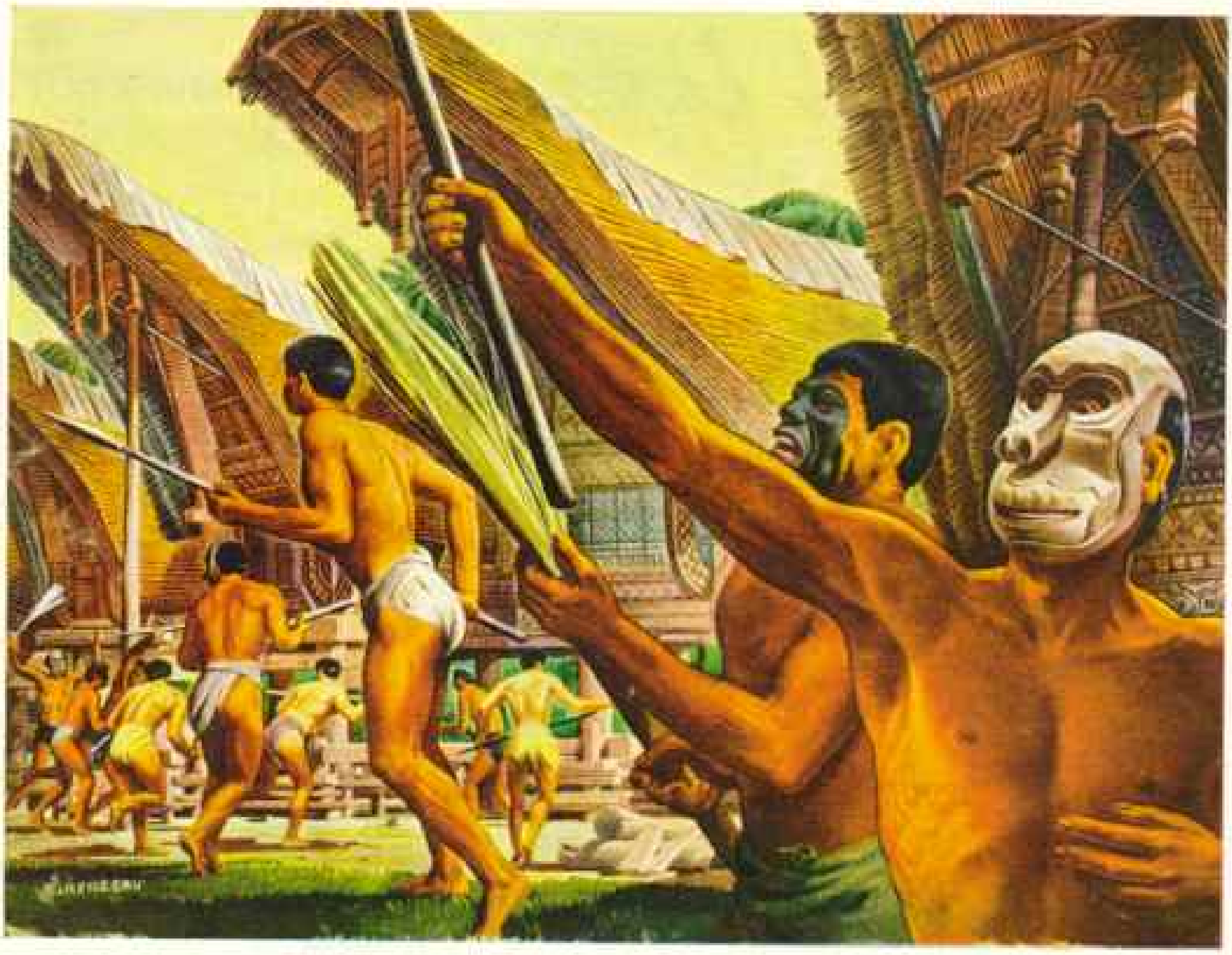

Devil drive

WHEN A VILLAGE in the northern part of Celebes is visited by a series of misfortunes, the natives lay the blame on evil spirits—and get busy with a devil-control ceremony.

