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THE NATIONAL GEOGRAPHIC MAGAZINE

Arkansas Rolls Up Its Sleeves

By FREDERICK SIMPICH

ARKANSAS now turns an old song around to make itself a new motto, thus:

Hang up the fiddle and the bow;
Get down the shovel and the hoe!

"Compared with a busy neighbor State, like Texas, I reckon we did oversleep a bit," says the Arkansan. "But we woke up in time to join that industrial parade now marching all down the Mississippi Valley."

That is true. Today this once-easygoing, rooster-fighting State speaks with new voices. After work hours you may still hear a lively fiddle tune, the faraway moan of fox horns, or the yelp of hounds on a hot trail.

But louder than hounds or fiddles are the challenging voices of this born-again Arkansas as it shouts to make itself heard above the roar of new paper mills and aluminum factories.

The whole State speaks now, you might say, with steam whistles, sawmill whines, and the whir of wheels. Shooting oil wells pays better than shooting ducks, and there's more money in milk than in moonshine.

Today's "Arkansas Traveler"

Today's "Arkansas Traveler" is no longer the fiddling horseman of Opie Read's tales. Now he's that free-spender who crowds the cosy Ozark tourist camps (Plate II), tries to pick a bangtail at Hot Springs races, or gets "boiled out" in its human laundries along "bathhouse row" where, legend says, De Soto and his ragged rangers 400 years ago got the first hot tub since they left sunny Spain.

On the newsstand of Little Rock's Albert Pike Hotel they still sell that flippant little book, *On a Slow Train Through Arkansaw*.

"A new edition is just out," said the clerk. "But it's no more true of our State now than legends of Sleepy Hollow are true of up-the-Hudson country."

"Some of us laugh, with the rest of the Nation," said Governor Ben Laney, "at cartoons of long-whiskered 'mountain boys' or a radio comedian's gags about his imaginary Arkansas kin who live on sowbelly, corn pone, and molasses. But the fact is, we raise enough rice to feed the Chinese army.

"We grow 195-pound watermelons and ship a flock of chickens every year big enough to black out all Chicago, if they could fly out under their own power. And while I'm bragging—we've got one of the country's biggest peach areas.

"To help you see all sides of our interesting State, I'm sending Mr. Glenn A. Green of the Arkansas Resources and Development Commission to show you about. His middle name is Avantus, but don't let that throw you! He knows every nook and cranny of Arkansas; he wrote that book, *We Challenge*, and I challenge any NATIONAL GEOGRAPHIC reporter to keep up with him!

"One more caution," warned the Governor. "Don't go out, like Cecil B. de Mille's men did when they came here to film the life story of our State hero, Dr. Corydon M. Wassell, to find a razorback hog. I know there's a lot of funny yarns about a sardonic wild swine supposed to roam our hills, with a snout so long he can drink out of a jug. But no such pig lives here, or ever did. I'll give you $100 if you can find one!"

Avantus was a good guide. By air, land, and water we saw Arkansas, inside and out.

State Has Good Neighbors

Like people in choice residential parts of a city, Arkansas has good neighbors. To her north is diversified Missouri. East, across

Staff Photographer Willard R. Culver

Through Romantic Decades This Graceful Edifice Was the State Capitol

After a new Statehouse was built (Plate I), this one was renamed "War Memorial Building." Begun in 1833 and remodeled in 1885, it is considered one of the best examples of Greek architecture in the South. The big, thick bricks in its walls were made by hand. Arkansas was our frontier when Mexico still owned our Southwest and California.

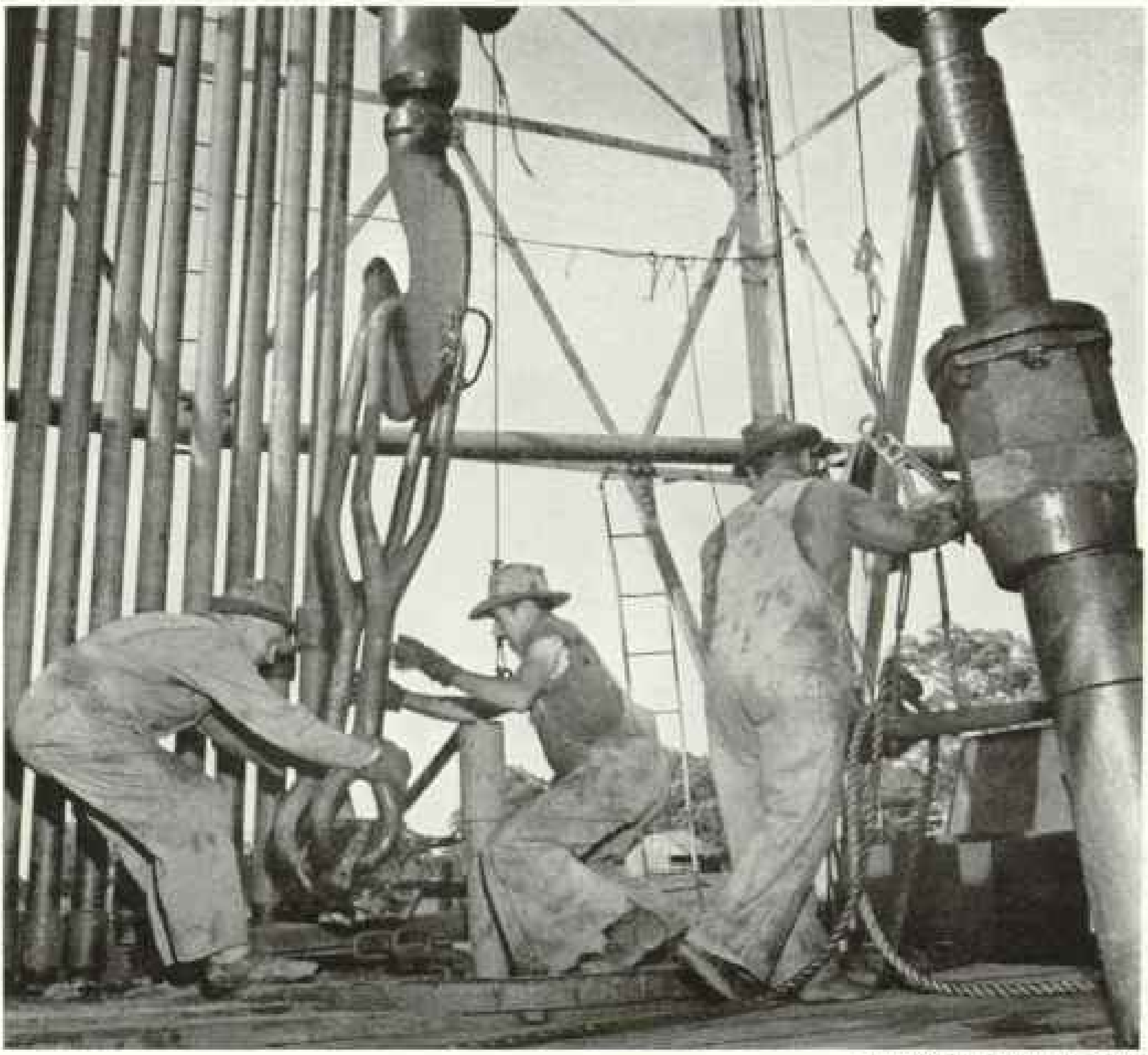
the Father of Waters, are the romantic States of Tennessee and Mississippi; west is opulent Oklahoma, and tough, tremendous Texas.* On the south is lush Louisiana, joining her rice and oil fields, her forests and cotton areas, to those of Arkansas (map, pages 280-281).

This State is about half mountainous and half delta lands. Highlands, which hold the Ozark plateau and the Ouachita Mountains and are split by Arkansas River Valley, lie roughly in the northwest half of the State. Lowlands, formed by the Mississippi Valley and the northern sweep of the Gulf coast plains, form the southeast half.

People in the two sections are as diverse as topography. Up in the cool Ozarks, for example, you find only whites. There housewives do all their own work, and many find time besides to run a roadside novelty shop, cafe, or gas station.

But on vast plantations along the Missis-

* See, in the NATIONAL GEOGRAPHIC MAGAZINE, by Frederick Simpich, "These Missourians," March, 1940; "Missouri, Mother of the West," April, 1923; "Land of a Million Smiles (Ozarks)," May, 1943; "So Oklahoma Grew Up," March, 1941; "So Big Texas," June, 1928; "Yield of Texas," February, 1945; and "Along Our Side of the Mexican Border," July, 1920; "Highlights of the Volunteer State (Tennessee)," May, 1939, and "Rambling Around the Roof of Eastern America (Great Smoky Mountains)," August, 1936, both by Leonard C. Roy; "Home Folk Around Historic Cumberland Gap," by Leo A. Borah, December, 1945; "Machines Come to Mississippi," by J. R. Hildebrand, September, 1937; "Texas Delta of an American Nile," by McFall Kerbey, January, 1939; "Louisiana, Land of Perpetual Romance," by Ralph A. Graves, April, 1930.



Staff Photographer William R. Culver

Lion Oil Company Drillers Sink a 7,500-foot Well near Waldo

Here pioneered Col. T. H. Barton, President of Lion Oil Company. His latest project is a giant factory to make ammonium nitrates, vitally needed in assembling the complete fertilizer so necessary to Arkansas agriculture. Lion Oil is to Arkansas what Union or Standard is to California (page 288).

sippi a more leisurely, almost feudal form of society still exists. One plantation, the Wilson, cultivates more than 60,000 acres.

Baronial Plantation Homes

Another show place is the baronial Bruins Plantation of Mr. and Mrs. Hugh M. Brinkley, fronting the river between Memphis and Helena.

I found planter Brinkley in his office at his general store, an old-fashioned country curiosity shop which sells everything from mule collars and animal traps to patent medicines, work clothes, canned goods, and snuff.

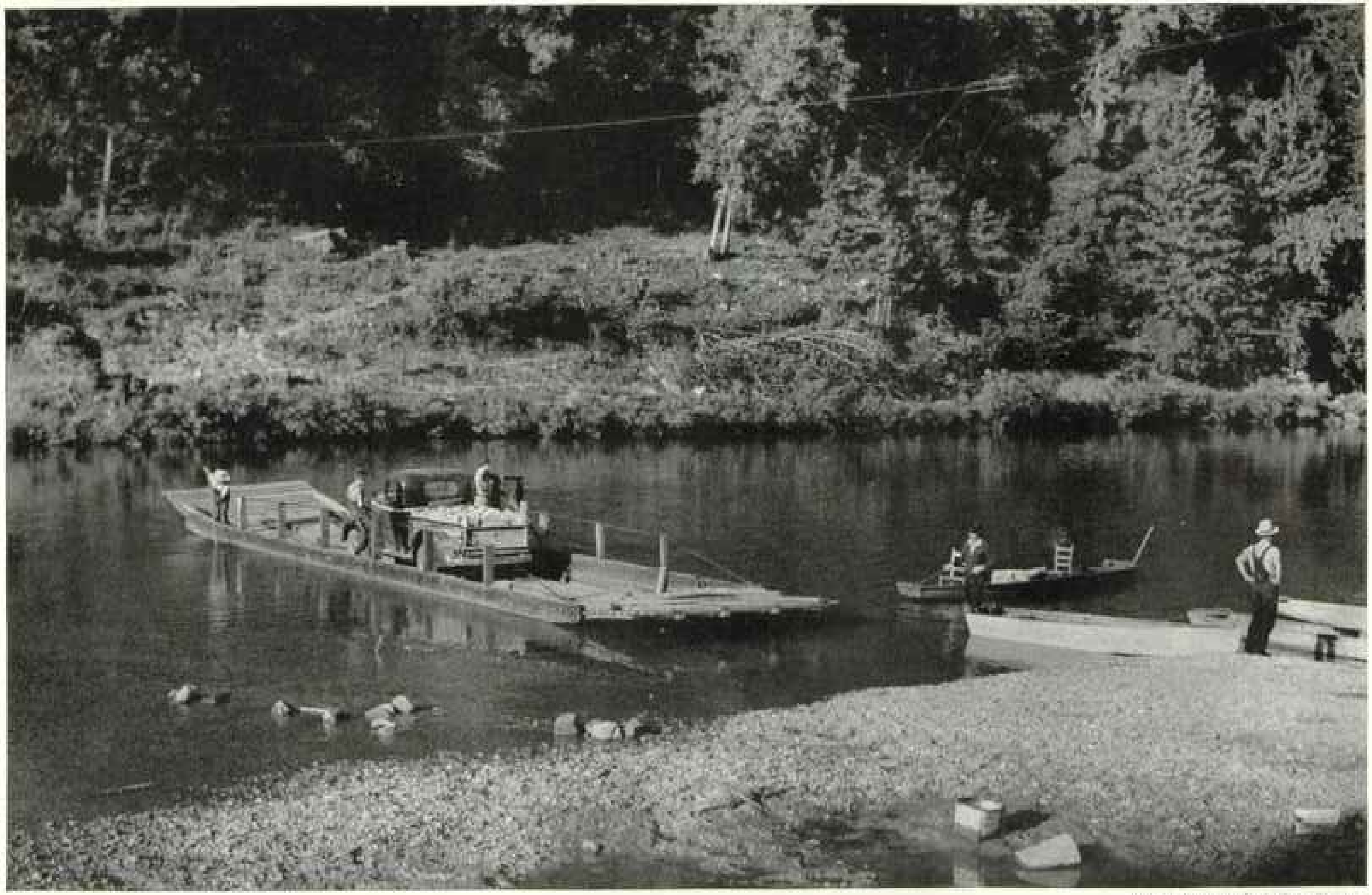
"Snuff, and chewing tobacco, are our fastest-moving items," a clerk said.

On the wall was a green poster, which read in part:

LOOK! Big free picnic. Five neighboring plantations consolidating Music and Public Speaking . . . 100 Prizes . . . Races, Rooster Fights, Money Scrambles . . . and a Rooster Drop . . . Positively no Pistols, Razors, or Ice Picks Allowed!

"That's been going on every Fourth of July for years," I was told. "What's a rooster drop? Well, we put a number on a rooster, attach him to a parachute thrown from a plane, and the person who catches him and brings in that number gets the goods."

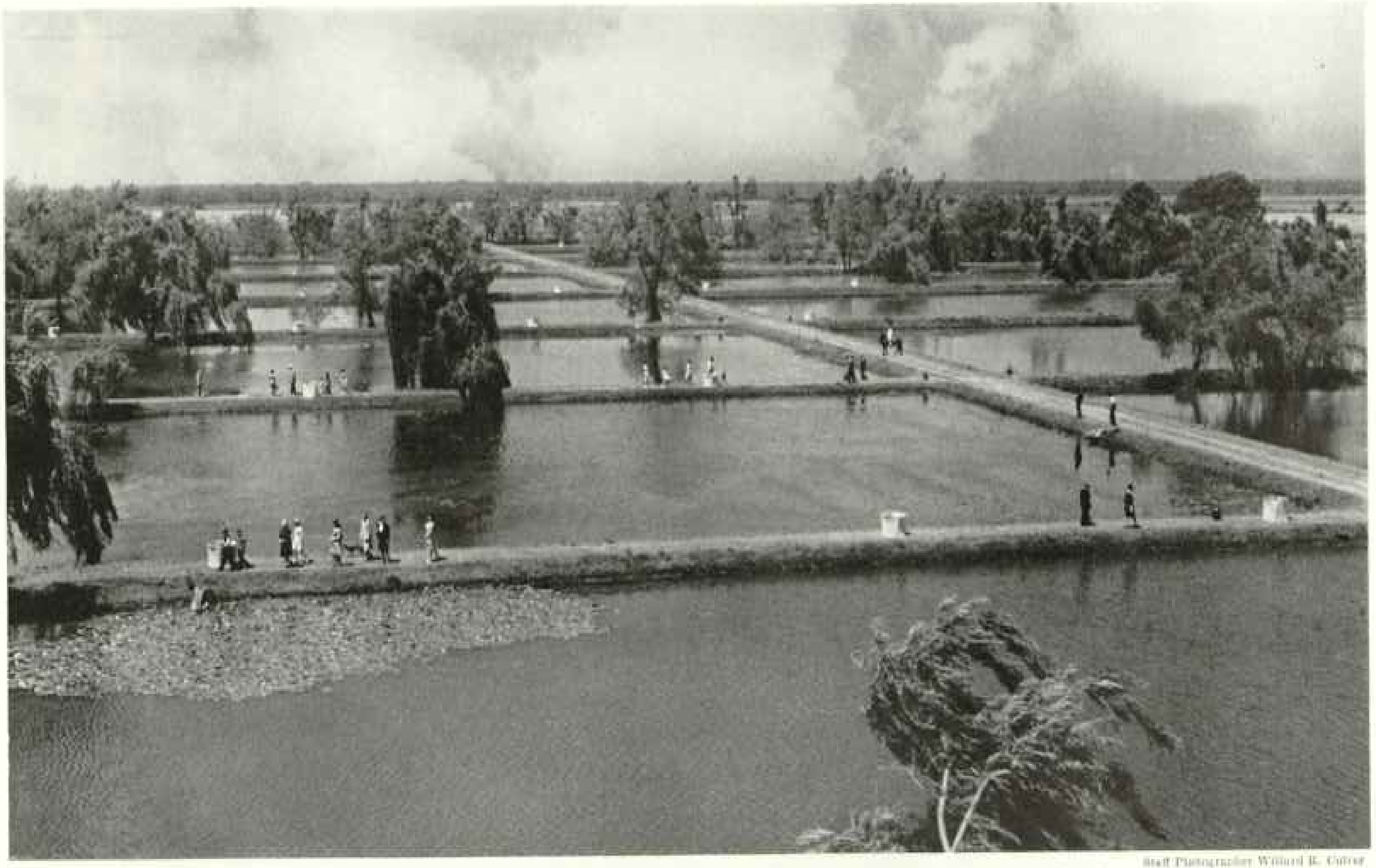
When Mr. Brinkley had finished giving morning orders to his field bosses, he took me for a motor ride over the estate. "In muddy weather," he explained, "we make our trips on horseback. . . . That big field of turnips over there is a community affair. All workers help themselves, free."



Staff Photographer R. Anthony Stewart

Crossing Hudson River on George Washington Bridge Is Quicker but Less Restful than This Leisurely Ozark Cable Ferry

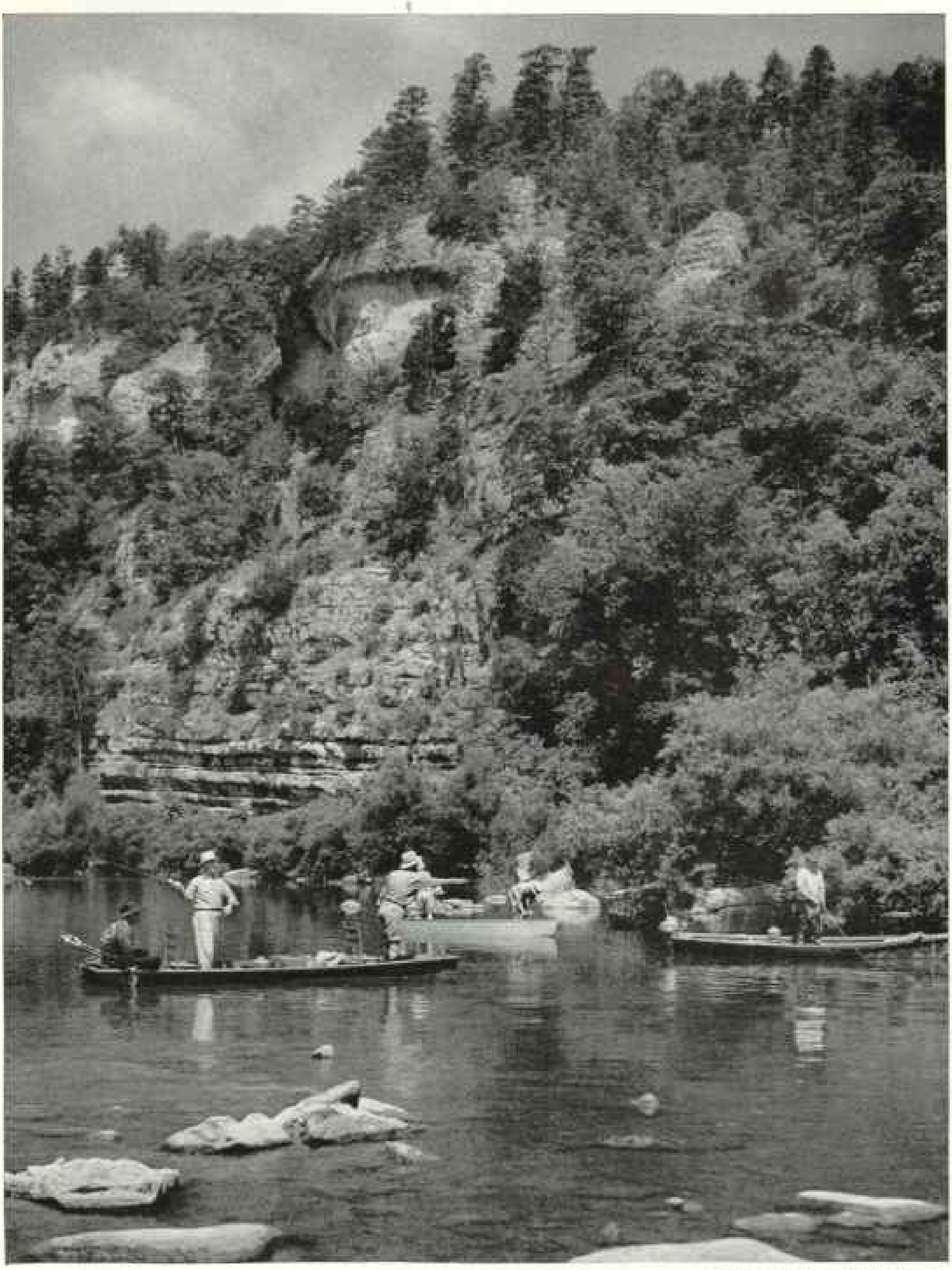
Here, near quiet, isolated St. Joe, mountain life is serene and unhurried. No motorcycle cop whistles at you to keep going. Just drive your car on, and the current carries the barge gently across. At right is a "float" fishing skiff, waiting to go on downstream.



Staff Photographer Willard R. Culver

Dikes and Causeways Separate Artificial Ponds of the State Fish Hatchery near Lonoke

Graceful weeping willows bend before the breeze as Sunday visitors stroll along the dikes to watch schools of young bream and crappie at play. Dark clouds of young catfish, which grow to enormous size, drift lazily in the shallow pools. Arkansas is noted for the abundance and variety of fish in its rivers and lakes.



Staff Photographer B. Anthony Stewart

You Could Buy Barrels of Fish for What It Costs to Make a Trip Like This

Yelling back and forth from boat to boat, these skylarking city visitors pass from work to play as they fish their way down Buffalo River. The big idea is fun. To catch a bass is pure accident, and lunch, most likely, is canned salmon or corned beef. Tree-covered limestone cliffs, as seen here, cast their shadows over practically all streams that flow out of the Missouri-Arkansas Ozarks.

Hundreds of Negroes live in little houses scattered over the fields. At one schoolhouse we listened while pickaninnies, taught by an old colored teacher, went noisily through their lessons. At times they all spoke in unison, like Arab kids shouting from the Koran.

All this was woods, and full of bear, when Mr. Brinkley came back from New York State College of Agriculture at Cornell years ago. Now, with a fleet of tractors, 125 he-asses and she-asses, menservants, maidservants, and an army of field hands, and hired planes to sow seed and apply fertilizer and weevil poison, the plantation operates as a self-contained unit.

Cotton Yields to Hogs and Alfalfa

Cotton was once the leading crop on this plantation. Now it is giving way to hogs and alfalfa. In fact, all over the State cotton yields to other crops and to livestock.

At a mill we saw fresh-cut alfalfa ground, toasted, and sacked, all in one hour. It makes a stock and poultry feed as palatable to pig and turkey as candy bars to a schoolboy.

Toward noon we turned back to the "big house" for lunch. Here the newly wed Brinkleys live in antebellum ease, with well-trained servant-sons of Eneas Africanus. And Olivia Brinkley fits gracefully into this picture, for she herself was raised on Magenta Plantation in Mississippi.

This sumptuous home is set in a vast landscaped garden whose lawn slopes down to a private lake. Running out into the lake is a fishing pier, and beside it a screened-in cottage where guests play bridge, sing to the soft tinkle of a guitar, or simply enjoy the tranquillity of sunshine or moonlight on the lake.

"We go south in winter," my host said, "and probably up north during the hotter summer weeks. Sometimes I'm called to Washington or Little Rock to work on farm problems. But we're happiest right here. We never even go up to Memphis except on urgent business."

"Bruins Plantation," I bantered, "has an ursine, or bearish, name. Why not change it to 'Olivia' in honor of your bride?"

She gave me a kindly smile. Mr. Brinkley looked pleased. Maybe there'll be a change!

Through yet more plantation lands we rode south to Helena. "Our only seaport" is what the State calls this venerable city under the levees, whose people are more Mississippian than Arkansan.

They fed us fried chicken at their country club, showed us their sporty golf course, and went over plans for a fine new hotel. Here a pipe line from Arkansas fields pours oil into river barges. Near by, a giant mill, owned by Chrysler, makes hardwood frames for station wagons and convertible sport cars.

Helena doesn't raise many "eating" chickens for the market, but it appreciates a long-legged, belligerent variety.

"We have to be careful," a reporter said, "to keep these gamecocks apart. If by accident two of them meet, they right away commence to fight."

High over the town rises a big steel tower that carried Arkansas Power and Light Company's juice over the river and helped TVA when water behind its dams was low.

"We're looking for a good Helena picture," I said. "And you've told me a lot about Arkansas panthers. Why not get a panther to cross the river on that high-tension cable, like a squirrel on a city telephone wire? That'd make a swell picture."

"It would that," they agreed. "But not even the National Geographic Society could coax a panther to cross the Mississippi River on a slack wire."

So we compromised. While Avantus shot a picture of the car ferry that hauls trains across the river, I walked along the levee and talked with a man who has spent 30 years in our Merchant Marine.

A Town Come to Life

"This town has really come to life since I left," said the tattooed sailor, who knows every water-front deadfall from Port Said to Shanghai. "They've got a new industrial engineer, from Illinois. He's stopped 'em talking about the generals they sent to the Civil War, and is simonizing our old Main Street. Some of those store fronts needed face lifting. They hadn't been painted since Mark Twain was a river pilot, wrote *Life on the Mississippi*, and took a crack at one of the State's 'bad men'!"

I hadn't seen Helena since I was here with Herbert Hoover and Dwight Davis, when I was covering the big 1927 flood for the NATIONAL GEOGRAPHIC MAGAZINE.* That disaster inundated 4,700 square miles of Arkansas. Now folks here feel safer, because engineers are ironing the bends out of the mad river and reinforcing the levees.

I couldn't quit Helena without visiting the adorable ladies who run the city museum, and its quiet, well-patronized library, so rich in manuscripts and pioneer records. Here are shelves of well-thumbed French classics, printed in French over a century ago. This is a cultured place.

* See "Great Mississippi Flood of 1927," by Frederick Simpich, NATIONAL GEOGRAPHIC MAGAZINE, September, 1927.


MISSOURI
Ozark Plateau
Grove
Anderson
South West City
Cassville
Seligman
Branson
Lake Taneycomo
Gainesville
Sulphur Springs
Pea Ridge
Eureka Springs
BENTON COUNTY
Bentonville
Rogers
Berryville
Green Forest
Siloam Springs
Harrison
Proposed Bull Shoals Dam
Mountain Home
Norfolk Reservoir
Viola
Salem
Flippin
Cotter
Pyatt
Yellville
Norfolk Dam
Norfork
Calico Rock
Melbourne
Springdale
Huntsville
Western Grove
Buffalo River
St. Joe
Fayetteville
Prairie Grove
WASHINGTON COUNTY
Westville
Lincoln
Canehill
West Fork
Jasper
Stilwell
Pettigrew
Marshall
Deer
Leslie
STONE COUNTY
Mountain View
Cushman
Marcella
Winslow
Gaylor Mountain
Chester
Boston Mountains
Shirley
Clinton
Mountainburg
Mulberry
Van Buren
Alma
Ozark
Clarksville
Altus
Coal Hill
Spadra
Arkansas River
Sallisaw
Heber Springs
Pangburn
Quitman
Dover
Fort Smith
Charleston
Subiaco
Paris
Russellville
Dardanelle
Mount Nebo
Atkins
Searcy
Kensett
Spiro
Greenwood
Hackett
Booneville
Magazine Mountain
Morrilton
Conway
Petit Jean Creek
Danville
Petit Jean State Park
Perry
Poteau
Mansfield
Hartford
Ola
Plainview
Nimrod Reservoir
Perryville
Beebe
Cabot
Heavener
Poteau River
Waldron
Fourche La Fave River
Camp Joseph T. Robinson
Jacksonville
Lonoke
Carlisle
ARKANSAS
Forester
Ouachita Mountains
Blue Mountain
Rich Mountain
Pine Valley
Little Rock
N. Little Rock
State Fish Hatchery
Mountain Pine
Hot Springs National Park
Lonsdale
Benton
Wrightsville
Bauxite
England
Mena
Pine Ridge
Mount Ida
Norman
Hot Springs
Hatfield
Cove
Vandervoort
Caddo Gap
Lake Hamilton
Lake Catherine
Magnet Cove
Malvern
Humphrey
Glenwood
Sheridan
Poyen
Altheimer
Grannis
Amity
Kirby
Donaldson
Pine Bluff
Gillham
Hochatown
Dierks
Pike
Arkadelphia
Carthage
Noble Lake
Broken Bow
Murfreesboro
Manning
DeQueen
Lockesburg
Nashville
Little Missouri River
Rison
Horatio
Gurdon
Sparkman
Star City
Haworth
Mineral Springs
Blevins
Prescott
Fordyce
Saline River
Ouachita River
Little River
Foreman
Okay
Washington
Bearden
Thornton
Ashdown
Chidester
Hope
Tinsman
Monticello
Red River
Fulton
Camden
Warren
Wilmar
DeKalb
Waterloo
Cullendale
Hampton
New Boston
Texarkana
Lewisville
Stephens
Hermitage
Stamps
Waldo
McNeil
Smackover
Norphlet
Calion
Fountain Hill
TEXAS
Fouke
Magnolia
Sulphur River
El Dorado
Hamburg
Naples
Canfield
Atlanta
Strong
Crossett
Wesson
Daingerfield
Bradley
Junction City
Huttig
STATUTE MILES
Springhill
Haynesville
LOUISIANA
Vivian
Bonita
Cities served by scheduled airlines
Elevations of cities and crosses are in feet.
Highways

"Go on south," urged the librarians, "and see the spot where the first whites settled in our State."

Arkansas Post, Built in 1686

Lost in lonely delta forests is all that's mortal of Arkansas Post, founded by French explorer Henri de Tonti in 1686 when he was hunting for La Salle, and later first capital of Arkansas Territory (page 286).

The pioneer Stillwell family, ancestors of Miss Caro Stillwell of the National Geographic Society staff, settled there in 1798. Stillwell Point, on the river, is named for them, and they still run a plantation hereabouts.

The Spanish gave all the land from Arkansas Post up to what is now Little Rock to the Stillwell and Winters families, provided they colonized it.

Today this historical spot seems utterly forgotten. I found hardly anybody who had been there. It is out of the way; no good road leads near it, and all the original town has vanished.

When yet a long way off we heard its heavyweight frogs, their deep bass bellows echoing through the giant pin oaks like the hoarse blast of a streamlined train. Turtles, too, are of nightmarish size. One, as a stunt, was used as a saddle horse by a man. When he stood up on it, it walked away with him!

This ghost town shows what a long time it took for Europeans to get a foothold in Arkansas. Though De Soto came in 1541, it was 132 years before another white got to Arkansas.

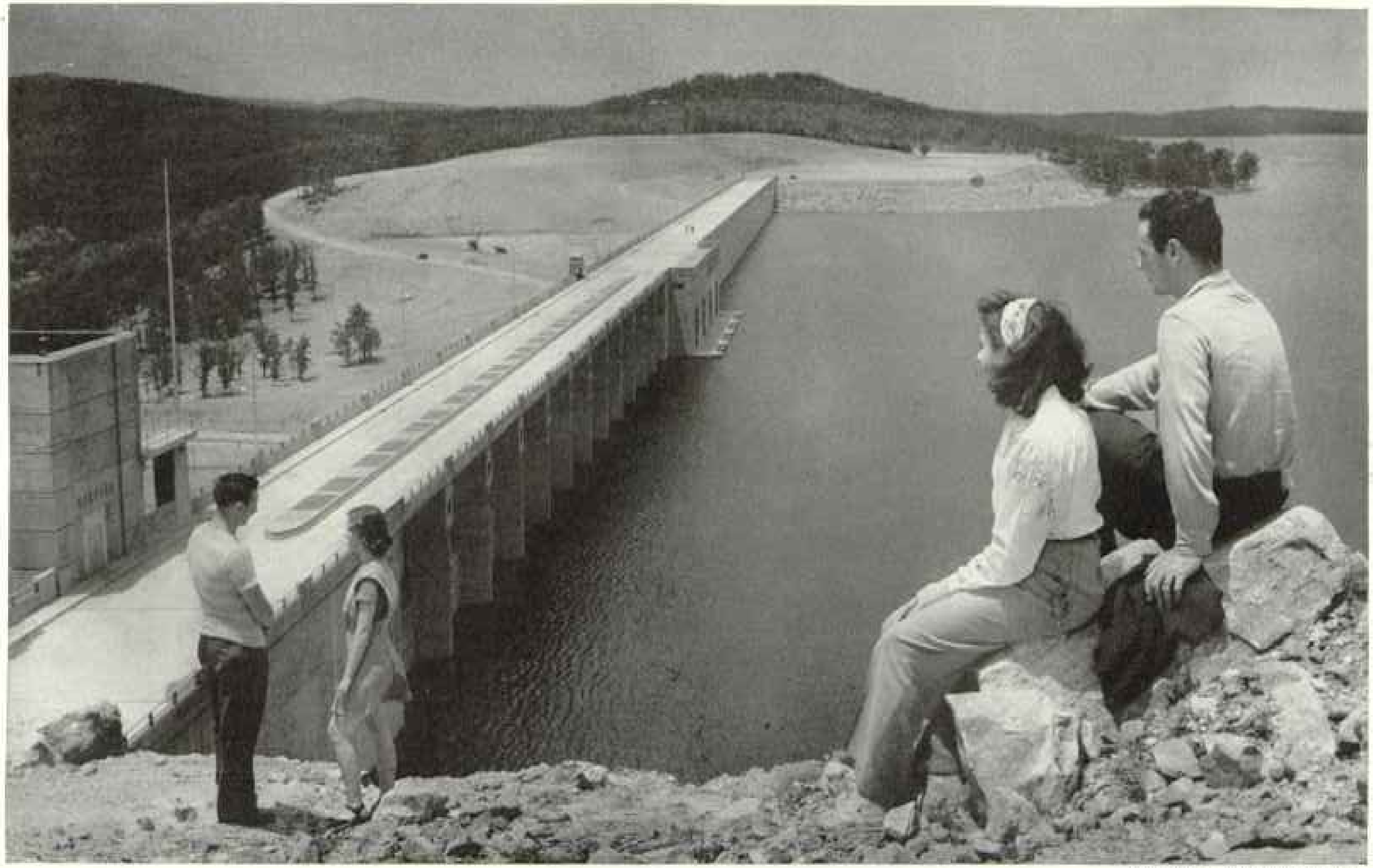
Father Jacques Marquette, a Jesuit, and the fur trader, Louis Jolliet, reached the mouth of the Arkansas, from up the Mississippi, in 1673, but no houses were built till Tonti came to trade, fish, and hunt. Ever since then, this State has been a nimrod's heaven.

Red River men hunt alligators at night, using a flashlight to catch the gleam of the reptile's eye. In mating season bull alligators figure in vicious battles, their foghorn fanfares resounding through the swamps.

Staff Photographer Willard R. Culver

Balmy Climate and Year-round Outdoor Games Develop a Robust, Athletic Breed of Boys and Girls

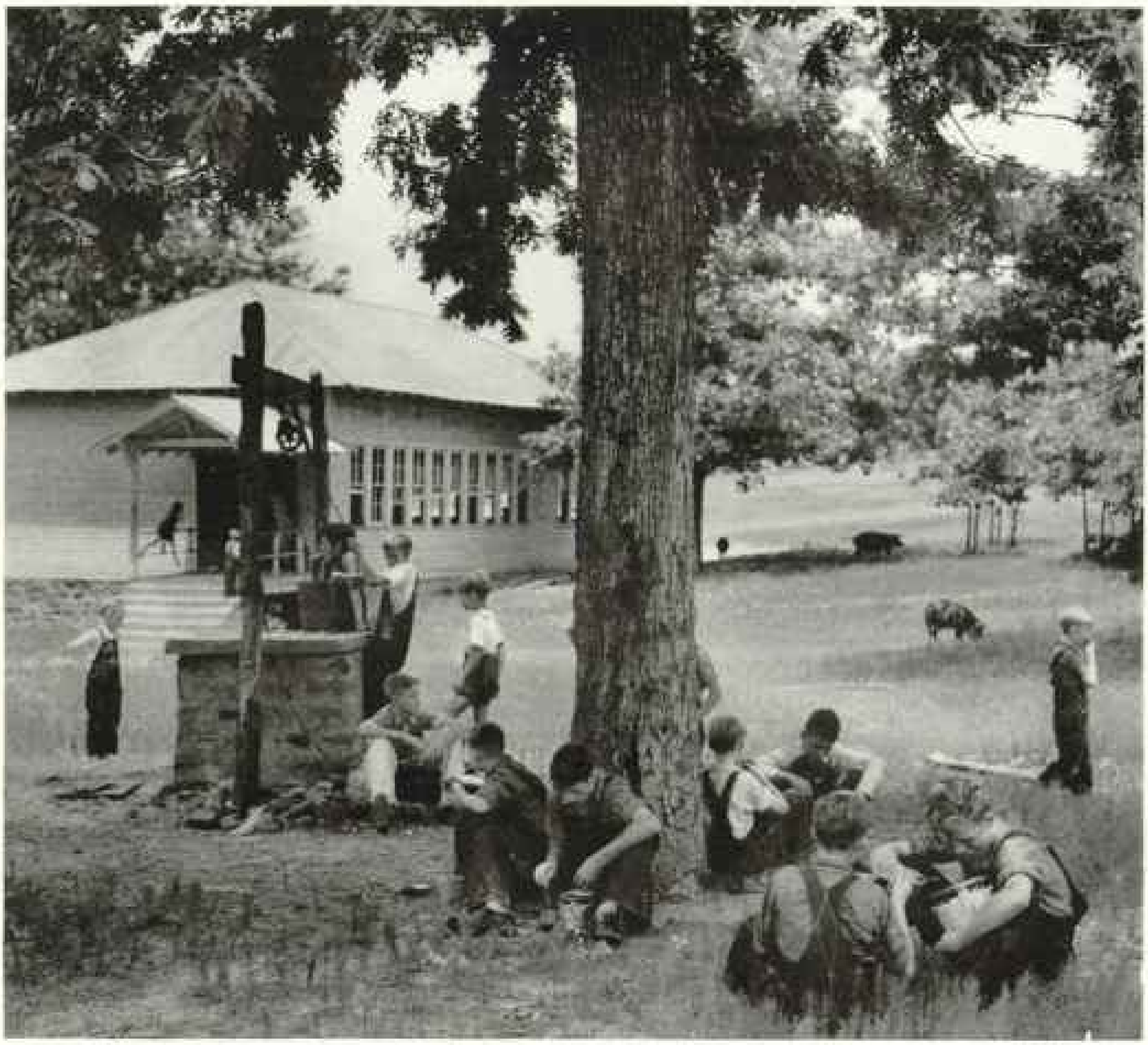
Aquaplaning on Lake Hamilton, near Hot Springs, is a popular water sport. Dams in Ouachita River form this forest-rimmed body of water and also near-by Lake Catherine. On lake shores many Arkansans have built summer homes, with private motorboat docks and fishing piers.



Staff Photographer Willard R. Culver

High Up in the Ozarks, Norfork Dam Rises in White River Basin to Form a Lake of 47 Winding Miles

With the reservoir at flood-control level, its shore line measures about 500 miles and some of its water is backed up into Missouri. Such big man-made lakes, stretching now from Atlantic to Pacific States, bring power and new recreational waters to many inland communities. Built by U. S. Army Engineers, Norfork Dam develops hydroelectric power and regulates the flow of the White River for flood control (page 297).



Staff Photographer B. Anthony Stewart

Under Ozark Oaks Country Schoolboys Eat Their Lunch from Tin Pails

At the left a boy pulls up an "old oaken bucket" to get a drink of cool water (Plate III). Girls play on the other side of the schoolhouse. Pigs nose about the school grounds; later they will fuss over crusts and other scraps tossed aside by pupils. School terms here end before snow falls, because of travel difficulties.

If you can "go like a duck" you may win that $1,000 first prize at the national duck-calling contest held each year in Stuttgart, rice capital of the State.

"Ducks are so thick here on autumn days that they almost blot out the sun. Then the whistle of their wings drowns out every other sound," said Dale Wiley, superintendent of the Arkansas Irrigation Company.

Duck-calling Contest

"In our duck-calling contest some entrants use their throats, which soon get sore. Best results come from instruments whittled from wood. With these a good caller can give a tricky imitation of a duck's feed call, his love call, his 'alarm,' or just his lazy quack-quack when the whole flock is at ease.

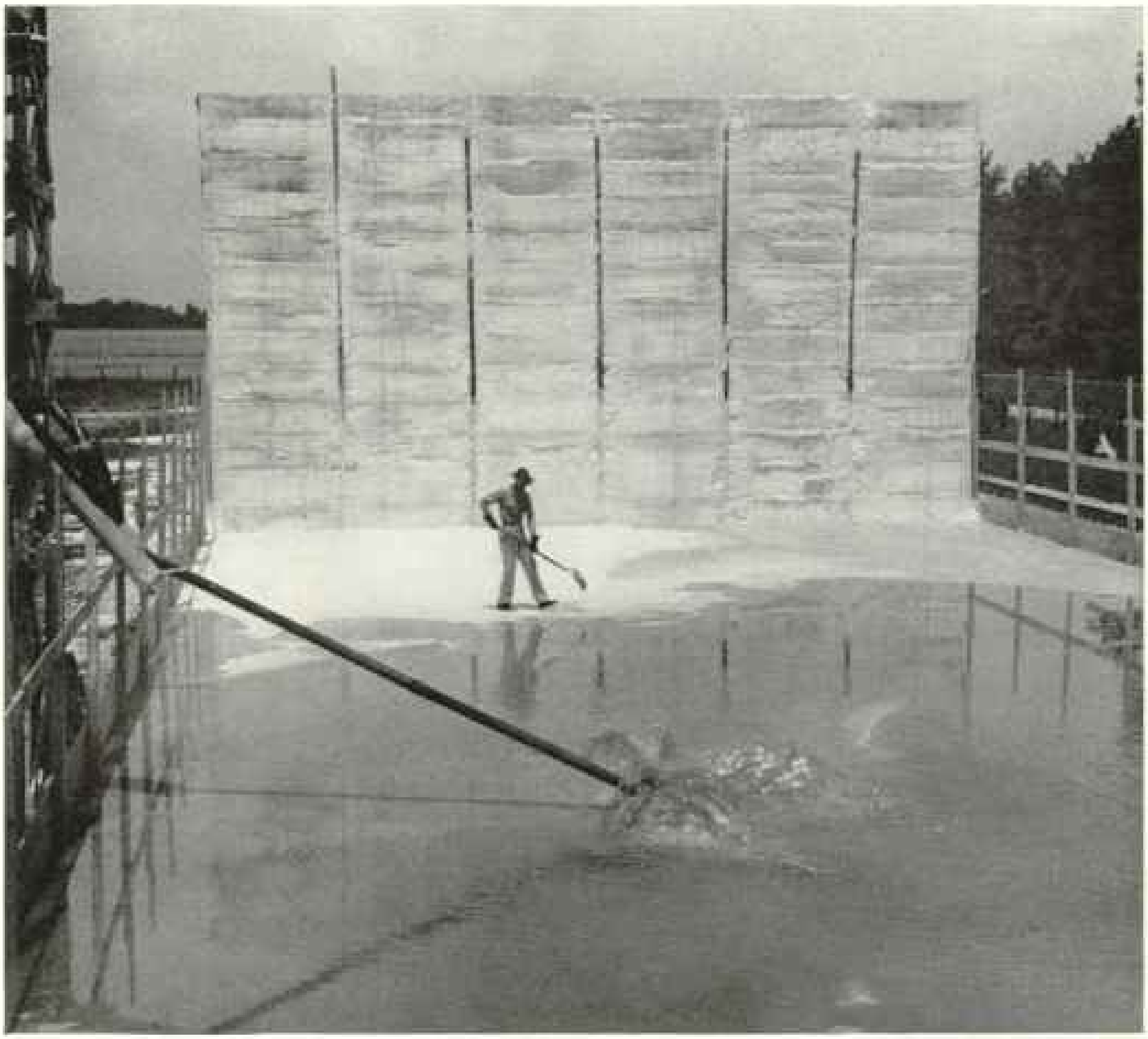
"Maybe finicky Donald Ducks wouldn't agree that our decisions are fair, but since we can't use a jury of ducks, we have to pick sports writers and hunters as judges."

With Mr. Wiley we rode over a 10,000-acre rice plantation for which he handles the irrigation. He showed us a 3,000-acre reservoir, with powerful pumps that lift the water onto the rice land.

Why ducks from the Mississippi flyway stop here for meals is plain. So much rice grows that it would take a train 70 miles long to haul out a season's crop.

Rice goes into many things, from face powder to beer, but it remains the most important food for half the people of the world.

Because housewives think they should have white polished grains, millers heretofore have



Staff Photographer Willard R. Culver

Pure Sulphur Is Made from "Sour," or Hydrogen Sulphide, Gas

Smelling horrible, like bad eggs, this by-product of natural gas is turned into molten sulphur at the Southern Acid and Sulphur Company's plant at Stamps. Huge blocks in the background are solid sulphur and will be used later to make sulphuric acid.

removed all the bran coating, which actually holds most vitamins.

The processing method of Walton Rice Mill, Inc., at Stuttgart, involves the use of steam to force vitamins from the bran into the cell structure of the grains. When the rice is milled, the vitamins, instead of being scoured off, remain in the grains.

Rice grows in many fields once used for other crops.

Around Hope they used to market 50,000 bales of cotton a year, at a time when this long-staple fiber was so famous that it was listed on Liverpool's Cotton Exchange. Today they grow only 6,000 bales.

Fields are diverted from cotton and corn to fruits, vegetables, dairy farms, and beef cattle, the latter now the chief "crop."

From here, too, go giant watermelons, weighing as much as a man. To Dick Powell in Hollywood, Arkansas-born movie actor, the city sent that 195-pound melon Governor Laney mentioned (page 273).

De Soto found this green land almost a solid forest. Pioneers burnt up fortunes in hardwood to clear farm land. When rails ran in, ruthless axmen followed, wrecking the woods in a "cut out and get out" raid.

Today, timber growth of some kind again covers about two-thirds of the State, thanks to sensible forest protection and management.

Conspicuous among good forestry operations is that of the Crossett Lumber Company. It owns all the land and almost every building except the post-office lot in the 6,000-people town of Crossett.

Portrait from life by Nicolas Mass

With His Artificial Iron Left Hand, Henri de Tonti Used to Knock Out the Teeth or Crack the Heads of Offending Indians

Friend and lieutenant of La Salle, this great explorer was among the first whites to see Arkansas. Through his heroic exploits and the vision of La Salle, France was able to unite warring Indian tribes and lay claim to the vast Mississippi Valley. From the Great Lakes region and from St. Louis to New Orleans and Mobile, historians still exalt the daring deeds of "Tonti of the Iron Hand."

Years ago it hauled its first sawmills in with ox teams. Gamblers came, to set up their tents and clean out the camp on pay-days. Everybody carried a gun. There was a rule, however, that no saloon could open closer than three miles to a church—but there was no church! So the good people built one, in 24 hours, to head off an invading liquor dealer!

Today the gamblers are gone; nobody totes a pistol. Playgrounds, swimming pools, schools, a good dairy, a hospital, library, churches—all are to be found in this modern city. The workers have had a contract with the company for 10 years and accept these improvements as a sign of new days and better working conditions in Arkansas.