As their first move, the Celebesians leave their homes and set up housekeeping in temporary huts outside the village. Then, after several days the men, some wearing masks and others with faces blackened, sneak back into the village.

At a prearranged signal, the posse rushes madly through the streets and underneath each house, brandishing swords, guns, spears, and brooms. The imaginary devils, according to the Celebesians, are frightened by the fierce cries and menacing gestures and are driven off into the brush.

Now, the aim of the Celebesians' devil drive is a good one. A misfortune-eradication program would be a fine thing for any civilized community, too, if it would only work.

But even modern safety measures can't be expected to keep your home, your office, your streets, entirely free of accidents and other mishaps. So shouldn't you take the following step right now?

Check your insurance to make sure that you've got enough accident, burglary, automobile, fire, life, and other kinds of insurance to cover your losses should misfortune come your way.

And when you look at the amount of each policy, remember that a fire or theft, a personal accident or an automobile smashup can be a lot more expensive these days than ever before.

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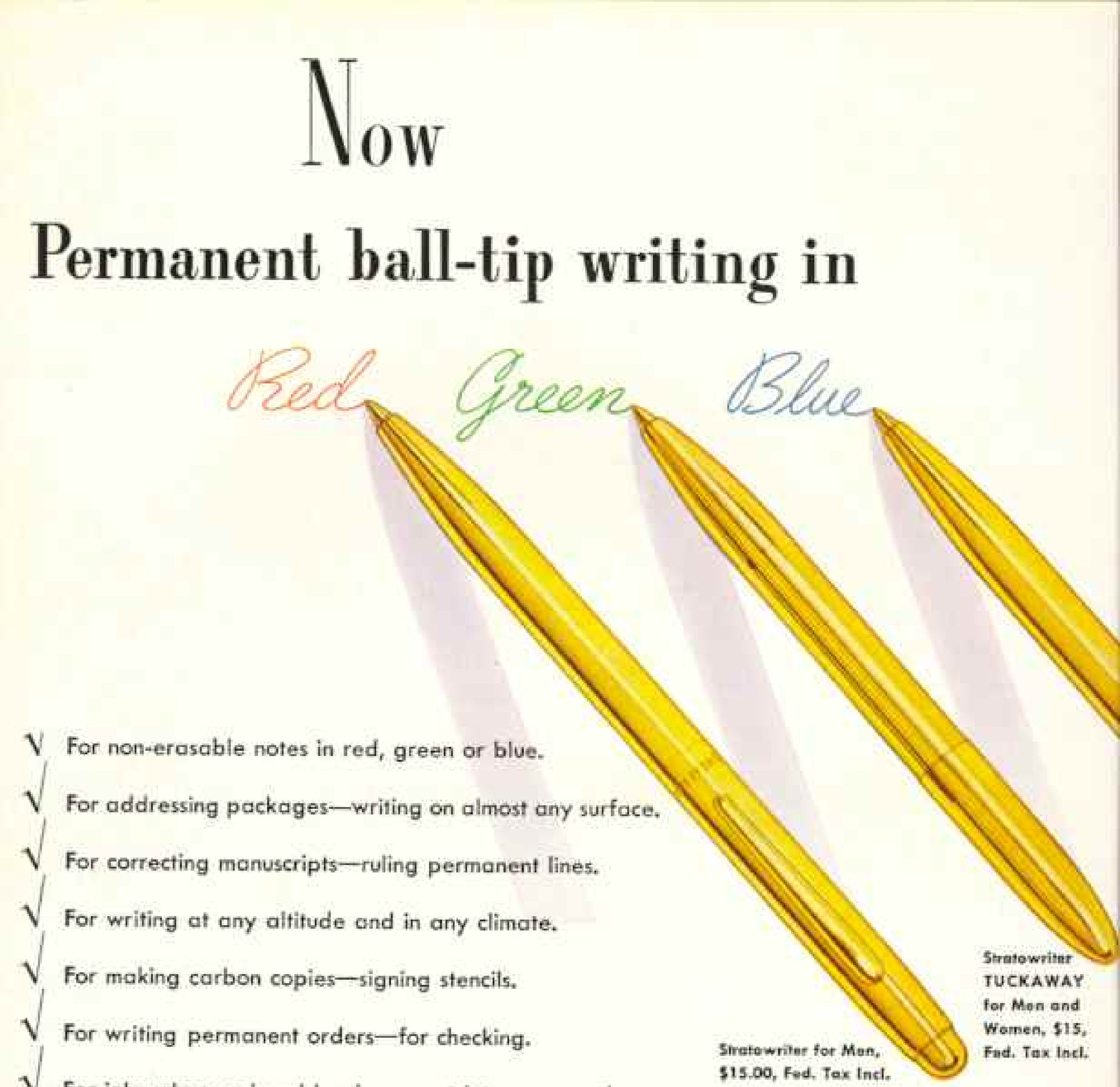