Forward-looking Forestry

Most pleasing is the company's long view of forest management.

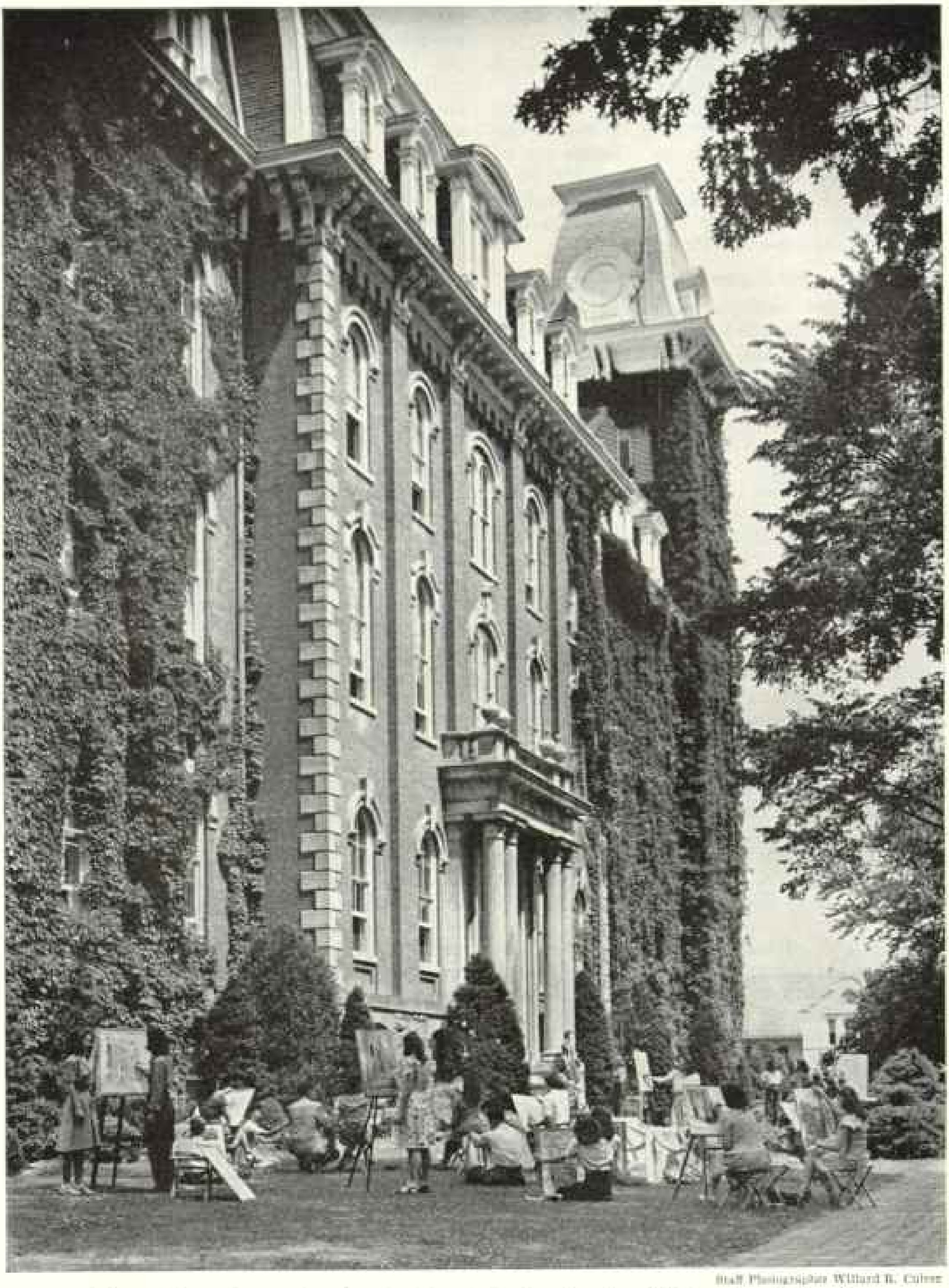
"Looking to the future," says 31-year-old vice president P. F. Watzek, "we're more interested in perpetuating our forests, to ensure steady wood crops, than we are in breaking plant production records.

"Although our foresters have complete authority over the size of the annual cut, our total yearly plant consumption, if rolled into one tree 18 inches in diameter and cut down, would reach over a distance of 7,000 miles from the stump, or close to one-third the circumference of the earth!

"Mere lumber, as boards, may one day mean less to us than by-products of trees. Here is what I mean: We used to waste the tops, the small crooked limbs, and all trees harmed by lightning or splintered when a big tree we'd cut fell on its little neighbors and smashed them.

"Today much of that stuff, unfit for making boards, goes into our big kraft paper mill, which turns out a sheet 16 feet wide at the rate of 1,400 feet a minute, or a sheet of paper every seven days long enough to reach from New York to San Francisco along the Lincoln Highway.

"The rest goes into charcoal, turpentine, alcohol, acetic acid, wood fats which we sell for the manufacture of soap, and into wood tar creosote. It is even possible to make sugar from wood if you wish.



Staff Photographer Willard R. Culver

Not a Lawn Party, but Art Students Hard at Work with Brush and Pencil

You don't have to live in Paris or on Cape Cod to paint. One or two youngsters painting "Old Main," mellow University landmark at Fayetteville, may gain fame. Others will revert to babies, buttermilk, or phonetic pothooks. But for the halcyon present, all are "art students."

"One odd item we found out is a 'liquid meat smoke' for use in curing hams."

Yale's School of Forestry students come here to get practical experience.

Over the State, Governor Laney told me, people do much fresh thinking on how to use their raw materials at home. Better use of wood is one striking result. Now the State has some 1,600 woodworking plants, making everything from wooden animals to furniture —a colossal industry (Plates VI, VII).

Here Geologists Get All Upset

"Children! Stop playing with our diamonds and go feed the chickens!" When America's only diamond field, near Murfreesboro, was worked, any mother there might have said that. In 15 years of operation it yielded 50,000 diamonds, both gem and cutting stones.

So many minerals abound in Arkansas that miners can't decide which to tackle first. East of Hot Springs lies Magnet Cove. This treasure house is three square miles of shrunken volcanic crater, where 70 minerals have been found.

In recent years Arkansas has given us from 94 to 97 percent of all aluminum ore mined in North America (page 302).

Coal and lignite deposits are extensive. Trainloads of "smokeless coal" ride out to St. Louis, where antismoke laws are enforced.

Manganese, mercury, barite, bentonite, gypsum, clay, glass sand, chalk, antimony, limestone, lead, quartz crystal, zinc, and marble, besides, of course, petroleum and natural gas, all figure in the State's profuse mineral production.

"Arkansas didn't find oil till 1921," says Col. Tom Barton, president of the Lion Oil Company at El Dorado (page 275). "That's when a torrent poured from the Busey well, a mile west of here. But next year a ripsnorting big gusher opened the great Smackover field, north of town, and since then we've found more fields hereabouts. In all, we've sunk over 10,000 wells.

"In our peak year, 1925, the State recovered more than 77,000,000 barrels. The roar of the first gushers stampeded the whole State; speculators and workers swarmed here by thousands. Huge quantities of oil went to waste, escaping from hastily dug earth reservoirs and running away in the creeks. Many wells caught fire, adding to the waste and pandemonium."

Finally the need for control brought more sane and scientific methods. Now, with deeper wells and modern repressuring methods, yield has settled down to a steady volume. In one of its plants the Lion Oil Company takes natural gas, air, and water and makes enough ammonia and ammonium nitrate each year to load a train of tank cars 58 miles long.

More and more, powerful new forces change the State's business geography. But it's not all work—look at Hot Springs!

From Indians to Invalids

Healing pools at Hot Springs help the sick. Indians, weary from warpaths, thawed out their stiff joints here. Rival warriors agreed not to fight while in swimming. Congress, 114 years ago, set this area aside for use of all the people. Later the National Park Service took over.

This cosmopolitan resort, wedged among forest-clad mountains, is in Arkansas but not of it. Rather, it belongs to the world. Among its 300,000 guests last season were some from 16 foreign lands.

One fine Sunday my host was Dr. Louie G. Martin, long in the British Army's medical corps, now resident in Hot Springs.

"See this place from the air," he invited. "That's the only way you can read our twisted map." Col. Earl T. Ricks flew us, the same Ricks who flew the Jap agents down to Manila to make surrender terms with General MacArthur.

Ours was a tiny, shiny new bumblebee of a plane. In it we buzzed the race track, the country club with its three 18-hole courses, and flew over placid Lakes Catherine and Hamilton, formed by dams in Ouachita River. Sumptuous summer homes with private boat docks and tennis courts fringe these lakes (page 282).

We went out also for a look at the Reynolds Metals Company's great new alumina plant on Hurricane Creek, near Bauxite.

When you look down on Hot Springs, with all its short streets feeling their way up narrow valleys, you agree with Dr. Martin that his home town *is* twisted.

"Just now we're over Hot Springs Mountain," said my host. "From its hot bowels comes the thermal water. About 47 springs are flowing; their hot water is piped to all those fancy Mormon-templelike bathhouses you see facing Central Avenue, the town's main street."

Most patients who take baths are immersed for 15 minutes (Plate XVI). They drink hot mineral water, to sweat faster, then get a massage and rubdown. Other forms of hydrotherapy are used for rheumatism, arthritis, and paralysis. Bathers who can't walk are lifted in and out of the pool with electric hoists.

Thousands of physically fit people come here also merely to rest, make whoopee at

 Kodachrome by Willard R. Culver

Seat of Arkansas's Political Power—the Great Statehouse at Little Rock

Visible for miles, this noble edifice rises from a landscaped park of rare charm. The statue is a memorial to the State's Confederate dead. The capitol was completed in 1915.

Kodachrome by Willard R. Culver

Arkansas Travelers Find Summer Comfort in Tourist Courts Rising on the Ridges of the Blue Ozarks

Once, when roads were poor, the Ozarks were isolated; now motor highways bring throngs of visitors. Many out-of-state mountain lovers, as well as writers and artists, have built summer homes here. Fishermen whip the tumbling streams for fighting fish.

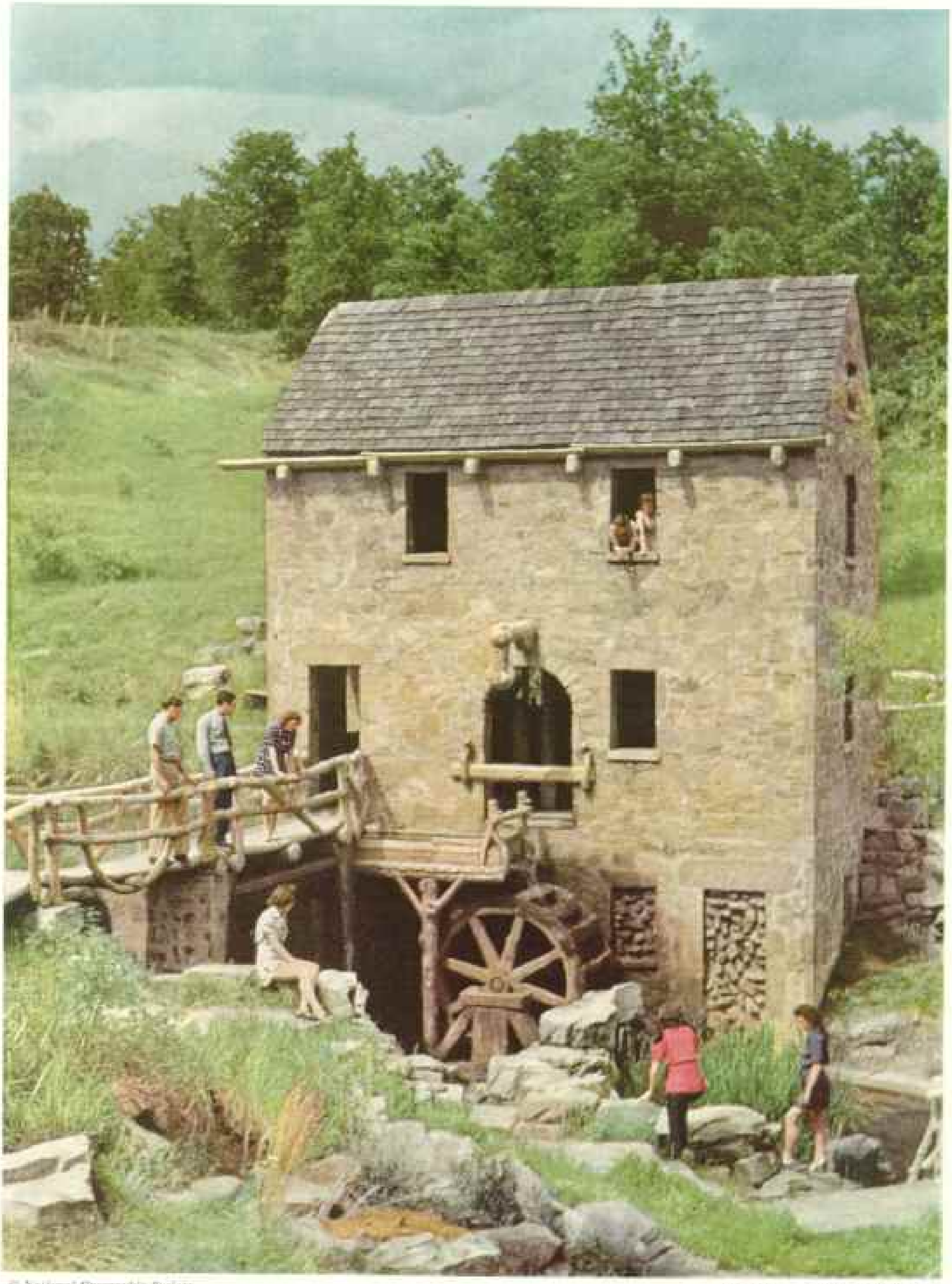
Where the Old Oaken Bucket Hangs in the Well

When you're hot and thirsty, no drink is so satisfying as pure, cool water from the depths of a rock-walled well. This type, near Booneville, is common throughout the Petit Jean Valley of the Ouachita Mountains.

Kodachromes by Willard R. Culver

"Loves Me, Loves Me Not," Told by Black-eyed Susans

More than 500 kinds of wild flowers may be found in one square mile of Arkansas mountain landscape. Daisies, black-eyed Susans, and coreopsis cover fields. Often highways are solidly bordered with blossoms.



 Reduction by Willard R. Culver

An Arkansas "Mill on the Floss" Designed by a Mexican Artisan

Dionicio Rodriguez built this ancient-looking gristmill near Little Rock. He worked the concrete with his bare hands, with sticks, and with a whisk broom to give it the semblance of old wood. With its slow wheel, rustic bridge, and crude woodwork, the structure reproduces a pioneer mill where the miller took his toll.

Paddling to the Rescue of a Modern Wood Nymph

The girl clings to a giant cypress in Hill Lake, which stretches for several miles along the Little Rock-Memphis highway. Anyone may canoe in these private grounds, but only hands from an adjoining plantation may fish.

 Kodachromes by Willard R. Culver

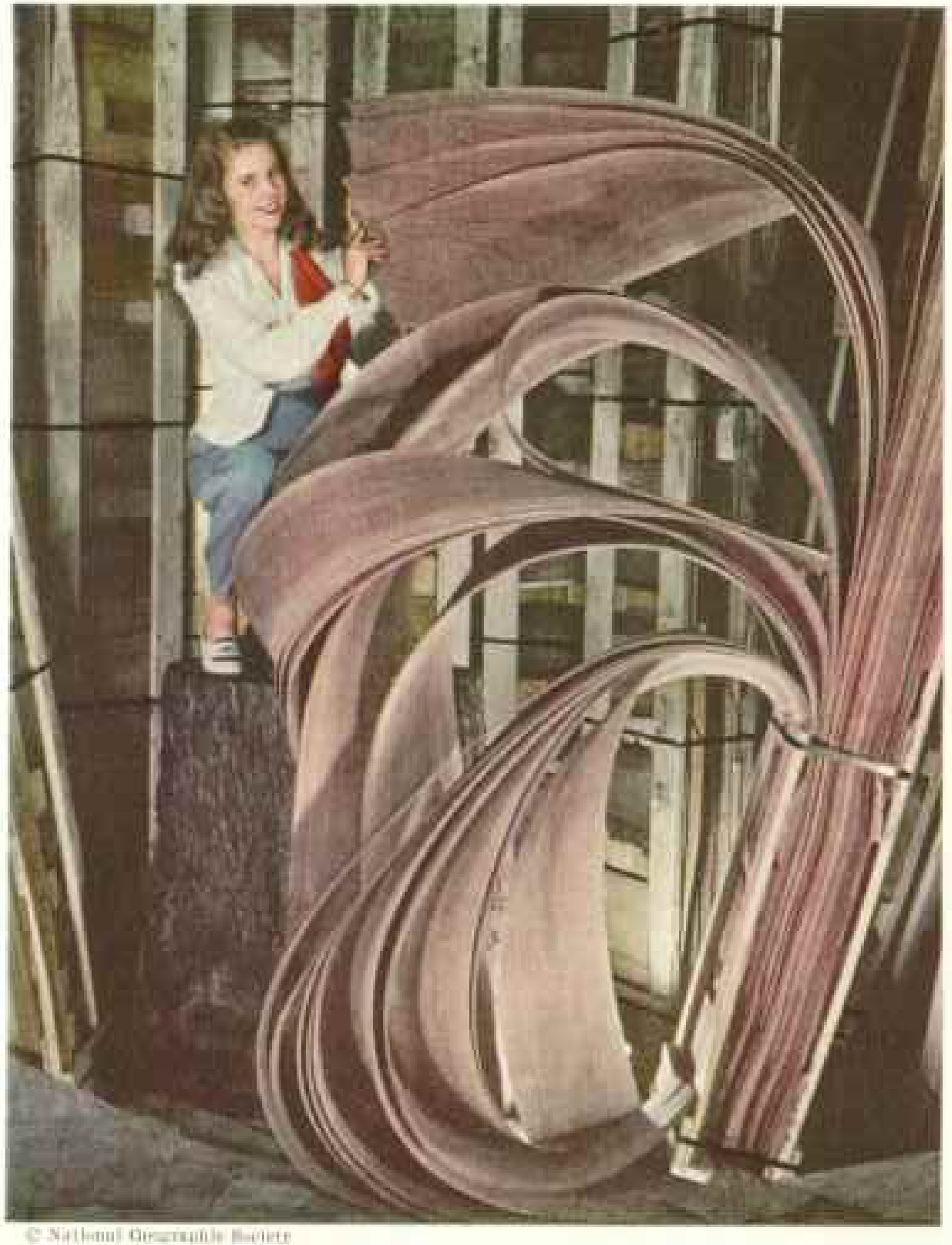
Arkansas Anglers Fish Most of the Time and Talk about Fish All the Time

That's easy. They've got 22 major rivers and more than 200 lakes in which to wet a line. The State is paradise for humble folk with no more than a string line, bullet sinker, a penny hook, and a cork float.

Kodachrome by Willard R. Culver

Time Was When Timber Hogs Almost Ruined Arkansas Forests; Now the State Grows More Trees than It Cuts

This log train loads for the mills of the Crossett Lumber Company, an exemplar of Arkansas's new conservation policy. The company pioneered in making scientific reforestation pay cash dividends. To it trees are a crop, like corn, to be grown and harvested. Yale's School of Forestry comes here to study its amazing work.



A Log Unrolls Veneer Like a Tropic Plant's Leaves

These walnut sheets are only 1/28th of an inch thick. They are used in furniture, boat trimmings, juke boxes, and walls. The Brower Veneer Company at Fayetteville cuts sweet gum and sycamore, too.

Reproduction by Willard R. Culver

Mammoth Fans Keep Warm, Lazy Arkansas Air in Motion

Cool your attic with this 4-footer? Blow sawdust from your mill, lint from your cotton gin, or hot, smelly air from your oil mill? The Phelps Fan people at Little Rock build any breeze you need.

From Every Mussel-shell Hole Came a Round, Shiny Pearl Button

True pearls, of substantial value, are shown between perforated shells (left) and buttons. Jewelers prize the best river pearls. Mussel-shell buttons are more lustrous than plastic imitations.

Kodachromes by Willard R. Culver

Palefaces Make Straighter, Truer Arrows than the Indians

Arkansans fletch arrows with turkey feathers and are choosy about woods, glue, and treatment of feathers. Ben Pearson's plant, Pine Bluff, standardizes arrows for weight, length, and balance.

night clubs, or to take chances on galloping dominoes or on the spinning wheel and its tumbling ball.

Taking a last turn over wooded mountains, we saw how the National Park Service lays out motor roads and lovers' lanes. From rustic benches we flushed a few startled couples!

From the Arkansas air you see many sights but few smokestacks, for nearly all factories run by electricity.

A Plethora of Power

Here actually is more electric power than the State needs. Steam-operated generating plants, because of cheap gas fuel, make juice for about half the cost of that made in the State's hydroelectric plants, which are most valuable for meeting peak power requirements.

So far, the REA, or Rural Electrification Administration, finds it cheaper to buy juice from business-managed power plants than to build its own. Before REA was formed, the Arkansas Power and Light Company had already laid lines into the country to serve farmers and villages. By the end of 1946, fully half of all Arkansas farms will be getting electric light and power.

Only one Government-owned power dam has as yet been built here. It is the Norfork, in a tributary of the White River (page 283). Many other dams, however, are planned, including one at Bull Shoals.

Norfork is primarily a flood-control dam; power generated at it is distributed by Arkansas Power and Light Company, which has passed on benefits to customers in accordance with the Flood Control Act of 1944.

Big Army Engineer job yet to come is taming the wild Arkansas River. It involves many dams, locks, and levees across Arkansas and into Oklahoma. If finished, steamboats from New Orleans may unload as far west as Tulsa.

Fort Smith especially will benefit, because for years high water has ravaged it despite struggles of levee builders.

Like Texarkana, this town is out where big hats begin, has corral dust on its boots, and echoes to mournful bawls of fat bovines ready for the butcher. Its main street, a wide avenue, was once parade ground for an army post.

Fort Smith tells with pride that near here lived Sequoyah, who came to Arkansas to introduce his famous Cherokee alphabet to the western Cherokees; that George Catlin, artist, painted Indians here; and that Zachary Taylor was among the great who lived here and made Southwest history.

Columnist C. F. Byrns of the *Fort Smith Times Record* is widely quoted, and new styles in furniture, created in famed local factories, are the pride of many a bride. They make enough glass here to put a hothouse over every vegetable farm in the valley if they wanted to, and bank rolls are fattest ever.

Into Fort Smith, as into Forrest City, Pine Bluff, Batesville, Blytheville, and every other growing Arkansas city, new people are swarming. Governor Laney showed me a stack of thousands of letters from out-of-State homeseekers.

Though wartime robbed Arkansas of 200,000 people, immigration now more than compensates. Ride north from Fort Smith to Fayetteville, to Eureka Springs, and on to the Missouri border, and all along the highway you pass new homes, roadside cafes, and novelty shops, newly cleared small farms, dairies, poultry yards, tomato and strawberry patches.

"It's as hard to get a room here as it is in New York," said Mrs. Roberta Fulbright, publisher of the *Northwest Arkansas Times* at Fayetteville . . . "Of course I'm proud of Bill," she continued. She meant her son, J. William Fulbright, Rhodes scholar, former president of the University of Arkansas, and now, at 41, Arkansas's brilliant junior member of the United States Senate.

No railroad led here when the University was young. Wagon roads were rough. State Senator Roy Milum of Harrison told me he drove three days to get to college when he went. "But W. W. Cartwright, of Stone County, actually walked 200 miles to get there," added the Senator. "That was the same year Admiral Dewey fought in Manila Bay."

Now cross-country tourists whiz along Route 62, oblivious of what strange stories of early Arkansas are told by exhibits in the University's museum.

Long after the Israelites waded the Red Sea, another tribe of wanderers settled among the caves and bluffs of Arkansas. Their woven sandals, with soles repaired, their sleeping bags, their mummified men, women, children, and dogs, are all shown in the University museum.

The First Arkansan

"This is the first Arkansan of whom we have flesh and bone evidence," said Dr. S. C. Dellinger, of the faculty.

"About the beginning of the Christian Era he appeared as a dweller in the dry shelters of northwest Arkansas. His wife cultivated corn, squash, beans, and gourds, and gathered wild seeds, nuts, and insects. He took the

native game with spear, hook, and snare.