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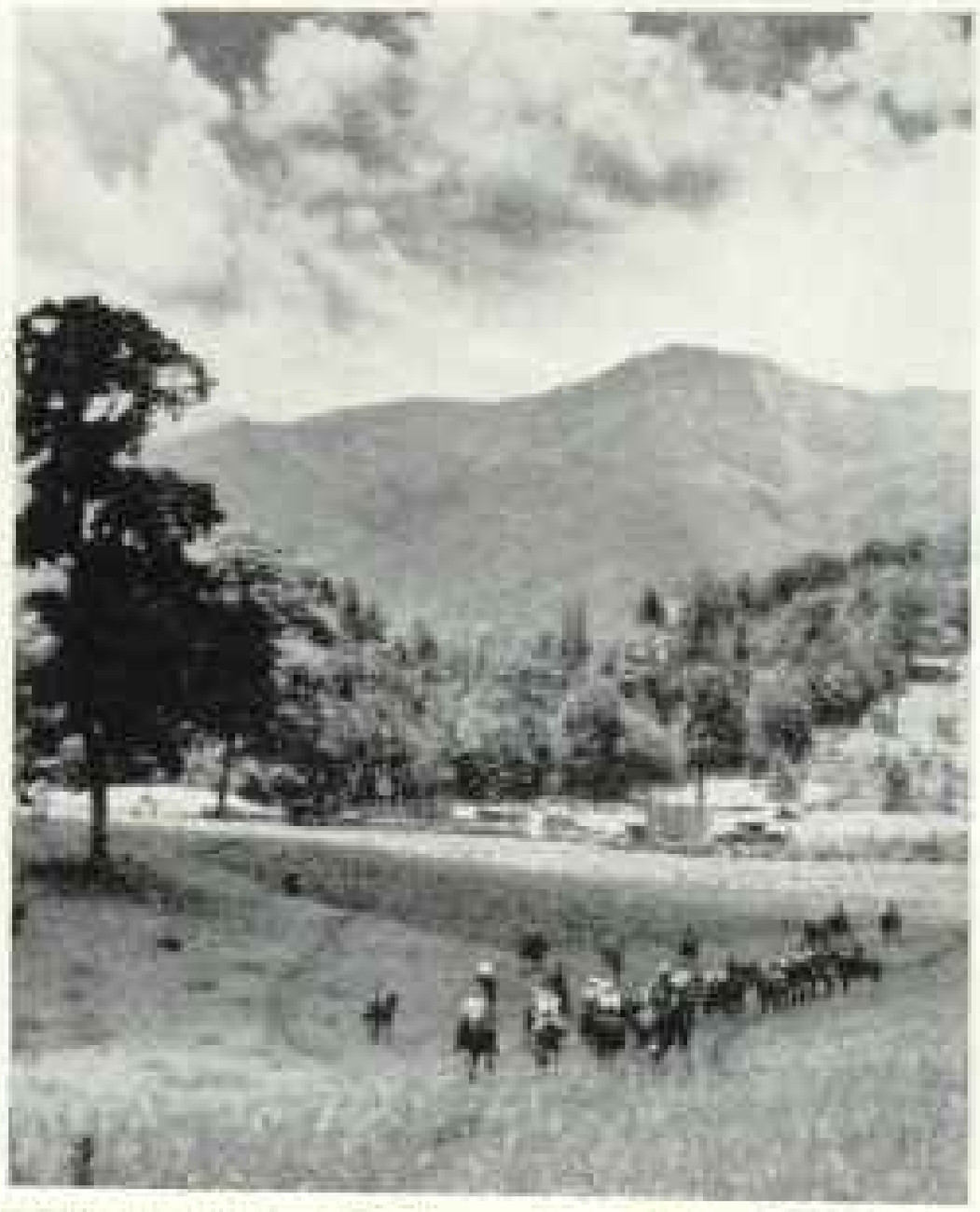

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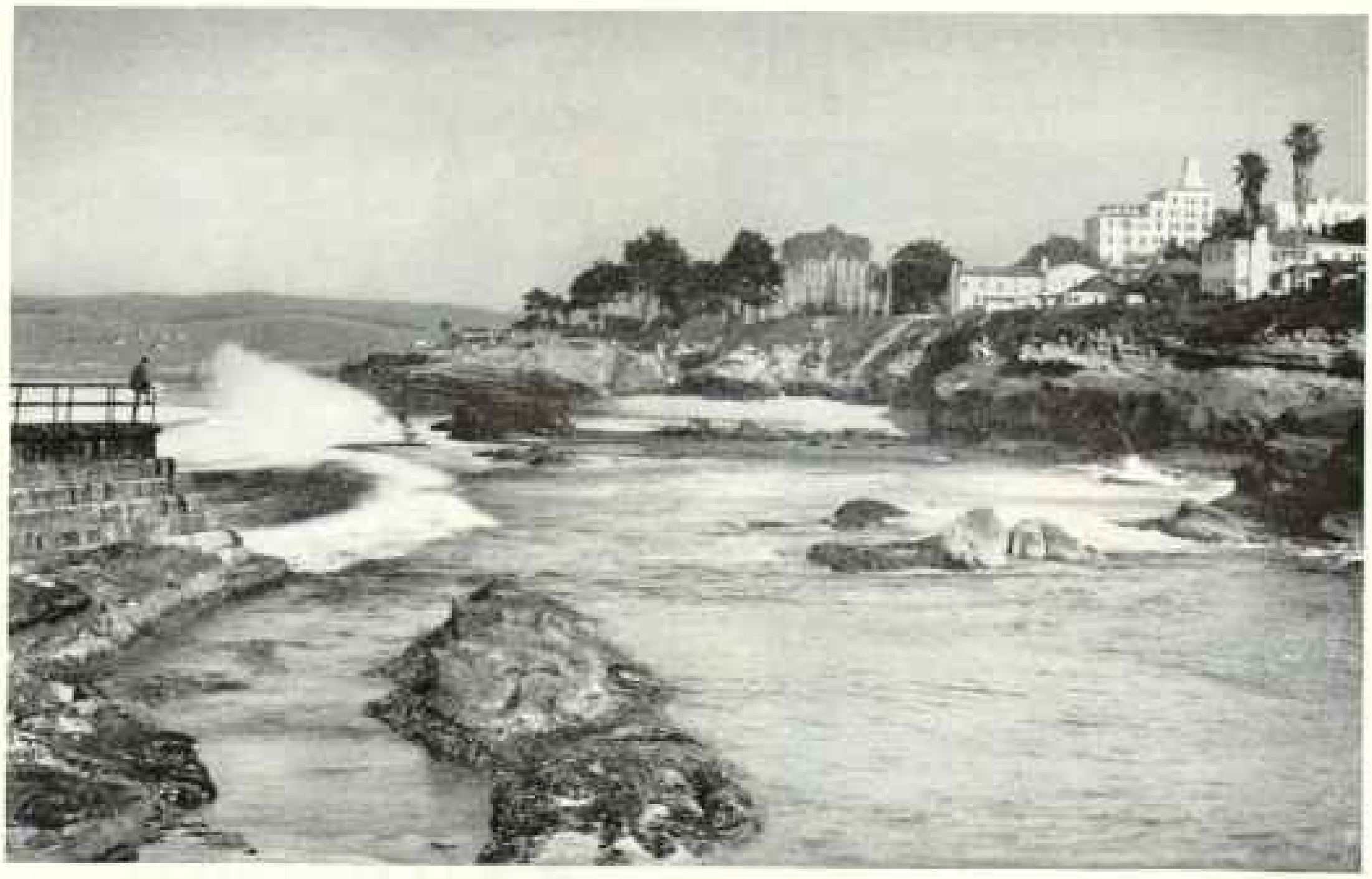