"Studies of their flesh, bones, and feces show that they were a healthy people. Although the solace of tobacco was wanting, the people played cane flutes, shook gourd rattles, and danced to while away the time."

These cave dwellers did not make pottery, but the later Mound Builders did. Look at that Asiatic face on that old jar here in the museum. It was dug up in northwest Arkansas a thousand or more years later. Where did Indian potters get such a Mongoloid pattern? No Hollywood make-up artist could achieve a more delicate image.

White pottery makers, taking up where Indians left off, run busy shops at Camden, Benton, and Little Rock. We saw one truckload, worth $3,000, leaving Camden for Kansas City, while another was loading for a big department store in Dallas. This Camark Pottery at Camden makes about 4,500 pieces a day, which sell for anywhere from 25 cents to $7.50 each.

Things made here range from graceful teapots and copies of Greek and Babylonian urns to comic figures of razorback hogs, a "cat-and-bowl," and two flirting swans.

Take your glad eyes off the mountain views as you ride leisurely east from Eureka Springs and pause now and then for talk with people. Or, if it's lunchtime, get "chicken, bread, three vegetables, dessert, and drink"—all for 40 cents! And the tip here is still a dime!

But when Avantus asked a plump redheaded waitress if she planned to go to college, she said, "No, I want to join a circus and be a bareback rider!"

Watch men among these oaks make barrel staves. What an invention a barrel is! Who first planned just how to shave its staves, bend them, fit in the heads, and finally hammer on the hoops? No nails, yet watertight.

Lumber? Mountainous piles, fragrant from fresh sawing. "Too fresh," a carpenter growled. "So many houses going up, there's no time for seasoning. It's still so wet when you hit a nail that the sap flies back in your eye."

Where Goats Bleat for Joy

Goats bleat for sheer joy in this happy land of succulent green brush. "They save work, too, in clearing brushy land," says Mrs. Clyde Greenhaw Newman, city editor of the *Harrison Daily Times*. "People here used to mock at billy goats when the first ones were brought in, and ask, 'Where you gonna get tin cans enough to feed 'em?' Now their cheese means a good living here for hundreds of Ozark families (Plate X).

"It's even rumored that some older hill men, after a moonshine snort, take a goat's milk chaser! Me? I'd rather write a good honest goat news story than society stuff—and I do—and sell it to the *Dairy Goat Journal*."

Chinchillas, of the 14-carat Fur

Near here is a chinchilla ranch, a "fur mint" which raises these 10-inch South American animals with the 14-carat fur. Though now reduced in numbers in the wild state, some introduced into the United States about 20 years ago have multiplied greatly on fur farms. Of luxury furs, theirs is among the most valuable.

Once chinchilla wraps cost $60,000 or more. It takes about 120 skins to make a full-length coat. New York furriers now have some skins, but probably no more wraps will be made for a few years, since the animals are at present in greater demand for breeding.

Near Calico Rock we crossed the White River on a cable ferry that's pulled across by the current. Once a drummer's car fell off one of these flatboats and dropped into the river. All his sample shoes washed away. For weeks after, downstream hill folks fished out runaway shoes. But they were useless, as the samples were all for one foot!

Marcella hamlet is far from main highways. But you never know whom you're going to find tucked away in these happy valleys.

Steering a 55-foot cruiser, George M. Stevens quit Chicago, where he was the artist member of an advertising agency, and set off—he thought—for the South Seas.

Riding down the Illinois River and then down the Mississippi, he got to thinking about the Ozarks, for Mrs. Stevens' grandfather had operated packets on the Mississippi. So, at the mouth of White River, he turned upstream, 400 miles, into the Arkansas Ozarks. That was 16 years ago.

"For a time I ran an art-crafts school," said Stevens. "We found these hill boys quick to learn—lots of latent talent and lazy ones scarce as left-handed monkeys.

"One day, in making a crossbow for a neighbor's boy, I hit on an idea for a new type—a repeater! I got a patent, opened this shop, built up a crew, and now we get orders from as far away as Cairo."

Avantus shot an arrow from one of these rugged crossbows; it went up hundreds of feet, almost out of sight in the Ozark sky.

All through here we saw fishpoles tied to hurrying cars, especially on Saturdays and Sundays. With all the new dams and reservoirs, fishing is better than ever. When it's too cold to fish, they can still talk about it.

Staff Photographer R. Anthony Stewart

Good Books and Magazines Are Even More Highly Prized in a Lonely Mountain Cabin than in Palatial Libraries of Big Cities

When not working with his goats, Mr. Theodore Richmond, who lives near Jasper, is busy passing out books from this wilderness library he conducts for the use of backwoods readers. Here three boys have come to borrow books. On the table beside the typewriter is an old-fashioned kerosene lamp.

Stone County, one hears, is the State's most isolated area. Here we stopped at a country school. Big, husky, red-cheeked girls played ball with the boys. One knocked a home run.

"It's the last day of school," a pupil said, "and it's teacher's treat. [I hadn't heard that backwoods phrase for 40 years!] He's giving us $30 worth of candy and fruit, and tomorrow he's hiring a bus to take us all to Mammoth Spring."

Riding down a last tree-clad slope, we came again, suddenly, back into the lowlands of cotton and rice. At Jonesboro we watched girls making bobby socks in a new knitting mill and talked with E. G. Donaldson, who ships carloads of chicken coops. "If it weren't for $1.50 coops," he said, "you city slickers would never see any chicken! You got to haul 'em—they can't run or fly to market!"

Here one Jonesboro glass blower makes a minnow trap. It's simple—just a gallon jar with one end bent in, plus a hole to let in the minnows. Put some bread crumbs bait in the jar and lay it in a stream with its open mouth against the current. In swim the hungry little fish, too feeble-minded to turn around and swim out again—so there's your bait.

Pearls and Buttons from Clams

Looking for fish bait, a man here opened a fresh-water clam and found a beautiful big pearl. More and more were discovered. Thousands of men and women quit their usual work to wade barefooted over the bottoms of shallow streams, feeling with their toes for this sluggish second cousin of the oyster.

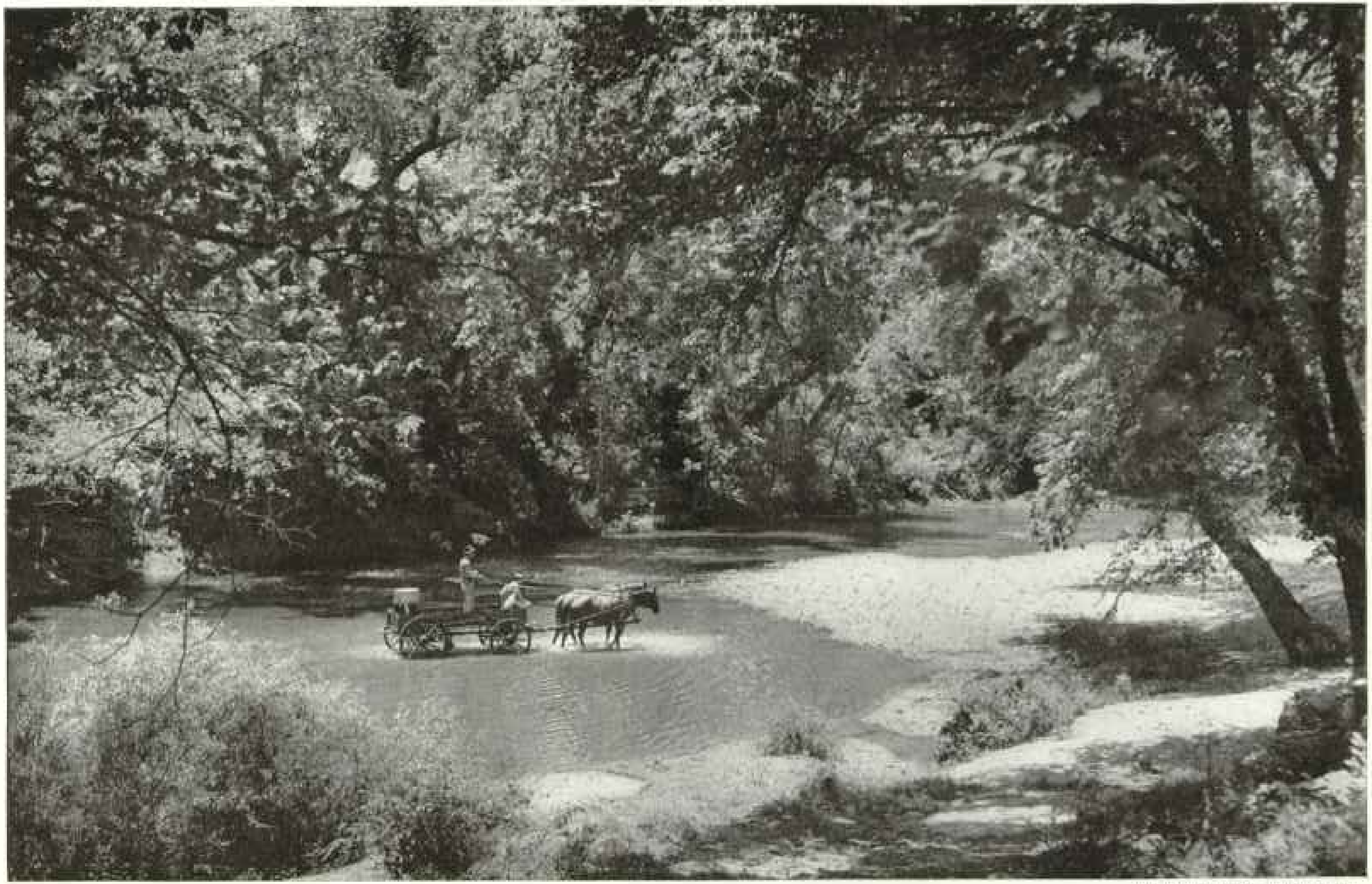
Lawyer Wesley H. Bengel of Newport, on the White River, long a center of the pearl trade, has an amazing collection of these gems. Mr. T. P. Umsted, also of Newport, has been buying pearls since 1900. He says his most valuable one weighed 52½ grains, which he sold for $6,750.

Smaller pearls are still found each year, but bigger ones grow rare. After pearl hunting passed its peak, the shells too became

Staff Photographer B. Anthony Stewart

"Have You Seen a Stray Cow?" Asks the Boy on the Mule, of a Neighbor

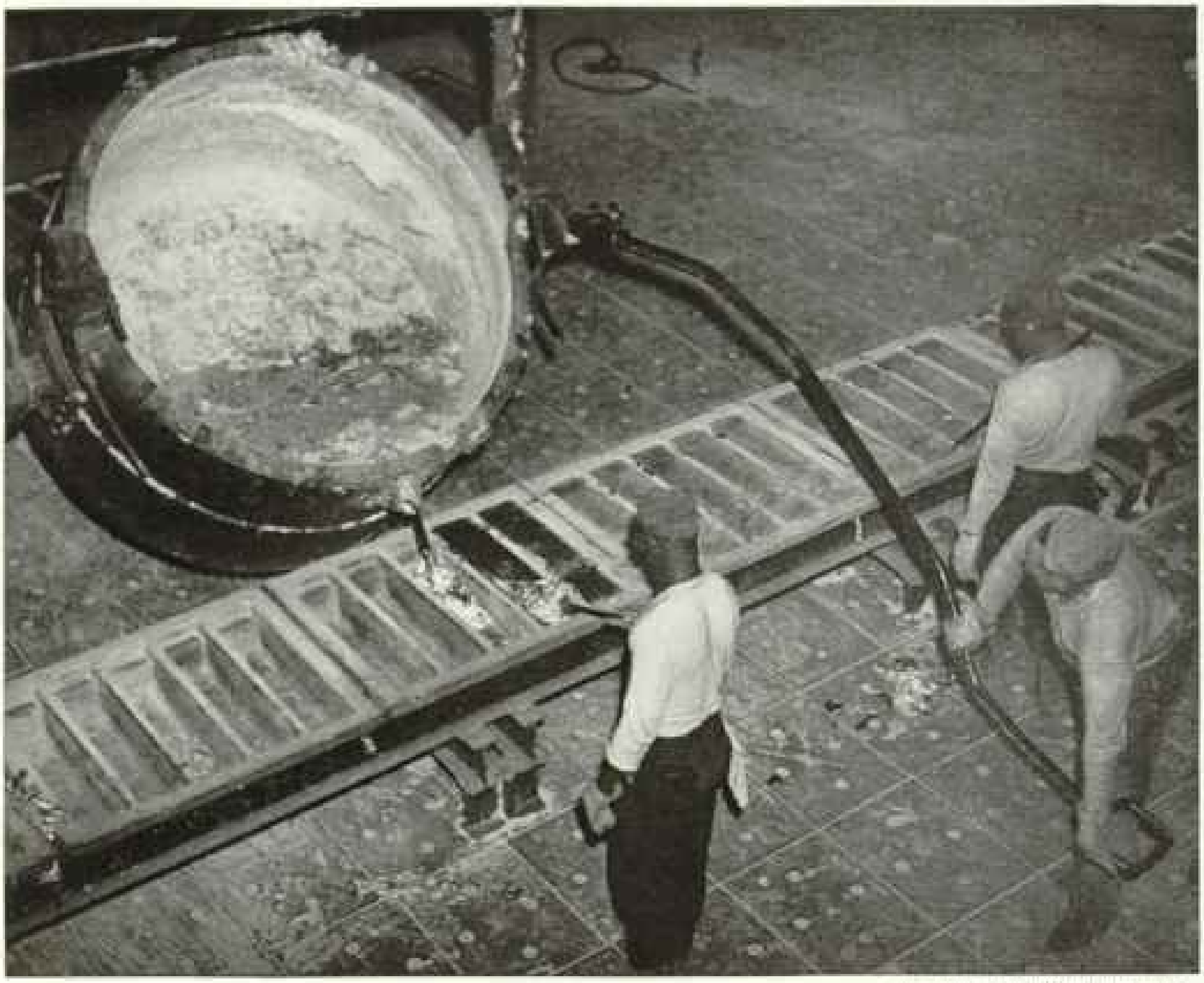
The log cabin with its roof of split-oak shingles, its rock and mud chimney, and its hand-split picket fence, is characteristic of the Jasper community, one of the most isolated in all Arkansas. Soil here is thin and eroded. Much of the heavy hardwood growth which once gave this land value has been lumbered off (pages 285-286).



Staff Photographer B. Anthony Stewart

Because Water in His Well Is Low, This Man Must Haul It by the Barrel from War Eagle Creek to His Hill Farm

In primitive back-country homes, water supply is a vital domestic problem. This man must work hours every day hauling water for his cows and poultry and for washing dishes and clothes. In the back end of his farm wagon's bed stands his water barrel, a tin tub inverted over it. Elms and cottonwoods shade the shallow stream.



Staff Photographer Willard R. Culver

Pouring Liquid Aluminum into Molds to Form Ingots Is the Last Step of Its Manufacture in Arkansas

From here, ingots go east to rolling mills. In recent years this State has yielded from 94 to 97 percent of all bauxite, or aluminum ore, produced in North America. From Surinam we also import bauxite. These 50-pound pigs are being poured at a Jones Mills reduction plant near Malvern (page 288).

valuable for button making (Plate VIII). Today diggers depend on shell hunting for a livelihood; to find a pearl of great price is pure luck.

One good new voice from here is that of Dr. George S. Benson, president of Harding College, in Searcy. Some 3,500 newspapers take his column. Each week Harding College is on the air; half the time Benson is lecturing, anywhere from Madison Square Garden out to Pacific coast universities.

To preach "freedom from fear," he says, is an appeal to cowardice. That phrase "freedom from want" is a bait for the lazy. No able-bodied man should depend on government for security—that's soft stuff. He told that to the House Committee on Ways and Means.

When rich men send him checks to set up scholarships at Harding, he says no. He may divide a check among several more needy youngsters, but "no free scholarships." Pupils study harder, he says, if they have to pay part or work their way entirely through by earning credits against food, clothes, and tuition on the school's farm or in its dairy, shops, laundry, etc.

The uses of adversity *are* sweet, Benson insists. And his work-their-way pupils do "find tongues in trees, books in the running brooks, sermons in stones, and good in everything." Maybe it's because Benson was 11 years a missionary in China and saw how hard the Chinese work that he's so strong for individual effort and self-reliance.

Thinking straight and hitting hard is an Arkansas habit.

Some Arkansas Who's Whos

General Douglas MacArthur was born in Little Rock, at an old Army arsenal; now the park which surrounds it is named for this

Staff Photographer Willard R. Culver

Public School "Thrift Club" Members Work, Save, Aid Each Other, and Run Meetings with the Formality of Bank Directors

Organized by Mrs. Susie M. Gunnaway of Little Rock, this movement is State-wide. Pupils hold office and take turns at presiding at meetings when each member reports how much he has earned, how he made it, how much he has saved, and what he spent the rest for. Members help jobless children find ways to earn cash.

famous fighter. General Brehon B. Somervell, formerly in command of the Army Service Forces, also is a native of Little Rock.

Catfish meat and watermelons nourished Bill Dickey of the Yankees, Lon Warneke of the Cubs, "Schoolboy" Rowe of the Tigers, and Travis Jackson of the Giants.

Navy's footballing Hal Hamberg and Clyde Scott came from Arkansas. So did E. J. "Dutch" Harrison of golf fame, known also as the "Arkansas Traveler." A highway is named for natives "Lum and Abner," and every lover of hillbilly radio corn-on-the-comedy knows Bob Burns came from Van Buren.

Talent "Siphoned Off"

All kinds of men, from oil geologists now in Arabia to bankers in New York, have come from Arkansas.

"My home State has been out of luck in that respect," Senator J. William Fulbright remarked to me. "We raise and train talented young men, then some other State siphons them off."

That excellent engineering college at the University has 39 graduates now working for Westinghouse and General Electric.

Scales tip the other way, too. As new factories are born, more and more chemists, engineers, and plant managers are drawn from outside Arkansas, at salaries never dreamed of ten years ago.

I never found a place where so many people want to write, or more do! Ozark hills swarm with poets! Knock on almost any cabin door; whoever answers may come out reciting one of his verses, like Falstaff in Allen's Alley of the air show.

At Lonsdale, Otto Ernest Rayburn publishes his quarterly *Ozark Guide*, in which fellow folklore writers break into print. Will Rice, dean of Ozark humorists; Tom Shiras,

"walking editor of the Ozarks," Cora Pinkley Call, president of the Ozark Writers and Artists Guild, are all Ozark-flavored favorites of Arkansas readers.

John Gould Fletcher, winner of a Pulitzer Prize for poetry, was born in Little Rock. Another razorback writer is Charles Morrow Wilson, who grew up in Fayetteville. His many books include *Aroostook, Acres of Sky, Backwoods America, Ambassadors in White.*

Known across America are the works of the late Charles J. Finger. This extraordinary Englishman, after years of adventure at sea and in the wilds of Tierra del Fuego, built rustic "Gayeta Lodge," near Fayetteville, and there raised his children after the manner of *Swiss Family Robinson.* When I first visited there, I found each child doing allotted daily chores.

Finger's *Tales from Silver Lands* won the Newbery Medal for juvenile literature; Australians thrill to his *Bushrangers* as our boys do to adventures of Daniel Boone and John Paul Jones.

In her Airedale-guarded studio, an old icehouse at Gayeta Lodge, Finger's gifted daughter, Helen, draws illustrations for juvenile books and children's magazines. She commutes between her Ozark hideaway and the dens of New York editors.

Early Papers and Printing

Among the State's newspapers is the *Arkansas Gazette,* one of the oldest papers west of the Mississippi. Its founder, William E. Woodruff, brought his hand press and type by the rivers from Nashville, Tennessee, to Arkansas Post, where the first issue was printed November 20, 1819. It published the news that American warships had seized the mouth of the Columbia River in the Pacific Northwest.

When the Territorial Capital was moved up to Little Rock in 1821, the *Gazette* came along. Some of the early issues may be seen in Woodruff's printing office, which, with one of his early homes, is part of that amazing restoration of historic buildings at Little Rock.

Accomplished largely by the efforts of Mrs. Louise Loughborough, a leader in Arkansas civic life, this restoration includes the old inn where the last Territorial Legislature met and various other graceful buildings which, long forgotten, for a time formed part of the city slums.

Owned for years by the Heiskell family, today's *Gazette* is ably edited by J. N. Heiskell, while his journalistic colleague, K. A. Engel, runs the rival *Arkansas Democrat.* To the nearly 2,000,000 residents of the State these two sound papers are respectively the *New York Times* and the *New York Herald Tribune* of Arkansas.

Little Rock, the State's metropolis, is the one big bright light between Memphis and Dallas. Standing on the Arkansas River, where Ouachita foothills quit and alluvial plains to the east begin, this tree-strewn city is the only one I know where mockingbirds compete with "Clang, clang, clang goes the trolley."

Steamboats once tied it to New Orleans. Before it had railroad shops, factories, or department stores, Little Rock was a rough-and-tumble frontier trading post, with a law that said "No shooting in the streets on Sunday."

When Col. Davy Crockett passed, on his way to fight Texas Mexicans and to die in the Alamo, the town staged a shooting match to honor him and served bear meat and wild turkey.

Urged to stay, Crockett said, "If I could rest anywhere, it would be in Arkansas, where men are of the real half-horse, half-alligator breed."

This is a rich, graceful city now, with a magnificent Statehouse (Plate I), a vast classic auditorium named for the late Senator Joe T. Robinson, one of the finest Masonic buildings in the country, luxurious homes set on quiet lanes that wind around tree-clad hills, and a host of churches.

Sunday mornings its streets are empty; everybody's in church. Through my hotel lobby one Sunday morning came a kindly old man, asking: "Anybody want to go to Sunday School?" Three strangers laid down their funny papers and sheepishly followed.

Coming back from the hilly country club, where I went to dine with friendly fellow writers, I looked down again at Little Rock in all its lush, semitropic beauty.

"We've summered in New England for 20 years," said one of my hosts. "But there's no place like home."

I had my plane ticket and was all packed to fly east, when I remembered to call Governor Laney. "You don't owe me that $100. I couldn't find any razorback hog!"

Kodachrome by Willard R. Culver

Albert Pike is a Heroic Figure in the Eventful Annals of Arkansas

Exploring the Santa Fe Trail, he wore greasy, wrinkled leather pantaloons. For $3 a month he taught country school. He smoked a cigar while he fought a duel. In the Civil War he led a brigade of Cherokees against the Federals. His portrait graces Albert Pike Memorial Temple, Little Rock.

Amazing Increase in Poultry Flocks Creates a Vast New Source of Arkansas Wealth

No domesticated chickens lived here when the first whites came. Today millions of broilers, especially from Benton and Washington Counties, go to market every year. Young chicks at Springdale.

 Kodachromes by Willard R. Culver

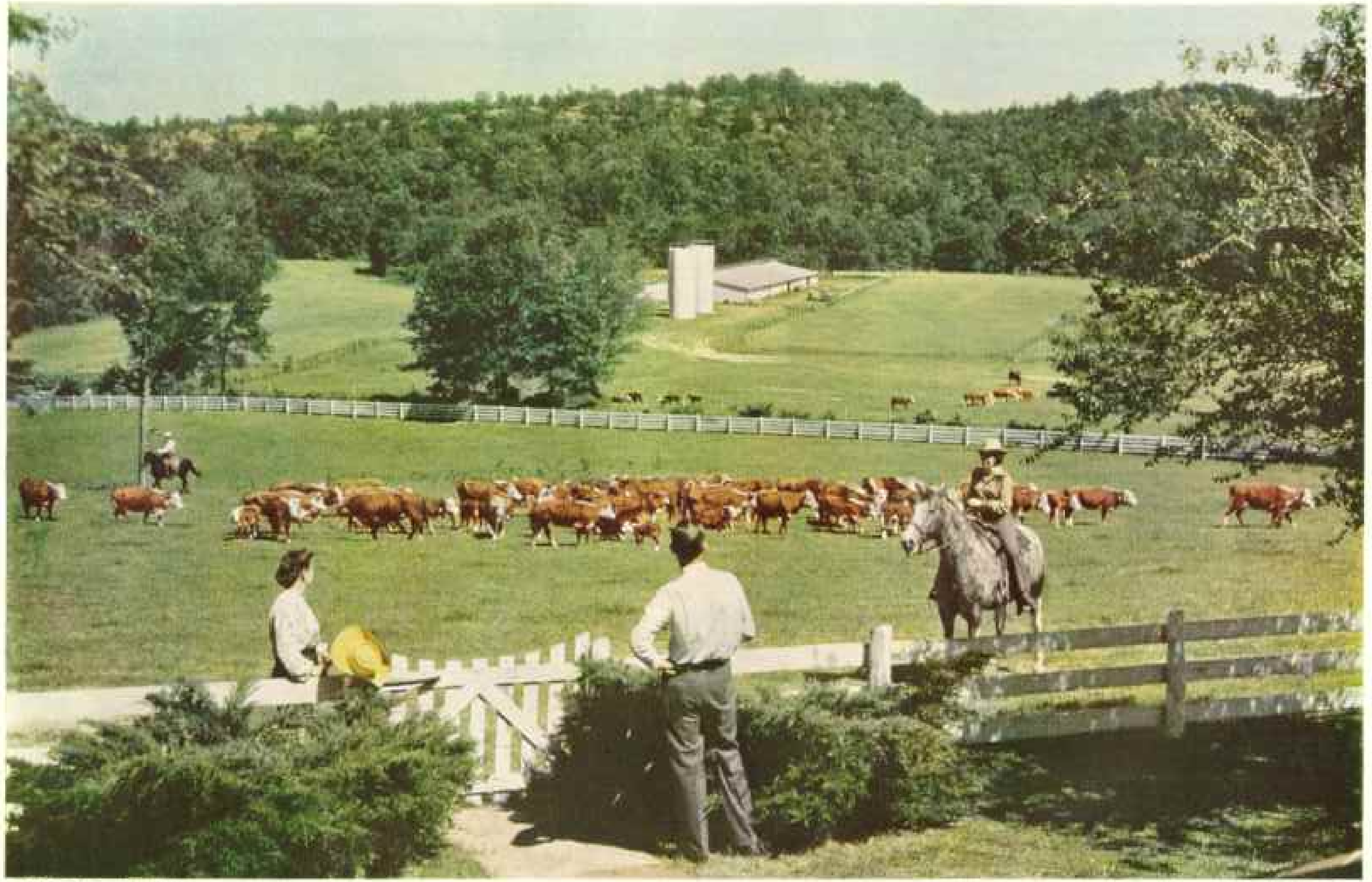
Even New York Smacks Its Critical Lips over Arkansas Goat's-milk Cheese

The Toggenburg and the Nubian goat both range the Ozarks, and their milk makes a succulent cheese. This flock is tended by a girl near Harrison.

Kodachrome by Willard R. Culver

A Champion Rug Hooker Sells Her Output Throughout the Western Hemisphere

In her Batesville home Mrs. Harry King hooks a Colonial Bouquet design, while her daughter checks the pattern. Since 1935 Mrs. King has manufactured 25,000 patterns on burlap, many copied from priceless museum pieces. Among her reproductions are those of 150-year-old Connecticut rugs.



Kodachrome by Willard R. Culver

Silos, Barn, Shade Trees, and Pasture Make a Happy Home for Fat Arkansas Cattle

This is part of the grassy Rodgers' Circle-R Ranch, near Fort Smith, which blends easily with near-by cow country of eastern Oklahoma. Arkansas's long grazing season, its rich hay and feed crops make it a good place for cattle. Prime ribs and veal cutlets still on the hoof bring millions to the State's cowmen every year.

Kodachrome by Willard R. Culver

Far from Ancient Greece in Time and Space, These Girls Are No Less Fair and Graceful than Maids of Athens

This classic Greek theater, overlooking the Ozarks at Fayetteville, was presented to the University of Arkansas by the National Organization of Chi Omega. Commencement exercises are held here, and open-air concerts are given by the University Band and the Northwest Arkansas Symphony Orchestra.

Kodachromes by Willard R. Culver

Little Rock High School Band Has Repeatedly Won National Tournaments

This brass band won the first national championship ever held and scored in each succeeding year. The choir, also shown, has won every contest entered. When it sings, all Little Rock listens. The school, covering eight city blocks, has an auditorium seating 3,500.

Goldenseal Herbs from This Quarter Acre Might Bring $5,000 at Top 1946 Price

Brilliant yellow roots, about finger size, produce an extract used by pharmaceutical firms in making tonics. Generally the plants require four years to mature. In ten years prices have ranged from $1.90 to $9 a pound.

 Kodachromes by Willard R. Culver

So Many Strawberries Grow That Schools Often Let Out Children to Harvest the Crop

Arkansas is a leading strawberry producer. Its crop runs around three-quarters of a million crates a year. The Judsonia area, where this picture was made, cultivates the berry intensively.

What Goes On? Just a Hydrotherapy Treatment at Hot Springs

For decades ill people have flocked to Hot Springs to take the cure. Here 47 springs, sealed against contamination, yield almost a million gallons daily at a temperature around 140° F.

 Kodachromes by Willard R. Culver

Never Mind the Young Woman! Look at the Rock Formation!

In the Petit Jean State Park near Morrilton strata are pressed into geological jigsaws. This particular rock takes on the look of veneered wood, a bolt of cloth, or a jelly roll.

Birds of Timberline and Tundra

By Arthur A. Allen

Professor of Ornithology, Cornell University

With Illustrations from Photographs by the Author

IT IS no longer a secret that the United States Government, cooperating in hemisphere defense, built an enormous airfield and set up an Army post at Churchill, Manitoba, a thousand miles north of Winnipeg on the shores of Hudson Bay.

It was not a thousand miles as the bomber flies, but it was at least that distance as the bulldozers and 3,500 workmen had to travel on the little one-track railroad through spruce forest, muskeg, and barrens to the mouth of the Churchill River.

Two years ago it was such a tight secret, however, that neither the Canadian Government nor the United States War Department would divulge a word in response to my inquiries about working at Churchill with cameras and binoculars in behalf of the National Geographic Society. Indeed, had it not been for a casual mention of a "restricted area" in a letter from the Hudson's Bay Company, I should never have guessed that permits were necessary.

As we approached Churchill, I became more and more uneasy as to the significance of a "restricted area" and how it might affect our work. When we stepped from the train and beheld an array of uniforms, my heart sank.

"I am Major Wilkins, in charge of the post here, and I have orders to expedite your work for the National Geographic Society to the best of my ability."

With these few direct words the handsome young officer who greeted us dispensed so much sunshine that I must have grasped his hand like an old friend.

"If you will come with me in my car," Major Wilkins added, "I will show you what you must not photograph and then I will give you the necessary permits to enter the restricted area."

Only the Birds Are Unchanged

A car at Churchill! There was no road a quarter of a mile long when I studied birds at Churchill ten years before. I was unprepared for all the changes we were to see.

A broad gravel road led from the townsite three miles straight down the Barren Grounds to the edge of the timber, and then two miles east to the ridge overlooking Hudson Bay, with extensions leading as far again into the spruce forest. The area over which I had trudged so laboriously ten years ago was now covered in a few minutes.

We whipped around the post, sped down the mile-long airstrip, inspected the hangars and a modern hospital, had a bit of refreshment at the Officers' Club, and were back at the townsite in less time than I formerly spent in hiking to the area where I wished to work.

Still more auspicious was the sight of curlews and phalaropes, sandpipers and plovers all along the roadside, as if nothing had happened to their nesting grounds, which they too had traveled thousands of miles to find.

The Army's plans had been accomplished. The workmen had left, save for a maintenance crew; the airport itself was no longer active; and the wildlife of the country had taken the incident in its stride. Caribou left their hoofprints in the sand at the roadside, wild geese swung low over the landing strips, and loons called from the ponds.

All seemed too good to be true, especially when we discovered that Mr. George Reid, proprietor of the little hotel, had a car in which he offered to taxi us each morning with our cameras and blinds to whatever spot we wished and to call for us at the end of the day.

Think of driving a car within sight of a nesting Hudsonian curlew, stilt sandpiper, or Harris's sparrow!

Railroad a Godsend to Naturalists

Only a few years ago the eggs of Harris's sparrow were entirely unknown and the nests of the other species had seldom been seen. If a naturalist wished to study these birds during their nesting season in June, he had to spend the winter with the Eskimos to be on the ground the following spring (page 337).

When in 1931, after fourteen years of persistent labor, the Canadian Government finally completed the railroad to Churchill, it was considered a godsend by ornithologists interested in Arctic birds. It mattered not that the railroad was built to open up a shorter route to Liverpool for the wheat crop of the Canadian prairies and that a huge wheat elevator had been erected at the mouth of the river. To them it was the open sesame to a new fauna.

Naturalists at last could get to the nesting ground of the golden plover, the stilt sandpiper, the parasitic jaeger, the Hudsonian cur-

In Manitoba a Mother Waits for Sextuplets or More to Hatch

A willow ptarmigan's family usually varies from 7 to 10, but as many as 17 eggs have been found in a single nest. The eggs are a rich buff with dark-brown markings which change with time to tan and black (page 316). Gulls often attempt to steal the eggs.

lew, and Harris's sparrow with a minimum of effort. They might have to walk only five or ten miles to find these birds. And now, in 1944, we were driving right up within a stone's throw of many of them.

Of course, Churchill is not in the real Arctic; it lies 500 miles below the Arctic Circle. But it was near enough for our work.

As one travels northward from Winnipeg and The Pas, one sees what are sometimes locally called the False Barrens, or the Little Barrens, 65 miles before one reaches Hudson Bay. An extensive area of spruce forest intervenes. Then the train finally leaves the last spruce behind and for some three miles chugs across the real Barren Grounds and into the station at Churchill.

The vegetation proclaims that this is near the real Arctic. Only creeping birches and willows and low, scrubby laurels lift their heads above the densely packed mosses and lichens that cover the rocks for miles.

But even here the Arctic is only beginning. Snow buntings, ruddy turnstones, black-bellied plovers, snowy owls, and whistling swans are not satisfied with these borderline conditions. They continue their sure flight on to the real North where thousands of miles of unbroken tundra make more of an appeal.

The borderline conditions, however, make for the greatest concentration of bird life and have made Churchill famous among ornithologists the world over. Many Arctic birds extend their ranges down to the border of trees, and some Hudsonian species extend theirs northward to the Barren Grounds.

Thus, within easy walking distance, one finds nesting such birds as the lesser yellowlegs, northern shrike, Bonaparte's gull, rusty blackbird, and black-poll warbler, all of which range to the southward, and others, such as the willow ptarmigan, golden plover, parasitic jaeger, and arctic loon, which are commoner much farther north.

Terror of Other Birds Is the Parasitic Jaeger, Shore-line Robber

Strong and swift in flight, jaegers live mainly on food they force terns and gulls to disgorge or on their neighbors' eggs and young. On tireless wings they patrol the tundra. Season, age, and individual variation, not sex, determine their color, which ranges from all black to slate-gray and white.

It was the eighth of June when my son David and I arrived. Sledges, so necessary during the long winter months, were now stacked against the frame houses, and the dogs, the trappers' proudest possession, were staked out for the summer where they would receive plenty of water and a generous chunk of whale meat every other day.

This was the season for whales—the white belugas that follow the fish up the river at high tide. When they come up momentarily for air, they look not unlike the icebergs among which they sport.*

Whole Town Meets the Train

The citizens of Churchill are friendly people. They were interested in what we were doing and were always eager to be helpful. From all walks of life and from all parts of the country they had come, and all seemed to like the place and to have no immediate plans for leaving.

The town itself is still primitive in most respects. The winters are long and severe, the summers short and plagued with insects. Entertainments are scarce and diversions few except for the arrival of the train, which the whole town turns out to meet. Yet the people are well satisfied with their lot and, like the birds that frequent the townsite, they take things as they find them.

The Hoyt's horned larks trot along the streets; Gambel's sparrows and Lapland longspurs nest by the back doors; the semipalmated plovers lay their eggs almost anywhere on exposed patches of gravel, and no one knows why they come to Churchill each June to raise families (Plates V, X, XI).

Certainly on their migrations they see thousands of places where food is just as abundant, where natural enemies are no more

* See "Whales, Giants of the Sea," by Remington Kellogg, National Geographic Magazine, January, 1940.

In Spring Dark Feathers Begin to Replace the Willow Ptarmigan's Winter White

Always wearing a cloak of invisibility, this bird of the North is all white in winter except for its black tail; in spring it blends with patches of snow and in summer it matches the tundra (Plate II and page 314). Natives and Arctic animals prize the ptarmigan for food. Its winter bed is a snowbank.

numerous, and where their offspring would stand as good a chance of surviving.

Early June shows little color on the tundra. The flowers that inundate the landscape later are still sleeping, their roots frozen in the ice a few inches below the moss. Indeed, the ice never melts more than some 14 inches except in gravelly spots, and it takes a hardy plant to bloom and nature seeds under such conditions.

The grays and browns, the lavenders and golden greens of the mosses and lichens, however, have a charm that is never eclipsed even by the pinks, yellows, and purples that follow in such profusion in late June. At the height of the flowering season there remains a conservatism to the colors quite in keeping with the austere environment and not at all comparable to the garish hawkweeds, mustards, and goldenrods of more southern latitudes.

The evening was pleasant as we sat on the high ridge of Pre-Cambrian rock overlooking the bay. It was 9 o'clock, but more than two hours still remained before the sun would drop below the horizon, and then for only a couple of hours.

The ice had gone out of the river unusually early, clearing a space for several miles along the shore, but the open water was still filled with shimmering bergs that threw pale-green or rosy-pink reflections across the deep blue of the bay. Beyond stretched the unbroken ice toward Southampton Island, more than 400 miles to the north.

Off to the northeast one could see on the horizon misty cliffs which our maps told us were not there. The illusion was as real as the rocks on which we were sitting, so fallible is the human eye in the presence of a mirage.

"Go Back," Warns a Brusque Voice

"Go back, go back, go back," came a voice from behind a huge boulder. Then, with a loud cackle, the author of the sound flew into

Six Inches of "Sandpeep" Seek to Cover a Large Nestful of Eggs

Smallest of shore birds, the least sandpiper is sometimes mistaken for its cousin, the semipalmated sandpiper (Plate XIV). It breeds from northwestern Alaska to Newfoundland.

Two Churchill Neighbors, a Snow Bunting (right) and Lapland Longspur

Both breed near the top of the world, the snow bunting laying its eggs as far north as land is found. In migration or on winter feeding grounds the Lapland longspur (Plate X) often associates with this bunting.

the air to make himself more conspicuous.

Landing about 50 feet from us, he revealed himself as a willow ptarmigan, resplendent in the snow-white body plumage and chestnut-brown head and shoulders of the male in the breeding season (page 316). We had evidently seated ourselves in his territory and he was complaining in his vociferous fashion.

Somewhere within a hundred yards there must be a protectively colored female sitting on a dozen strikingly beautiful eggs—deep buff with strong black markings (Plate II and page 314). It would be David's job to find that nest and mine to make color photographs, for we had come these thousands of miles, under the auspices of the National Geographic Society, for the purpose of bringing back natural-color studies of the birds of timberline and tundra.

Much would have to be crowded into the three remaining weeks of June—tramping the tundra, wading the sloughs, searching the stunted spruces for the nests of those Arctic and Hudsonian birds which we in the United States know as transients for a few brief days in spring and fall, or as hardy winter visitors. Among them are some of the world's greatest travelers.

Birds Fooled by "Go-awayster"

One gains considerable familiarity with birds by watching them through binoculars, but there is nothing equal to studying birds at arm's length to give real insight into their behavior. This is best accomplished from observation blinds set up near their nests, and for successful photography this procedure is essential.

Hence, strenuous but fascinating days lay ahead of us, with mile after mile of tundra to be covered before we could even locate a nesting pair of stilt sandpipers or golden plovers, to say nothing of the many other species (Plates IV and XIV).

Next step would be to watch them from concealment until they should unwittingly give up the secret of their nests; then to set up a blind so made and so placed that it would not disturb them.

The following day, perhaps, we could move it closer to the nest until it finally would stand within six feet of the birds' home; then we would have only to wait for a day of sunshine so that the colors would register accurately on the film.

Finally the day comes. I crawl into the low blind with the cameras, one for stills and one for motion pictures, and when all is in readiness David walks conspicuously away. If all goes well, the bird returns within thirty minutes, well satisfied that there is no one around, for he cannot count and is fooled by the disappearance of the "go-awayster."

However, he may not like the looks of that great eye, the lens of the camera, staring at his eggs; or he may not like the click of the shutter. Indeed, the reactions of no two birds are exactly alike, and the uncertainties of the game of life history studies, with the fascination of watching unusual birds at such close range, give one all the excitement of a major sport. If "our team wins"—well, herewith are a few of the trophies.

In a small lake southeast of Churchill is a large boulder from which the frost has chipped a rectangular block, leaving a somewhat protected ledge that makes a suitable site for the nest of a herring gull (Plate VI).

I have seen herring gulls nesting on similar boulders in some of our Adirondack lakes. Between the Adirondacks and Churchill there must be thousands of such rocks. But every year a pair of herring gulls passes them all by, bound for the one in Isabelle Lake at Churchill. Ten years before, when I made my first studies of birds at Churchill, the rock was occupied, as it has been every year since.

Ten years ago, too, I photographed an arctic loon that was nesting at the end of a little peninsula jutting out into a near-by lake. The site was somewhat unusual, for all the other loons' nests of that region were on small islands where they were safer.

Loons Cling to Old Nest Sites

Imagine my surprise and pleasure, on revisiting the little peninsula after a decade, to find a loon's nest within five feet of the old site. The former home was now untenable, as the level of the lake had dropped several inches; so the bird, which ordinarily laid its eggs on the shore a few inches above the water without much pretense of a nest, had built up a platform of mud above the action of the small waves and was sitting with no cover at all about it (Plate VIII).

Still another loon, nesting on an island but similarly affected by the lowering of the lake level, had worn a channel like that of a muskrat to its nest, which was now several feet from the present shore line.

Loons are practically helpless on land, because their legs are placed so far back, but they can propel themselves in very shallow water by a froglike jumping motion and a final leap to the nest. Rather than desert its chosen nesting site of the previous years, this loon had worn the channel and clung to the old site in spite of its clumsiness and the attendant dangers.

"No Privacy, Even Here in the Far North"

On her nest in a spruce near Hudson Bay, a female black-poll warbler glances at the camera with disgust and doubt in her shoe-button eye. Olive-green and black plumage makes her hard to see, but she wears the white wing bars of her black-capped gray-and-white mate. Black-polls travel far for their size (Plate X and page 320).

On an island in Rosabelle Lake we discovered about twenty pairs of arctic terns nesting (Plate XVI). Here I found a dead tern with a band on its leg bearing the number 36-339172 and the statement, "Notify the Biological Survey, Washington, D. C."

I sent the band to my friend Frederick C. Lincoln, who has charge of all the cooperative birdbanding work, and he found that the bird was banded as a nestling at Churchill, perhaps on the same island, by Mr. Albert L. Wilk, of Camrose, Alberta, on July 10, 1937.

In the meantime the bird had made seven round trips to the Antarctic by way of Europe and Africa. Each trip involved some 22,000 miles, making a total of 154,000 miles.

Just why this little tern could not be satisfied with the coast of Maine or Labrador, Iceland or Scotland, but had to travel possibly an extra 2,000 miles to Churchill; just why it could not migrate down the east coast of America instead of crossing the ocean before traveling south—these are mysteries that scientists have not yet satisfactorily explained.*

Odyssey of the Golden Plover

The golden plovers, whose great speckled eggs we found in the tundra moss about the middle of June, leave Churchill in August and head eastward over James Bay and across the Labrador peninsula to Nova Scotia or Newfoundland. Here they grow very fat on the abundant "curlew berries" (crowberries) until they feel ready for the trip south.

Twenty-four hundred miles over the Atlantic they fly; over Bermuda, over the mangrove swamps of the coast of Venezuela, never stopping until they reach the lowlands of the Orinoco River.

*See "Our Greatest Travelers," by Frederick C. Lincoln, in *The Book of Birds*, published by the National Geographic Society.

Here again they rest for a while before taking the next big jump over 2,000 miles of Amazonian jungle to southern Brazil and northern Argentina.

Several months pass before they reach southern Argentina, so it is time to start northward again almost as soon as they arrive.

But they do not retrace their flight. Instead, they cross the high Andes of Peru and cut across one corner of the Pacific to the highlands of Honduras.

Then, when the urge to move again strikes them, they cross the Gulf of Mexico and enter the United States on their northward journey through eastern Texas and western Louisiana. It is March when they arrive here, and they are still in their winter plumage with gray breasts instead of black.

Slowly they journey up the Mississippi Valley, acquiring new black feathers on their underparts, and it is mid-April when they arrive in the vicinity of St. Louis.

There is no need of reaching Churchill before the first of June, so they loiter on their way, frequenting burned pastures and plowed fields wherever food is abundant. Thus, when they finally reach the breeding grounds, they are in their lustrous black, white, and gold liveries (Plate IV).

The golden plover is not a common bird at Churchill. In the 15 square miles of tundra where we did most of our hunting, we located only six pairs, and these birds restricted their activities to patches of dry, moss-covered tundra where the grays, yellows, and blacks of the lichens made them very inconspicuous.

As with the herring gull, the loons, and the arctic terns, we found their nests not far from the spots that had been occupied by plovers ten years before. The passage of ten years, the passage of a thousand years, perhaps, produces little change in a land where man has not interfered with the balance of Nature.

The millions of miles traversed by golden plovers on their migrations, with the attendant hazards, serve to thin their ranks so that the suitable nesting spots never become overpopulated; yet they continue to be occupied, generation after generation.

Mighty Mite Flies 10,000 Miles Yearly

Not far from the tern island we found a little black-poll warbler nesting in a stunted spruce (Plate X and page 319). It, too, must be conceded one of the world's great travelers, for although it was not banded and we cannot trace the exact route that it followed, we know that no black-poll spends the winter north of Venezuela.

This little mite of a bird, therefore, weighing less than an ounce, must have traveled at least 10,000 miles from the time it left Churchill the year before. Surely gasoline is not the last word in motor fuel.

Thus, as we hiked about the tundra and paid our respects to plover, curlew, and sandpiper, many of which winter in South America, we felt that we had come to a veritable explorers' club and that we were the merest novices in the sport of touring. Not until we have our individual planes and hop from Churchill to Rio de Janeiro and Timbuktu can we qualify with these feathered denizens of the Barren Grounds.

There were, of course, birds like the ptarmigan that claim Churchill for their permanent home. These birds do not migrate more than a few miles to find the buds of willows and birches projecting above the snow.

Others, like the tree sparrows that we found building their feather-lined homes in the bases of willows or little spruces, wander southward only as far as the northern United States (Plate IX). Indeed, with them we felt much at home, for every winter they come to our window for seeds, and when we put bands on their legs we find the same ones returning year after year.

I don't suppose any of the tree sparrows wintering at Ithaca nest actually at Churchill, but it gave us a friendly feeling to see them—like discovering a buddy from the old prep school in some outpost of the far Pacific.

Ubiquitous Starlings Discover Churchill

When Percy A. Taverner and George M. Sutton published a list of the birds of Churchill in 1935, they included 146 species which had been recorded from that area up to and including their visit. Of these, fewer than 100 are of regular occurrence, and the rest are more or less accidental.

Every year a few individuals of species found to the southward overshoot their migration schedule and arrive at timberline, where they do not belong. If a careful observer lived at Churchill long enough, he could, without doubt, double the number on the list, although some species might never be recorded a second time.

Nearly every ornithologist who visits Churchill adds one or two birds, and our trip was no exception. We added seven to the list, the most interesting, but also regrettable, perhaps, being the starling, four of which showed up on June 12.

By some accident their number was reduced to three in two days, and one of the survivors had lost its tail.

 Kodachrome by Arthur A. Allen

A Much-traveled Yellow Warbler: It Flew from South America to Hudson Bay

In a stunted willow near timberline at Churchill, Manitoba, it stops at last and builds its cottony nest covered with Arctic pussy-willow down and lined with ptarmigan feathers. This "summer yellow bird" breeds from northern Georgia to Alaska, some individuals flying much farther than others for reasons unknown.

Kodachrome by Arthur A. Allen

Visibility Zero when Viewed from Above! A Female Willow Ptarmigan Almost Matches the Reindeer Moss

So protectively colored is she that one can pass within three feet of an incubating bird without seeing her. To overcome this camouflage, the photographer lowered the camera to ground level and caught her in silhouette. In winter this Arctic dweller lives on birch and willow buds projecting above the snow.