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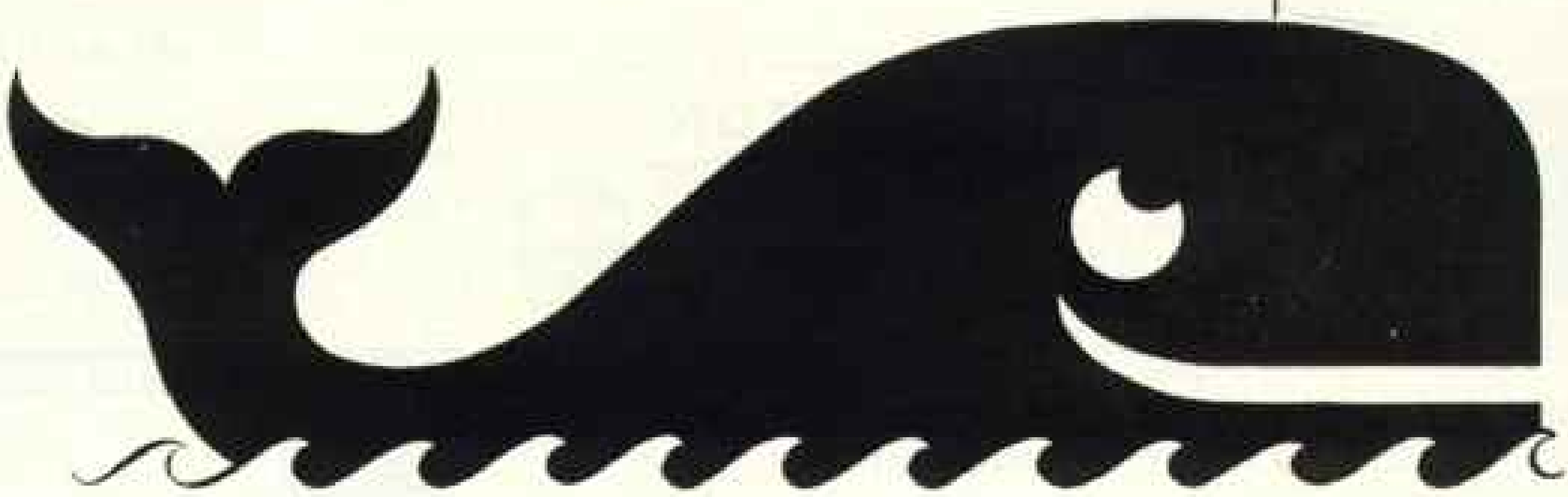

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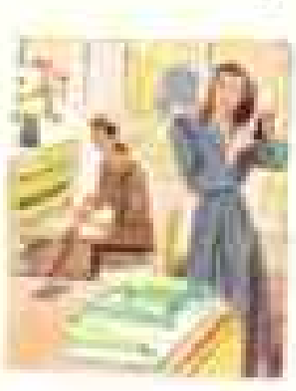

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