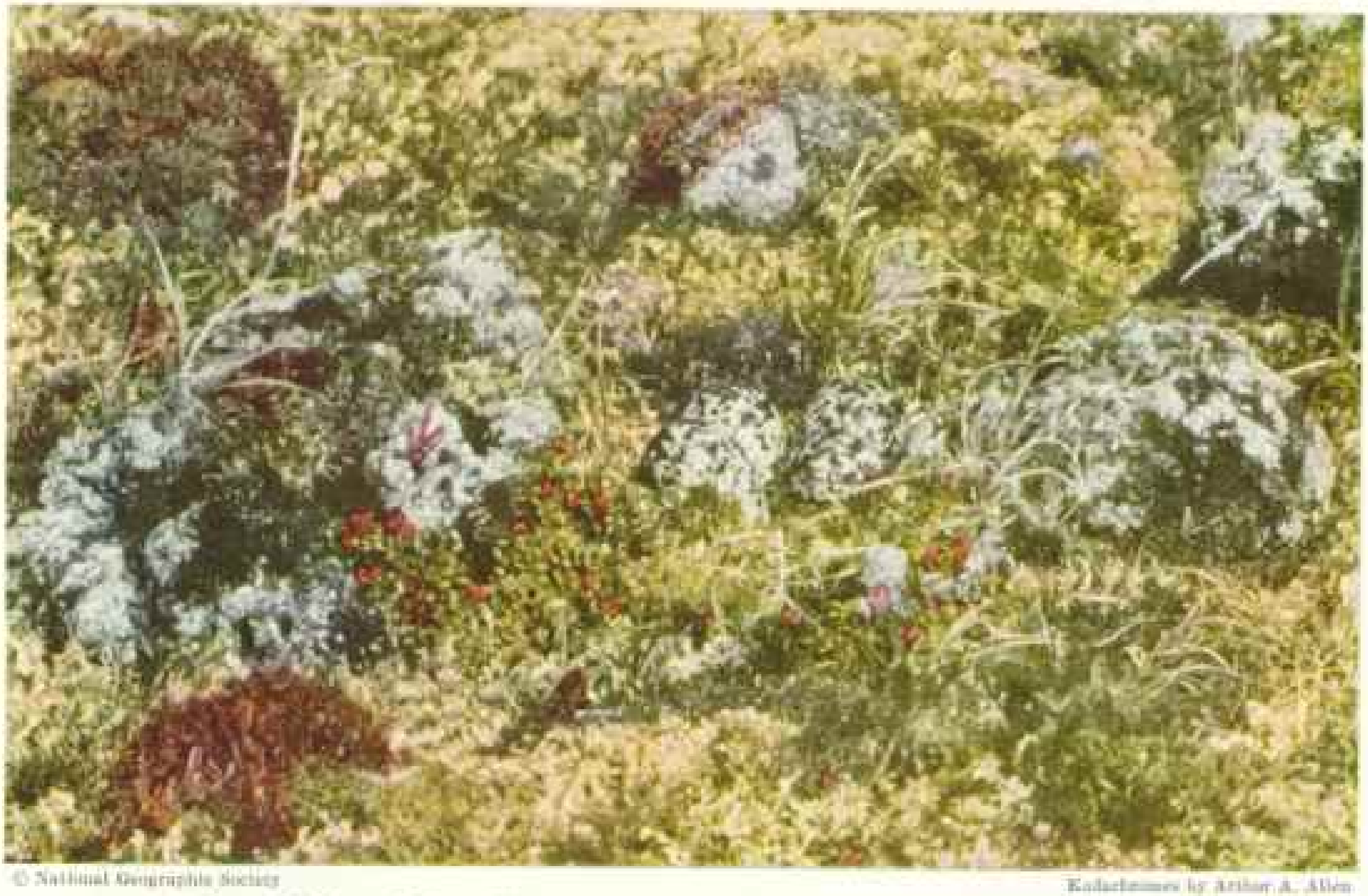
Kodachrome by Arthur A. Allen

Worn Wing Feathers Are Eloquent of the Long Distance Flown by This Hudsonian Curlew

An inter-American traveler, it spends the winter in South America and nests only on Arctic coasts. Here the long-billed bird is settling on its eggs in the reindeer moss. The breast feathers are lowered, exposing double brood spots of bare skin which will make contact with the eggs.

One of Our Greatest Travelers, a Golden Plover, Reaches Journey's End

This resplendent bird nests only in the Arctic and winters on Argentine Pampas. Pacific Golden Plovers that nest in Alaska find Hawaii, mid-Pacific isles, Australia, and New Zealand with the accuracy of a B-29 navigator.



Kodachromes by Arthur A. Allen

Eggs of the Golden Plover Afford a Study in Protective Coloration

Tans and blacks of the chosen site almost perfectly match their colors, thus hiding them from marauders such as the parasitic jaegers that continually beat back and forth over the tundra in search of eggs or helpless young.

Semipalmated Plovers Choose Gravelly Sites, Sometimes Between Railroad Tracks

Common at Churchill was this bird, also called the Ring-necked Plover. It looks like a small killdeer but has only one band across its breast. This photograph was made between 8 and 9 p. m., thanks to the long Arctic evening.

Kodachromes by Arthur A. Allen

A Hoyt's Horned Lark on Four Olive-gray Eggs Awaits a Quadruple "Blessed Event"

A relative of the European skylark, this is North America's only true Lark. It nests from the west shore of Hudson Bay to the mouth of the Mackenzie River and winters chiefly from Ohio to Nevada.

Kodachrome by Arthur A. Allen

Herring Gulls Return Each June to Nest on This Wind-swept Boulder in Arctic Wastes Adjoining Hudson Bay

With thousands of more hospitable nesting sites available, this familiar Gull of our ports and beaches picks a lonely, frost-cleft "rock of ages" in Isabelle Lake, near Churchill. Revisiting the site after ten years, the author found Herring Gulls using the identical spot. Old Gulls sometimes practice infanticide.

Reproduction by Arthur A. Allen

"What's That Noise?" A Startled Hell Diver on Its Houseboat Anchored among the Reeds in a Pond near Churchill

Horned Grebes get their nickname from marvelous proficiency in swimming and diving, but their legs are set so far back that they are almost helpless on land. Their floating nest makes them independent of changes in water level. In fall, when they move south to the Gulf of Mexico, they lose their bright colors.

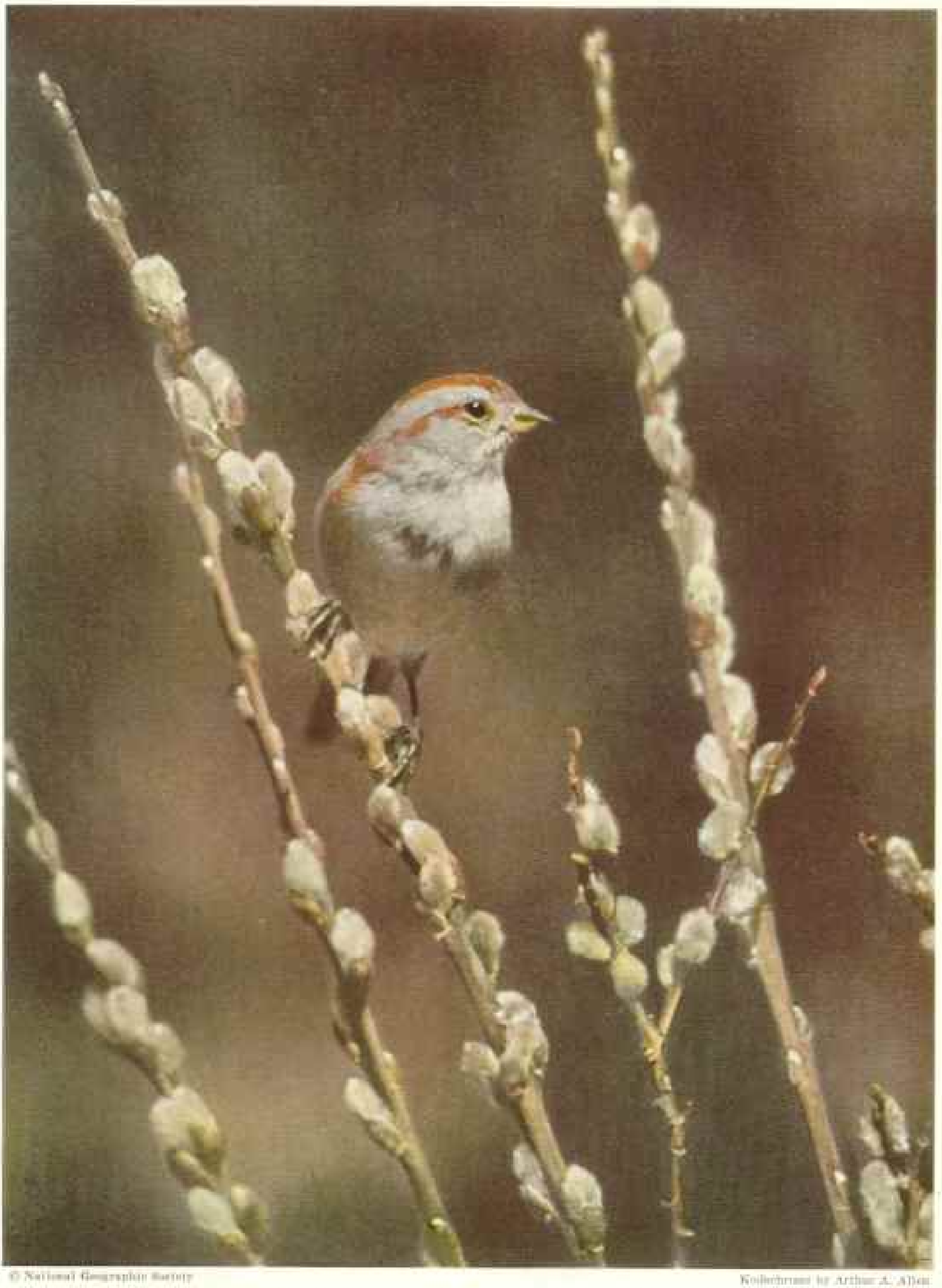
A Crazy Bird on a Crazy Nest—an Arctic Loon

All Loons have a reputation for insanity because of their wild, demoniac cries, and this one's madhouse is a tiny artificial island built up by the birds with small pellets of mud to support the two oval, dark-olive eggs.

Kodachromes by Arthur A. Allen

Flipping an Egg into the "Incubator" Is a Delicate Operation for a Loon

Eggs threaten to roll off the nest, but they must be tucked into the small brood spot between the bird's legs or they will never get warm, for the rest of the breast is covered with dense insulating feathers.



Kodachrome by Arthur A. Allen

Pussy-willow Time Sends the Tree Sparrow North to His Hudson Bay Home

All winter the hedgerows of the northern United States tinkle with the cheerful notes of this gay little Sparrow. Then in late March or early April he journeys north and builds with his mate a feather-lined nest in the base of a dwarf willow or spruce in the solitudes of timberline.

Doughty Arctic Explorer, a Lapland Longspur Pauses Before Its Hidden Door

In tangled roots of dwarf rhododendrons and crowberries it builds its secluded nest. In Siberia, Lapland, and Arctic America its tinkling summer song is heard. In migration, millions have perished during storms.

Bailey-Hermes by Arthur A. Allen

Home at Last after a 10,000-mile Round Trip to South America

This little **Black-poll Warbler,** incubating five eggs in a dwarf spruce at timberline on Hudson Bay, must have traveled at least that far since leaving its home the previous August. It winters in Venezuela and Brazil.

A Semipalmated Sandpiper at Home: It Looks to the Surf for Its Supper

Following the receding waves, the little "sandpeep" seizes tiny crustaceans while fastidiously avoiding wet feet. Common on beaches east of the Rockies, it migrates to the Gulf, West Indies, and even Patagonia.

Kodachromes by Arthur A. Allen

When Standing, He Towers on Stilts above His Lesser Cousins

Long spindly legs of the **Stilt Sandpiper** are folded up as he takes his turn on four beautifully spotted eggs. The nest is a sparsely lined depression on a grassy bit of tundra near Hudson Bay.

A Papa Phalarope's Place Is in the Home

A male **Northern Phalarope** sits on the nest, deserted by his spouse who lets him do the work and goes off gadding with the girls. Another Phalarope oddity is that the female wears the brighter colors.

Kodachromes by Arthur A. Allen

Not "the Bird on Nellie's Hat," but the Greatest Traveler of Them All

The **Arctic Tern** is champion long-distance migrant among birds, wintering in the Antarctic and summering in the Arctic. This one probably flew some 22,000 miles since it last rested on its mossy island near Hudson Bay.

Starlings were first introduced into North America from England in 1890 in Central Park, New York City, and have proved themselves so adaptable and so prolific that they are now the commonest bird in most places east of the Rockies. This, I believe, however, is the first record of their appearance so far north in the New World.

Other birds not on the Taverner-Sutton list that were seen at least once during our three weeks' stay were the redwing, cowbird, song sparrow, house wren, alder flycatcher, and barn swallow—all common birds a few hundred miles farther south.

The robin, which was only an occasional bird ten years ago, had become in the meantime a very common species in the spruces at timberline, and a number of pairs were nesting about the town.

Indeed, the only species which seemed to be much less abundant was the ptarmigan, and it always has had its ups and downs. Apparently in 1944 it was again near the bottom of the cycle, for we saw fewer than twenty birds and found only two nests.

The Hudsonian curlews, once listed as on the downgrade, have once more become abundant, and their tremulous calls could be heard in all directions.

As we tramped the tundra we usually had one or more pairs in noisy attendance, for it is their custom to fly toward an intruder, scolding loudly, and to escort him beyond the borders of what they consider their territory.

To find a curlew's nest, therefore, one has to conceal oneself beyond this area, wait for the disturbance to die out, and watch the birds through binoculars. Usually within an hour the curlew would return to its eggs. Since there are few landmarks on the tundra, however, it was even then difficult to walk to the exact spot where the bird had disappeared (Plate III).

The smaller shore birds, like the northern phalaropes, stilt sandpipers, red-backed sandpipers, and dowitchers, usually flew from their eggs forty or fifty feet ahead of us. But even when the approximate spot was noted, it was often difficult to locate their nests, so protectively colored are their eggs.

Honkers at Home

Ptarmigan, on the other hand, would let one almost step on them before leaving, and, since the females are so protectively colored that they are invisible at five or six paces (Plate II), their nests were exceedingly hard to find.

To one familiar with wild geese only as the conspicuous wedge of migrating birds during spring and fall, their behavior on their nesting grounds may be a surprise.

If you take no notice of the old gander standing in the shallow water at the edge of a pond, he will honk wildly to attract your attention.

Then you may walk within twenty feet of his mate, flattened on her island nest with her long neck and head pressed to the ground, and not ever see her, though the short brown sedges offer little concealment. Indeed, she can sneak off the eggs without being observed and then noisily take wing a hundred yards away as if she were just leaving her nest.

The pintail duck sometimes performed the same trick, but most of the waterfowl, of which the old-squaws and red-breasted mergansers were most numerous, merely flopped from their nests at our approach and thus made them easy to find.

Nest of Wary Harris's Sparrow

Nest hunting among the dense dwarf spruces at timberline was really difficult, and we considered ourselves fortunate in finding four nests of Harris's sparrow and one of the northern shrike.

As mentioned above (page 313), the eggs of Harris's sparrow had never been described prior to the building of the railroad, and once its completion made it possible to get to timberline during June, a race ensued among rival ornithologists to be the first to find them.

The Harris's sparrow is a fairly common bird in the central United States during winter, and the naturalist Ernest Thompson Seton in 1907 found the nest and young in Last Woods on an expedition from Great Slave Lake to the Barren Grounds. It remained for Dr. George M. Sutton, formerly Curator of Birds at Cornell, to find the first set of eggs on June 16, 1931, near Churchill.

Since then a number of nests have been found, but the bird is so wary that photography is extremely difficult, and our single picture of the bird on its nest gave us more trouble than that of any other bird. We spent nearly a week getting the bird accustomed to a blind, and then at the first click of the shutter she left and did not return until I gave up after two hours of waiting (page 339).

The young shrikes left the nest the middle of June, indicating that nest building must have started in early May, when the ground was still covered with many feet of snow and the temperature was still far below freezing. Indeed, there were still many snowdrifts among the spruces when the young birds left home, and we had a few snow flurries as late as June 27.

A Dive Bomber Lands in a Treetop

Bonaparte's gull frequently "dive-bombed" the author from behind, though it rarely struck with its bill. This bird is a great destroyer of insects, which it gathers in the air and on the marshes and prairies. It ranges from Alaska to the Bahamas, around the Gulf coast to Texas and Yucatán, and winters from Washington to central Mexico. It is small for a gull, and in the air it flies lightly with the grace of a tern.

The shrikes disliked our close approach to their nest, which was located in the top of one of the taller spruces about 15 feet from the ground (Plate XII). When David climbed to the nest they attacked him furiously, striking his head and neck with bill, wing, and claw. It was just as well for David that the bird was the size of a robin and not that of a hawk.

The arctic terns and Bonaparte's gulls likewise were not timid in protecting their nests, and the latter bird in particular had a disconcerting habit of dive-bombing an intruder from behind, even at considerable distances from its nest. Though it seldom struck with its bill, the accuracy of its bombs was extremely disagreeable.

Most gulls nest on the ground on rocky islands or in marshes, but the Bonaparte's gull nests on horizontal branches of spruces, usually 15 or 20 feet from the ground. We were fortunate in finding one in a dead spruce only five feet up. This made the building of a blind much simpler, except that it stood in a pond where the water was knee-deep and ice-cold.

Churchill is rather far north for horned grebes, but this same pond, which had been formed by the damming effect of the new road leading to the airport, gave shelter to two pairs. With great anticipation we watched one pair building its floating home, and when, after a week, I could discern the female flattened on the nest, I waded out to see if it was time to set up a blind.

To my sorrow I discovered that the female was dead. Her oviduct was clogged with the first egg, perhaps the first she had ever tried to lay. There was no mark of violence on her body and her plumage was unruffled; so I assumed that Nature had gone awry and that the bird had made the supreme sacrifice in trying to reproduce her kind.

The other pair was found shortly afterward, and when they finally accepted our blind, which was unavoidably conspicuous, we were successful in preserving their home life in kodachrome (Plate VII).

A few species at Churchill eluded us and we never found their nests, notably the Hudsonian godwit and the Bohemian waxwing. The latter may not have started nesting until after we left, but we had several pairs of the former under observation and spent many hours watching them from concealment to no avail.

Though seemingly attached to a definite area and behaving as if they were about to give up their secret, they invariably flew clear out of sight—only to return to the same

A Sight Few Human Eyes Have Seen—a Nesting Harris's Sparrow

Although fairly common in the central States in winter, this secretive bird breeds far in the North, and not until 1931 did a scientist succeed in finding its eggs. Immediately after this photograph was taken, the startled bird fled and did not return though the author waited two hours (page 337).

spot later, for we repeatedly found them there the next day.

Fickle Arctic Weather's Whims

No account of Churchill and Hudson Bay would be complete without some mention of its weather. To say that of the 21 days spent there it stormed all day on nine days, was clear all day on six, and clear half of the time on the other six, while the wind seldom stopped blowing, may give some idea of its fickleness.

"Nice day, Mr. Reid," I said to the hotel proprietor, one of the older residents who knew his Churchill weather.

"Yes, fine," he replied, "so far."

It was then 8 o'clock in the morning, and the sun was bright; there was not a cloud in the sky and the wind was only moderate from the northwest.

We started in his car for the reservoir, three miles away over the new highway. Before we reached it the wind was howling out of the north, the sky was completely clouded, the temperature had dropped ten degrees, and a spurt of cold rain greeted us as we stepped from the car.

"Never mind," he said. "It may clear." And sure enough, with no change in the wind, it was all clear by noon and the temperature was up 20 degrees.

Cold pockets of air could drop down in the middle of the day or the middle of the night. If the evening was quiet and warm, as sometimes happened, and one left the window open, it was pretty sure to blow up a gale and drop almost to freezing by morning.

But in spite of the small percentage of sunshine and the high winds that made the use of blinds so difficult, we were able, because of the long days, to accomplish most of our objectives. In fact, many of our photographs were made at 8 or 9 o'clock at night after the wind had stopped.

These quiet evenings on the moss-covered rocks overlooking the deep-blue waters of Hudson Bay and its shining icebergs were most restful.

The long tramps over the tundra hunting the nests of rare birds; the hours spent in blinds with the intimate observations of strange denizens of the Arctic at close range; the delicate flowers peeping through the moss; the friendly people; the howling dogs; the bronzed Indians and trappers, all combined to make a memorable experience where the North begins.

An Insect Community Lives in Flower Heads

By James G. Needham

Emeritus Professor of Entomology, Cornell University

With Illustrations by Staff Photographer Willard R. Culver

THIS is the story of the discovery of an animal community that lives in flower heads, and a brief account of what I saw going on in it during a winter in Florida.

The members of the community are mostly very small insects. They live in a shifting environment, and they shift with it. As in animal communities generally, there are a few lifetime residents and many transients.

One species of plant, shepherd's needles (*Bidens pilosa*), supplies both food and shelter in flower heads that are scarcely larger than peas (Plate I). In these little heads the residents live together as neighbors, each minding its own business.

Among them there are producers, consumers, parasites, and scavengers, all performing the usual community functions. Herbivores produce flesh; predators devour the herbivores; parasites feed within the bodies of both, and a clean-up gang removes the remains.

Insect Hotel Found by Accident

I came upon this community by the merest chance. I was standing beside a car on a swamp road in the Everglades of Florida at Ochopee, waiting for a friend, when I noticed that the flower heads of shepherd's needles at my feet were partly lacking in the showy white ray flowers and that some heads were misshapen.

I got out my knife, split a few of these heads open, and found that some of the outer florets in every head were developing little swollen green galls with yellow tips instead of black seeds.

Then I cut away one side of a single gall and, with the aid of a little magnification from my ever-ready pocket lens, I found that a gall midge was developing inside (Plate III).

Opening more heads, I found other residents, mainly the young of flies and moths. It appeared that each kind of resident had its own place in the flower head. Gall midges dwelt in the florets toward the outer side of the head, while little flies developed in those at the center. The young of moths, minute caterpillars, ranged through the head more widely, eating through the layer of developing seeds.

These were the principal producers of flesh in this community. Closely associated with them, as we shall see later, were numerous consumers: predators, parasites, scavengers.

I collected enough heads to fill two big coat pockets and returned to the Bass Biological Laboratory at Englewood, Florida, to study them. I found I had "brought coals to Newcastle," for shepherd's needles were growing along every roadside there (page 341).

The heads were tenanted by the same insects and marked with the same signs of their presence. I had only to look to find them; I had not looked. The plants were too common—just weeds. But when once shown the signs, little Helen Hegener (Plate I), who often went afield with me, could find the insects as well as I could.

Shepherd's Needles Offer Home, Food

At Englewood I made a preliminary study of this community as time permitted, through the winter months. I also collected more heads on chance visits northward to Venice, Sarasota, and Lakeland, and eastward to Punta Gorda, Arcadia, and Clewiston. These same resident insects were present wherever shepherd's needles grew.

Now, a word about this weed which, directly or indirectly, feeds a whole community and also provides shelter for nearly all the members of it. It is a white-flowered member of the same genus of plants as the better-known pestiferous yellow-flowered weed called Spanish needles. Like that one, it produces seeds with two long barbed prongs (whence the name *Bidens*, meaning two-pronged) that stick to woolen clothes.

It is also a honey plant of some importance. The flowers are very pretty and give off a delicate fragrance. Honey made from their nectar has something of the same fragrance.

This Bidens is a common roadside and pathside weed in the coastal areas of southern Florida and throughout the West Indies. It is a tender plant that is killed by even a light frost. It is long-lived and vigorous, but it dies back from the top after fruiting, and comes again from below in new branches that appear in an all-season succession. Thus it is in flower and in fruit every day in the year.

A continuing insect community requires the continuing food supply that is assured by this steady fruiting (page 344).

The developing flower heads of Bidens are

Only Weeds, but from Them He Wrung Absorbing Secrets

Near his Florida laboratory the author gathers flower heads of *Bidens pilosa*, commonly known as shepherd's needles. Putting them into glass jars, he studied the strange and varied insect inhabitants which fed on the flower, its seeds, and their neighbors. More than 40 species were counted as permanent or temporary residents (pages 340 and 356). The midges and flies which start the cycle of gorge-and-be-killed are only about a sixth of an inch long and others are much more minute.

very neat and sanitary packages of choice food. Until the heads are nearly grown, they are quite secure packages, for the scales that enclose the sides of the head bend inward, meet by their edges, and tightly seal the top.

When the enclosed florets are ready for exposure these scales lift their tips, uncovering the massed florets of the disc, which then are free to grow upward.

Guests Troop In Opened Front Door

First, single marginal white ray flowers project their plaited tops straight up, white with faint lines of purple on the margins of the folds. Then they unfold and spread out flatwise, showily. The yellow tubular flowers of the disc follow along, rising and opening progressively in circles from outer rim to center, over a period of about two weeks.

When the covering scales of the involucre lift, they open the front door, so to speak. The insects then slip in and lay their eggs. They have to be prompt about it, for their brood must complete its growth before the quick-growing seeds become too hard for them to eat.

This story is about the way the members of this community live; how they manage to get along together in the flower heads, finding there all that the best of communities can offer: food, shelter, and fit conditions for the nurture of their young.

I studied the population of these flower heads first by direct examination, opening them

A Magnifying Color Camera Reveals the Teeming Life in a Flower

With the advice of the author (right), National Geographic Society Staff Photographer Willard R. Culver carefully arranges the square tinfoil reflector to provide proper lighting of the insect-occupied blossoms before making the accompanying color plates in the field in Florida. Magnifying equipment was needed, since the creatures are tiny. The screen keeps the wind from blowing the fragile insect actors away, and the beach umbrella prevents premature wilting of insects, flowers, and photographer alike.

one by one, hundreds in all; and then by keeping large numbers of clipped-off heads in glass jars with removable covers and capturing the adult insects day by day as they emerged from the heads in the jars (page 355). I then isolated individuals for rearing and made a beginning on the study of life histories and habits of a few of the species.

I began with the resident member I first encountered, the seed destroyer which causes the greatest deformation of the plant and the greatest involvement of other members of the community. It is a frail little midge about one-sixth of an inch long, pale brown and patternless in color, with slender legs and long, hairy antennae. It is much smaller, slenderer, and paler than a mosquito.

The female midge has a long egg tube (ovipositor) at the end of her body with which she inserts her eggs deep in the chinks between the crowded flower buds of the head, as soon as the way to them is opened by the lifting of the protective covering scales.

The presence of the egg and of the microscopic larva that quickly hatches from it has an astonishing effect upon the growth of the little flower.

The larva enters it near the base of the unopened corolla, or petals, above the part that will form the seed. This middle part then swells up inordinately by the stimulated overgrowth of new tissue and forms a hollow gall, green on the outside, thick walled, and lined with a soft, white, spongy webbing.

When the gall is older, the middle tissue of the wall turns black underneath its coat of shining green.

The growth of the seed below the gall is stopped; the tip of the corolla above it remains yellow, but never opens. Inside the cavity of the gall the little white larva feeds upon the plant juices that ooze from the spongy lining of the wall. It has only to absorb and assimilate the food prepared and brought to it by the plant which is its host. There is here a power of control over a plant's productivity by mere presence (common to all gall makers) for which science has as yet found no full and satisfactory explanation.

The larva grows with astonishing rapidity. It attains full size in a few days, even before the central florets of the head have opened. It then transforms within the gall into a shiny amber-brown pupa (the middle, or resting, stage of an insect's life history, during which larva is being made into fly; in butterflies, the pupa often is called a chrysalis). The midge pupa has a short triangular spine projecting from the front of its head.

When a gall is opened, there may be found in it a fat, soft, white midge larva half filling its cavity; or, if older, a shining brown pupa; or, not infrequently, the larva or the pupa of a parasite that has eaten the midge.

If the midge has already transformed and flown, there will be left the empty pupal skin from which it emerged, sticking out of a hole near the top of the vacated gall.

Adult Midges Nocturnal

It is probable that the adult midges are strictly nocturnal in their habits. I have never seen one in the field but only in my rearing cages, where they sit motionless all day long.

The presence of galls in the flower heads may be easily detected without opening them, for conical tips of the unopened yellow buds at the green gall summit are visible among the brown and withered corollas of faded flowers, or at the sides of the barbed spines of the maturing seeds. Also, if the galls are numerous, the heads will be swollen and will be hard and uneven to the pressure of fingertips.

The galls rarely occur singly. Usually several are present and in contact in a head. The extreme range in numbers per head that I have found is from one to seventeen. They are in the outer rows of disc flowers, never at the center. Though normally more or less top-shaped, they may be variously ridged and hollowed by mutual crowding during growth.

Gall midges divert the energies of the plant from seed production to feeding their own helpless larvae. They do not interfere with the maturing of seeds at the center of the heads. They live and let live.

Three kinds of little flies (true flies, or Diptera, with two wings) are alike in their seed-eating habits. They choose the center of the flower head as the place to lay their eggs. Their larvae enter single corollas near the base and eat their way downward through the developing seeds.

The larvae are soft, white, cylindric, headless and legless creatures, blunt at the rear and tapered forward to the place where a head would be expected but where there is only a mouth. They lack true jaws for chewing, and they feed by tearing up the plant tissues with a pair of sharp black hooks placed within the mouth.

They simply wallow in the liberated juices of the plant, and are so sticky that when removed from the seeds they adhere to anything they touch. They consume the substance of the developing seeds and grow exceedingly fast. Then they pupate within the cavity that they have eaten out.

The larvae feed head downward, consuming all the substance of the developing seed as they advance, but when fully grown they turn around and pupate head upward, toward the outer world. Each forms its pupa within the loosened and hardened, and later contracted and barrel-shaped, larval skin.

At first it is white, but it turns brown in drying. It is stuck fast to a partly enveloping scale which the adult fly leaves behind when it emerges through a circular slit near the front end.

Larvae Like Liquid Diet

Larvae of midge and fly have very diverse feeding habits, though both require liquid food. The midge larva does not eat the seed; it merely diverts the food from forming a seed at the bottom of a floret to forming a gall in the corolla higher up. Its food exudes in liquid form from the soft tissues of the inner wall of the gall. The fly larva tears the soft tissues with its mouth hooks and sucks up the juices so released.

The largest of these three flies seems to have no common name, so I shall call it the Bandwing (Plate II). Its scientific name, *Xanthaciura insecta*, is out of all proportion to the size of a fly that is only a sixth of an inch long. This dainty little black-backed fly has big green eyes, drooping yellow antennae, and a row of stiff white bristles set across the rear of its head like a back comb. Its under parts and legs are clear yellow.

Gleaming, resplendent wings are like ban-

Each Open Flower Head Is an Insect "Grand Hotel"

Blossoms of the *Bidens pilosa* weed are scenes of deadly drama, with predators preying on peaceful browsers while parasites bedevil both. In the center of the bisected flower head at lower right rests the pupal case of a Bandwing fly (Plates II and III). The midge at right and aphid at lower left struggle helplessly in silken spider threads.

ners, black from base to tip, with large transparent triangles of a glassy clearness cut out of both front and rear margins. There are two or three little transparent peepholes in the black.

This fly behaves as if quite conscious of the elegance of its dress. It struts this way and that, making little vacillating turns, then stands momentarily flirting its wings, turning each like a fan, in a manner that recalls the actions of a girl model displaying the latest styles at a fashion show.

The wing pattern is obvious camouflage.

I have seen the adult female fly in action among the weeds, walking on top of young heads as if in search of an early-opening cluster into which to push an egg.

I have seen a fly larva hanging with half its length inside a hole that it apparently had just made in the side of an unopened floret. After entering the corolla, it bores downward into and through the seed and then, being not quite grown, it gouges laterally into the sides of two or three adjacent seeds.

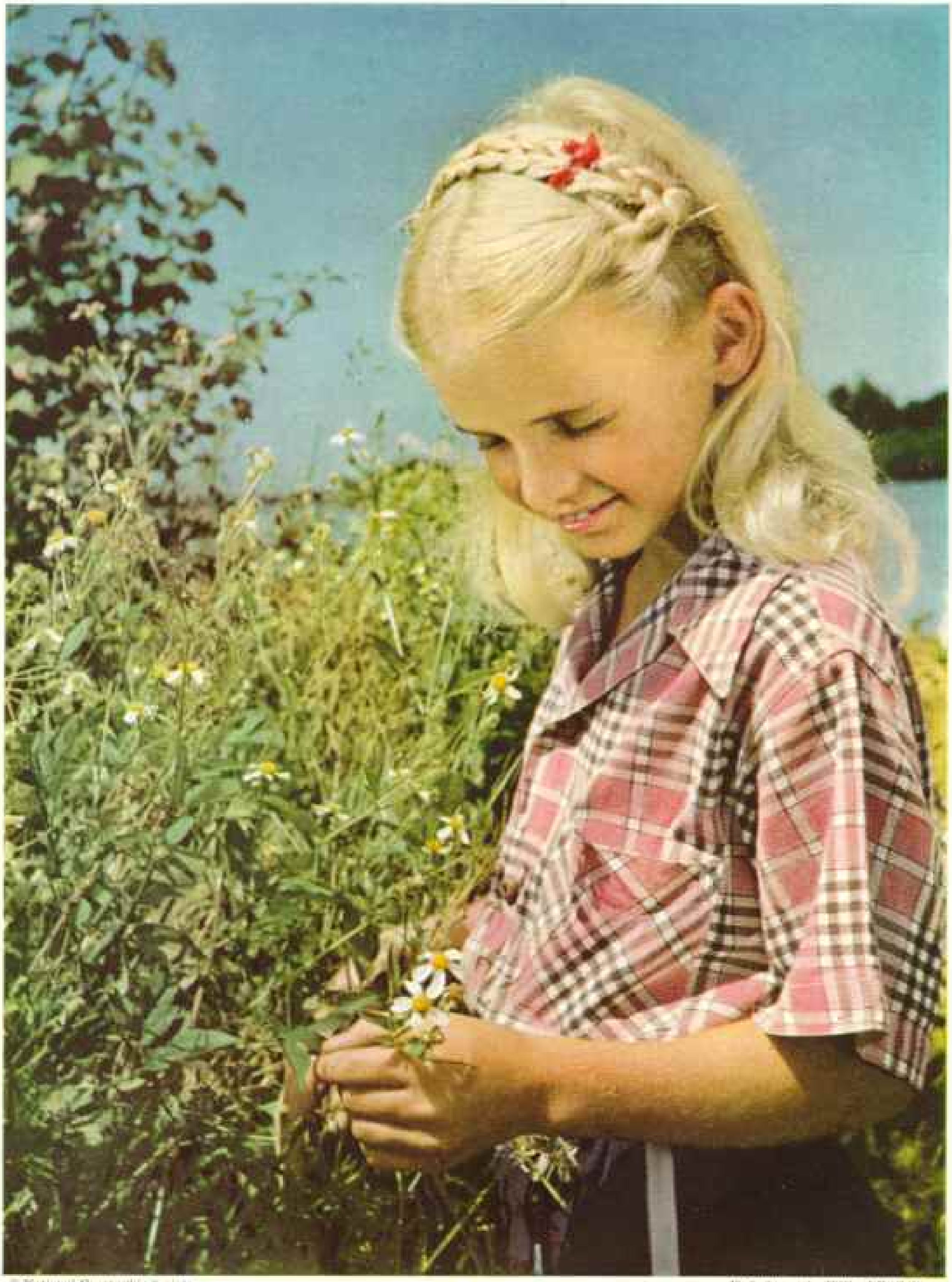
All the way down it has been leaving a trail of natural adhesive. As this dries, it fastens together a number of withered corollas at the top and a number of flower scales at the sides. These remain attached and come off the heads together at the scattering of the seeds. Sometimes two or three or even four flies may grow up side by side in a single head, and then all are massed together at the center.

The pupal period lasts about seven days.

Spotwing Walks Sedately

The Spotwing fly (again I have found no common name and, not wishing to say *Paroxyna picciola*, have made up one) is smaller, only about an eighth of an inch long (Plate II). It lacks any marked body color pattern but has distinctive wings. They are gray, with a large number of unequal roundish transparent spots that give it the appearance of a dissolving film, through which the black supporting veins of the wing show plainly. It does not flirt its wings but walks around sedately.

Though often abundant, it is hard to see in the field. I made one stroke with my collecting net, trying to catch a syrphus fly on some freshly opened flowers, and caught along with it eight Spotwings I had not seen at all.



Kodachrome by Willard R. Culver

In Her Posies 40 Kinds of Insects Dwell in Self-sustaining Communities

Tiny producers, consumers, parasites, and scavengers live together in the flower heads of shepherd's needles (*Bidens pilosa*), tropical cousin of the widespread Spanish needle. Some fatten on the plant, only to become choice morsels for predatory flesh-eating neighbors. A clean-up squad removes casualties.

A Bandwing Fly Flaunts His Finery against a Ray Flower, While a Spotwing Feeds (Right)

These are descriptive names. Science calls the flies *Xanthaciura inserta* (left) and *Parexyna picciola*. When not feeding or laying, they dart about herbage, where man seldom notices them.

Kodachromes by Willard R. Culver

Bandwing and Spotwing, Rivals for Brooding Space, Hunt Apartments for Their Young

These flies scout the tops of unopened flower heads for a crevice in which to deposit eggs. Plant juices will nourish their young. Magnification is about seven times.

 Kodachrome by Willard R. Culver

Cut Open, a Flower Head Reveals a Nursery Nearly Ready for Release of Winged Insects

The center has been eaten out by a Bandwing larva which has now encased itself. As an adult fly, it will emerge through the hole in the top. On each side is a gall, a plant swelling caused by a larva. That on the left has been opened to show the pupa of a Gall Midge. Between the galls, slim black seeds mature.

Kodachrome by Willard R. Culver

Who'd Suspect This Killer? A Ladybird Beetle Rests after Wiping Out an Aphid Colony

In orange armor, *Cycloneda sanguinea* visits a shepherd's-needle guest. Both adult and larva feed on plant lice. To farmers this beetle is a valued ally. California imported an Australian species to control a citrus scale. Ladybird, traditional "bird of Our Lady," also is the children's "ladybug" ("Fly away home!").

A Community of Dwarfs

Florets (Left) Develop the Black Pitchfork Seed Unless a Midge Produces a Gall (Right)

Enlarged ten times, five florets show successive stages of opening. Nature designed the seed's barbs to stick to passers-by. Within the gall, a larva gorges on plant juice, preventing seed formation.

Kodachromes by Willard R. Culver

Little Gray Ghost, a Moth Sleeps by Day Weirdly Balanced on a Flower Stem

Its name is *Phalonia*. Its caterpillars devour shepherd's-needle seeds, midge larvae, pupae, and galls. Tent caterpillars and wool eaters are types of destructive moths, but their cousin, the silkworm, works for man.

A Larva, Camouflaged and Spine-armored, Stands Guard over a Plant

Baccha clavata's false eyes are respiratory openings (left). The faceless head is to the right. This specimen enwraps a stem. Having no legs, it travels sidewise by lifting and heaving its front and rear alternately.

Kodachromes by Willard R. Culver

Baccha Hoists an Aphid and Drains Its Blood (Left)—A Red Ant Watches His "Cow's" Doom

In return for honeydew, a sugar excess secreted by aphids, ants shepherd the insect herd, driving away some enemies. When selecting victims, a Baccha larva sometimes thumps their backs, like a boy testing melons.

Kodachrome by Willard R. Culver

Fat, Lazy, and Unarmored, Mealy Bugs Are Easy Pickings for Insect Aggressors

Feeding on a shepherd's-needle stem, *Pseudococcus citri* cover themselves with a white mealy powder. Adult males have wings but no mouths. Females have sap-sucking beaks but no wings. This plant louse is one of the destructive scale insects. A useful few produce shellac, Chinese wax, cochineal dye, and ground pearls.

 Kodachrome by Willard R. Culver

A Honey Giver, Shepherd's Needle Attracts a Gorgeous Nectar Drinker (6 Times Enlarged)

Hemiargus hanno, a butterfly, is one of the Lepidoptera, an order which includes moths. One way to distinguish the two is to observe their wings at rest: butterfly's typically erect, moth's folded back (Plate V). Butterfly's club-shaped antennae are rarely seen on a moth. Both develop from caterpillars.

I have observed the female inspecting the flat tops of unopened corollas. With her long, telescopic-jointed ovipositor, she can place her eggs far down between the corolla bases of young florets.

The Clearwing fly (again of my own christening, for what is perhaps a new species of *Agromyza*) is the smallest of these three important members of the producing class in the Bidens-head community. It is only about a ninth of an inch long. It is black or blackish all over except for reddish eyes, and its wings are quite transparent. In its habits it is much like the other two.

Bandwing, Spotwing, and Clearwing are direct competitors for place and food and shelter. Their larvae tear up the juicy young seeds, live on the fluid contents, and grow fat. They "turn grass into flesh." Only the greedy caterpillars, to which I now come, are more important producers in the Bidens community.

Puzzle: Find the Caterpillar

Here among faded *Bidens pilosa* flowers is a "looper" caterpillar (at upper right with head to left) that has camouflaged itself by biting off pieces of corollas and fastening them to the spines on its back. Larva of a beautiful pea-green moth, *Synchlora denticulata*, this creature is akin to the common "measuring worm" (page 354).

Moth larvae (called caterpillars by nearly everybody) damage the heads of Bidens flowers in two ways. Some that are very small live within the heads and eat the seeds; others, a little larger, stay on top and browse on the corollas.

All moth larvae spin silk. Silken threads lining their burrows and brown pellets of refuse stowed behind the silk are sure signs of their presence in the heads.

I had most fun trying to learn the ways of one of the smallest of these moths, a little *Phalonia*, perhaps as yet undescribed (Plate V). The adult is a tiny atom of a lepidopteran, with a wingspread of about a third of an inch. It is silvery gray, finely mottled with scales of brown and black. Faint bars of brown cross the forewings, fringes of long, tawny scales hang to their rear margins, and there is a faint wash of rose pink over the front wing border.

I did not see a single specimen of this mothlet in the field, but it emerged in my cages in some numbers. It is nocturnal. By day it sits on a dried stem in a seemingly unbalanced posture, so unlifelike as to escape notice.

The larva is a pale little grublike caterpillar. I found a very small one half inside a freshly eaten hole in the side of an unopened corolla. It eats its way downward into a seed, feeds a while within it, and then tunnels laterally into other seeds.

If galls are encountered, the larva seems to

prefer their softer, juicier tissues. When there is a midge pupa in the gall, the larva then eats that. Even after I had seen much of its browsing in gall tissue, I was loath to believe it would eat flesh. But finally I found the larva at the entrance hole it had eaten in a gall, with a half-eaten midge pupa inside the gall.

The larva when grown pupates in its burrow. On emergence as an adult moth, it leaves its empty pupal skin sticking out of the hole. This empty shell may easily be distinguished from that of the gall midge by lack of a horn on the front of the head and by having wing sheaths for two pairs of wings.

Seed-eating larvae of at least four other kinds of moths live within the Bidens heads.

Adults of all four came out of the heads I collected and put in my glass-jar rearing cages. Two are much like the Phalonia in size and habits. Two are larger kinds, a single one of which may devour all the seeds in a head. Such ravage by many individuals would be a scourge to the whole Bidens community, but the many parasites of these larger ones seem to keep their numbers down.

The full-grown larvae leave the heads and spin their slender cocoons in a corner of the rearing cage, amid a tangle of silken threads that looks like the work of spiders.

Colors Camouflage "Loopers"

Other caterpillars live not in the heads but on them. These feed on the corollas. Because they do most of their eating after the flowers have been fertilized, they do the plant little injury. Two of them intrigued me by the perfection of their protective resemblance to fading corollas. They live out in the light where color counts, and their colors protect them well. Both are caterpillars of the kind popularly known as "loopers."

Who has not had himself measured, inch by inch, for a new suit by a green "measuring worm" that had come down from a treetop to his shoulder on a long swaying thread of silk so fine that the thread was almost invisible?

These Bidens loopers are very inactive. The one shown on page 353 sat very quietly for this photograph. It is the larva of a very beautiful pea-green moth *(Synchlora denticulata)* and is camouflaged by its own efforts. It fastens bits of corollas to the tubercles on its own back. Under these its concealment is perfect. I had been handling the flower heads in one of my rearing jars for several days before I saw one larva that must have been repeatedly before my eyes.

The other is marked protectively by the colors in its skin: a ground color of brown, the shade of withered corollas, with yellowish quadrangular spots along the sides, one on each body segment, lined up like the windows in a railway coach.

Two groups of animals, thrips and mites, are the most constant residents of all in Bidens flower heads. They are so minute as to require technique that I could not use with the equipment I had available. They are small enough to enter bodily into the crevices between flowers, or to go down in the depths of the corolla tubes and live there, adults and young together. Individually they are so small that the damage to the plant is usually negligible.

Aphids, Mealy Bugs, and Their Train

Aphids and mealy bugs, being sluggish insects, are unable to gain access to the rich stores of food within the Bidens heads and must content themselves with sucking sap from the outside. With their slender tubular beaks they penetrate to the sap channels of the plant.

Gregarious, they habitually cluster around the base of the Bidens head and up its sides, where new-formed tissues are softest and where sap flows most freely (Plate VII). They are enormously prolific. Young and old remain together and quickly form colonies. Quite unarmed for defense, they invite aggression.

As is well known, both aphids and mealy bugs secrete honeydew. The colonies are attended by ants which gather the honey and, in a weak measure, herd the colonies, driving away some of their enemies (Plate VI).*

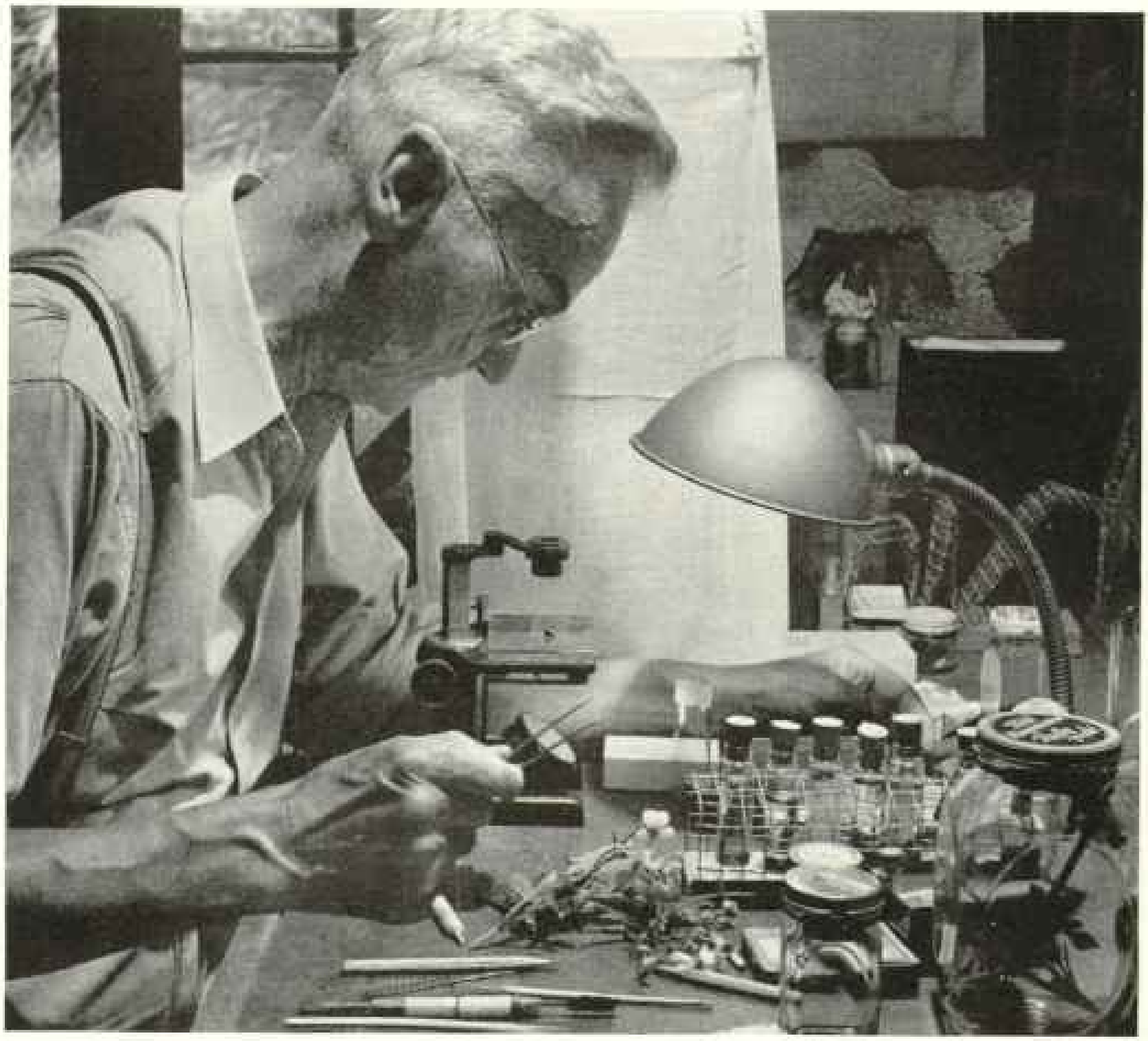
Among their predatory enemies, a conspicuously colored ladybird beetle (Plate IV) was much in evidence. Both the adult and its larva could be found devouring the helpless aphids, cleaning up entire colonies in a remarkably short time.

Another predator in the colonies of both aphids and mealy bugs is the larva of the flower fly that has the roistering name of Baccha *(Baccha clavata)*. It is very inconspicuous. Though quite common, I discovered it only by first finding the big red ants that were attending aphid colonies, and then searching the flower heads near the ants.

The Baccha larva is headless and footless, with a body nearly long enough to encircle the flower stalk at the base of a head. It seems to stay in place there constantly (Plate VI).

At the tapering and pliant front end of the body it has a pair of murderous mouth hooks.

* See "Stalking Ants, Savage and Civilized," by W. M. Mann, National Geographic Magazine, August, 1934.



Before the Understanding Eyes of Science the Drama in a Flower Unfolds

On the author's laboratory table at Englewood, Florida, lie flowering *Bidens pilosa* weeds with their white ray flowers and yellow centers. The scientist places them in glass-jar rearing cages and studies the many insects which emerge from the flowers. Dr. Needham, veteran Cornell University naturalist, is the author of many books and papers on insects and biology.

In feeding it drives these hooks into the back of an aphid, lifts it aloft, and sucks out its blood.

I got quite a thrill out of finding this extraordinary larva for the first time. It is known to be a friend of the cotton grower, for it devours the aphids that cluster around the base of the young cotton bolls, stealing the sap that should go into the making of cotton.

Here it was doing the same protective service for Bidens, sidling its way among the animated sap pumps and devouring them one by one in rapid succession.

Its long, tapering body is decorated in the softest pastel shades of green, brown, lilac, pink, and tan, matching the Bidens heads. Its back is armed with rows of erect white spines. On its blunt rear end is a pair of conspicuous brown-rimmed respiratory openings (spiracles) that might be mistaken for eyes on first sight if one did not know that they are at the wrong end.

I watched a Baccha larva that seemed to be selecting its food. It lay in the midst of an aphid colony. It reached about with its mouth hooks, tapping several of the aphids upon the back before hurting any of them. In this it reminded me of the way in which as a boy I used to go through the family melon patch, thumping the watermelons with my finger, testing them by sound to find out which melon was ripest.

Presently the larva with a heavy stroke plunged its mouth hooks into an aphid, lifted it aloft, and began to suck and swallow. Thus Baccha goes through a colony, eating the mem-

bers one by one, feeding almost incessantly until all are gone. Then it travels laboriously down a twig to a fork and up a branch to another head to find another colony.

Its method of locomotion is the strangest I have ever seen. It travels sidewise, both up and down, with its soft, footless belly all the while partly enwrapping the stem. It moves, not at all as a snail glides, but by lifting alternately front and rear ends, swinging them sidewise and setting them down again farther ahead. Its trail, if it left a trail, would be a zigzag streak down one side of the stem. Its progress is slow, but it has not far to go to find another head. Possibly it may be guided by scent; possibly it may feed again or starve, according to the bestowal of Providence.

In the train of the aphids and mealy bugs, besides the friendly ants and the hostile predators, there is also a host of parasites. Against all these enemies their only hope of continuing upon the earth lies in their extraordinary fecundity; millions of them may be killed, but by chance always a few survive.

Intruders Attack Flower Guests

Now that I have added aphids and mealy bugs to the midge and fly larvae and caterpillars first discussed, I have named all the important producers of flesh that I found in the Bidens community. As in communities generally, both animal and human, the consumers outnumber the producers in kinds. The larger of them are in this case predators, and the smaller ones parasites.

Some of the largest of the predators, spiders and ambush bugs, hide among the flowers in the head and lie in wait for the butterflies and moths that visit the flowers for nectar. Several times I found a beautiful blue butterfly (Plate VIII) held fast in the clutches of an ambush bug.

The bugs use the flower only for cover. They were rarely seen by me when I was putting the flower heads into the rearing jars, but came into view some time later, when moved out by hunger. Even the largest of them are hard to see. One big ambush bug did not leave the drying heads to report "present" until it had been in a covered rearing jar 12 days—plenty of time to work up an appetite.

Four kinds of flesh-eating flies *(Tachina)* came out from the heads in my cages in small numbers. These follow the larvae and caterpillars into their burrows, destroy them, and transform into pupae in their shelters.

As for scavengers, there is not much of a clean-up job to be done in these heads, for the seeds ripen and fall as litter. But there is one very little red midge larva that I have found frequently among the wastes left by the other larger larvae among the damaged seeds. It is not a gall maker. It belongs to a group of midges, some of which are scavengers, and it is probably one of that habit.

The number of parasites that my rearing jars yielded was astonishing. They outnumber all other insects (except thrips) put together. As yet, I have done nothing with them but save the specimens and send them to specialists for naming. Nineteen species have been found, among which are two that are new to science. Much further work will be required to determine which parasite belongs with each host.

Tenants Arrive by Air

The foregoing account of some of the more important members of this Bidens community includes only those insects that have emerged in my rearing jars after the heads were inspected, cleared of scatterlings, and put into the jars without stems or leafage. By such simple means more than 40 species of residents were found. I count only those insect intruders that find food or shelter or both in the heads of *Bidens pilosa* and that are entitled to be called permanent or temporary residents.

This animal community exists as a nomad population dependent on the Bidens flowers. Its members arrive at the flowers by air: flying insects, ballooning spiders, and mites so small that they drift about on air currents.

They must be small, for there is little food and less standing room in the flower heads. They must be quick-growing, for the time when newly hatched larvae can find floral tissues soft enough for their survival is very short indeed, and proper timing is all-important.

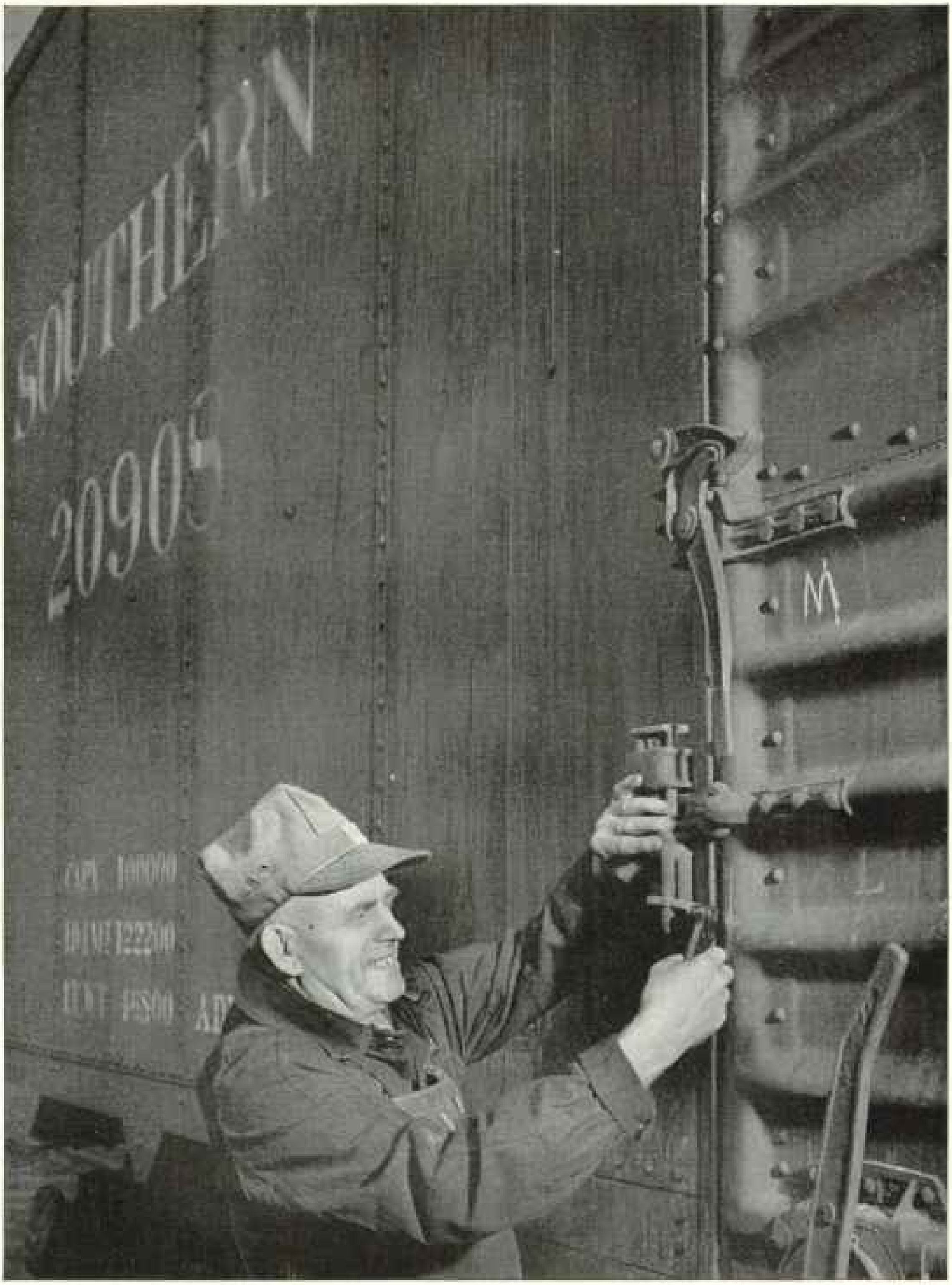
This community, like every other, has its system of checks and balances. Its members have their ups and downs. In December at Englewood I found that nearly every Bidens head had galls in it. The midges in the galls were heavily parasitized. A month later the parasites had so reduced the gall midge population that I could find scarcely one gall in a hundred heads.

These parasites, having then destroyed their own food supply, all but disappeared. A temporary rise in the population of the two-winged flies followed, bringing in a new set of parasites. While the numbers of single species thus fluctuate, the collective numbers of carnivores, herbivores, parasites, and scavengers remain more constant, for they perform continuing community functions.

Staff Photographer Volkmar Wentzel

Now Vacationists, Honeymoon Couples, Mothers and Daughters Travel by Air

Before the war, most civilian plane passengers were businessmen or movie stars. Here a 60-seat DC-4 of Pennsylvania-Central Airlines is about to leave Washington, D. C. A total of 2,122,716 domestic air travelers flew in the first quarter of 1946—more than double those who flew in the same period of 1945.



Staff Photographer B. Anthony Stewart

Boxcars Will Bring You That New Radio, Washing Machine, Vacuum Cleaner

Here a trainman affixes a seal in the Alexandria, Virginia, yards. If it is found broken when the car reaches its destination, the receiver can demand instant check to see if any of the contents have been removed en route. Newly perfected wheel assemblies soon will move many freight trains at passenger speed.

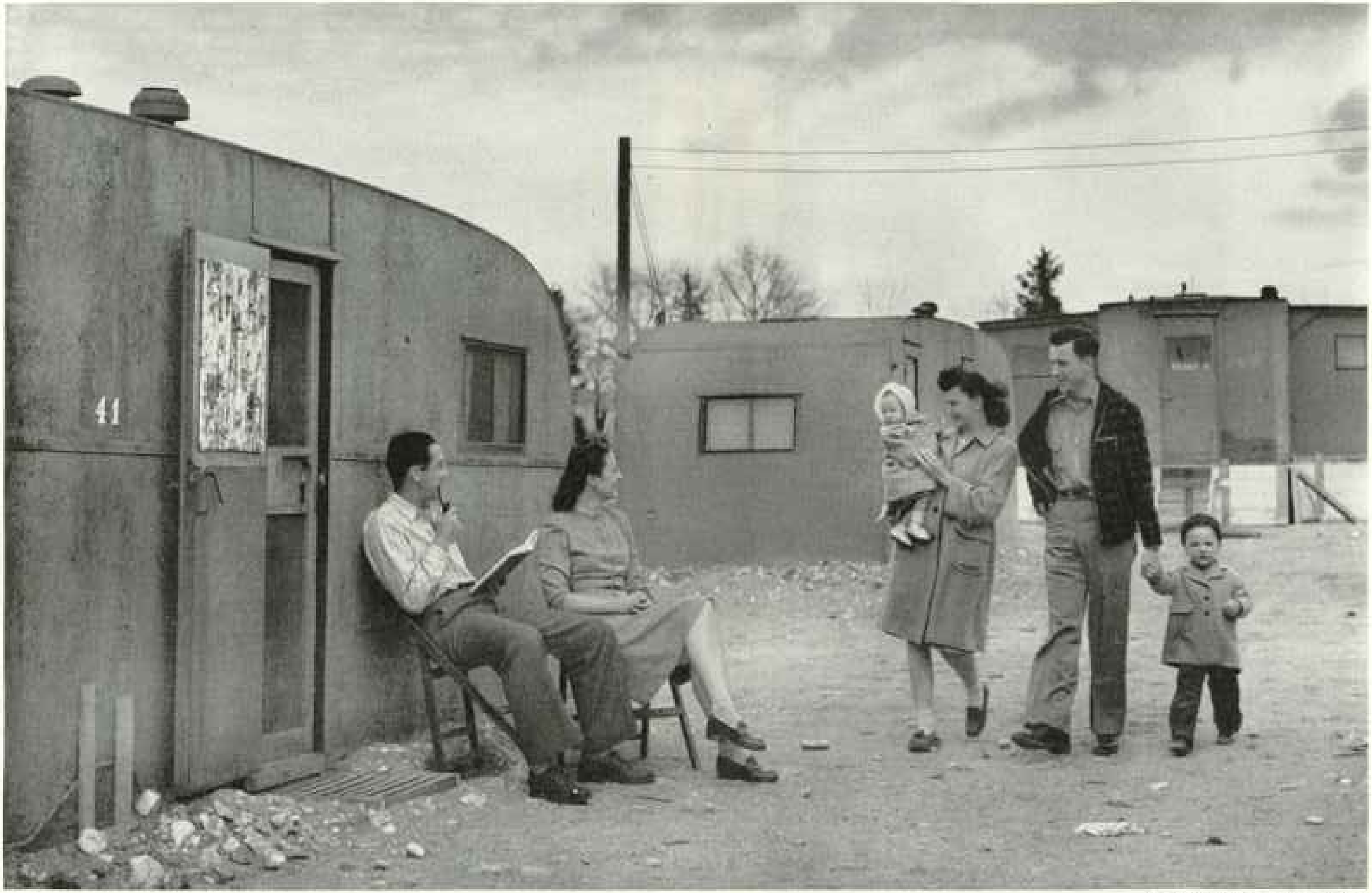
Joan Fontaine Entertains Passengers on a Transatlantic Flight

Pan American Airways introduced movies on some cross-Atlantic trips with such success that all its planes in this service soon will be equipped with screens and projectors. When Pan American's new Boeing Stratocruiser comes into service, it will be equipped with a cocktail lounge.

Staff Photographer J. Baylor Roberts

Cookstove Aroma Interrupts an AAF Graduate's University Lessons

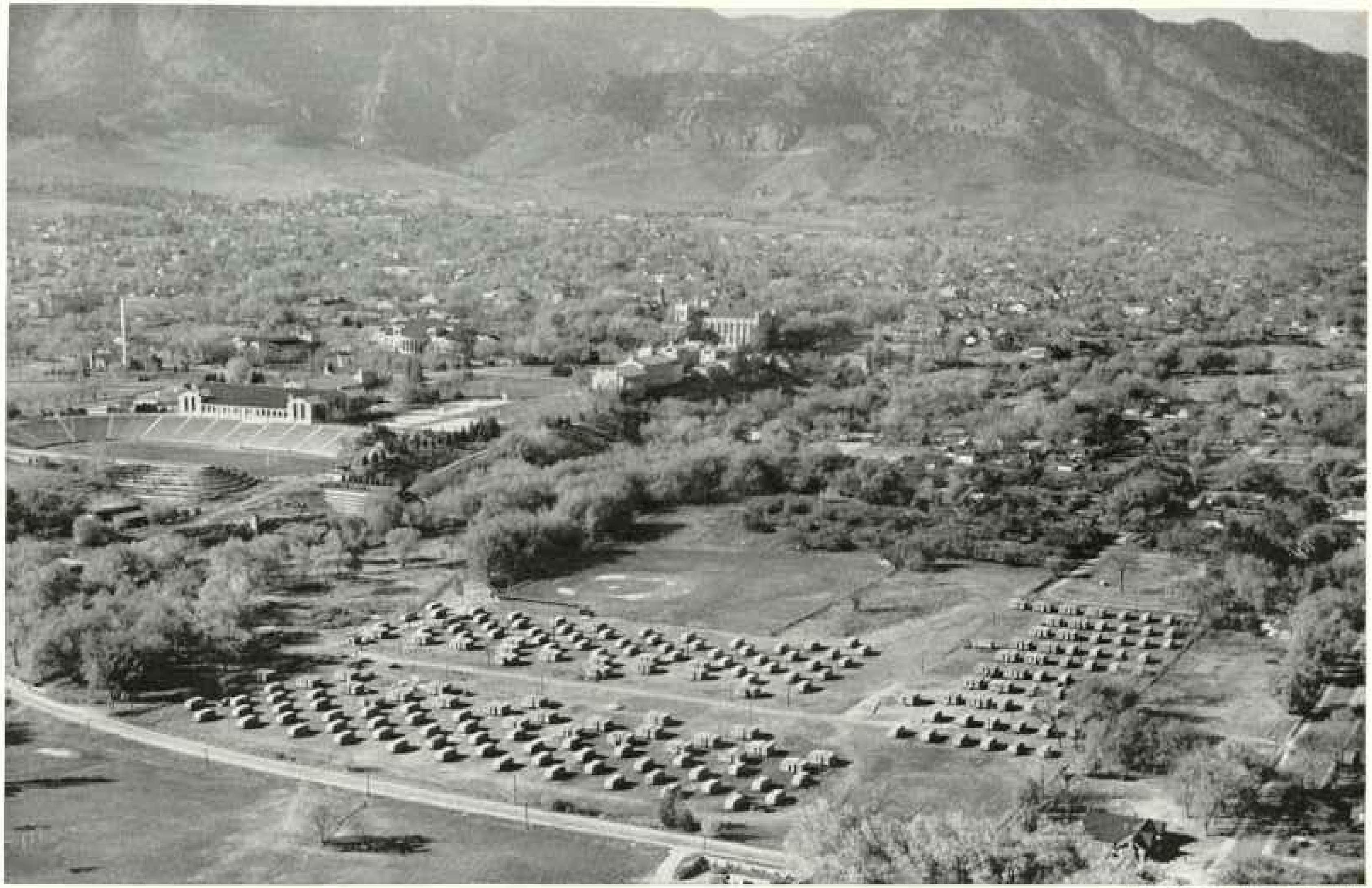
Such trailer-settlement couples at Laramie, Wyoming, play cards, go to the movies, lead normal lives with one big exception. "There's no place for company to sit except on the bed," wives complain.



Staff Photographer J. Baylor Roberts

War Veterans at University of Wyoming's Trailer Camp, Laramie, Study Textbooks, Raise Families, and Solve the Housing Shortage

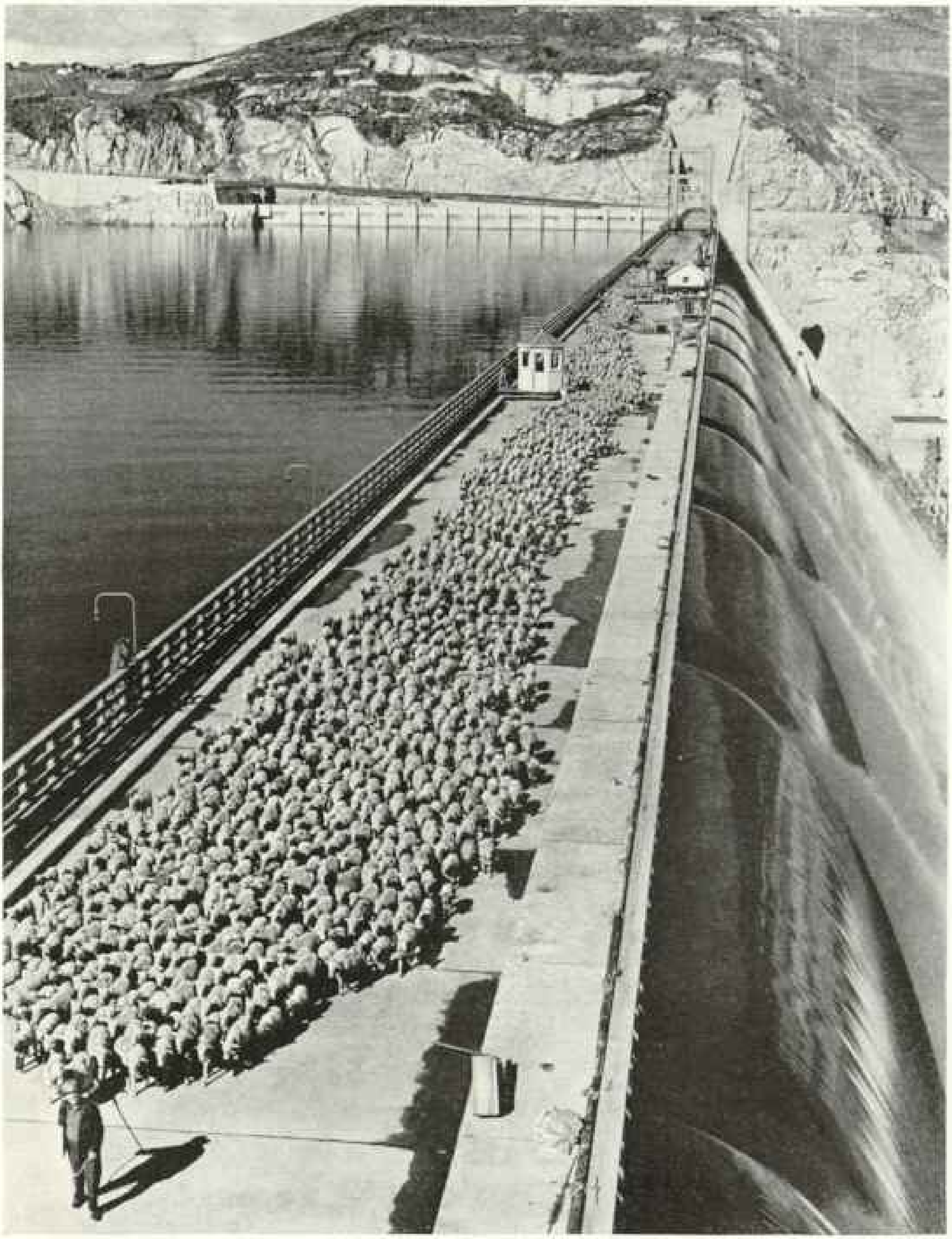
More than a million veterans, some married, have applied for education under the GI Bill of Rights. "Where shall we sleep?" they ask. To help them, several colleges have set up trailer camps. Yale maintains Quonset huts. A California college bunked 700 boys in a gymnasium.



Floyd Walters, University of Colorado

University of Colorado's Trailer Village at Boulder Reflects the Population Strain on American College Towns

College trailer camps have electricity and running water; community centers offer bath and laundry facilities. Some camps have "mayors." Young married folk, oblivious of hardships, live happily on trailer vacations. Wives love to decorate their shacks; husbands cherish their independence.



U. S. Bureau of Reclamation

Sheep on the Move Cross Grand Coulee Dam en Route to Summer Grazing Grounds

Here, at the end of the dam's 151-mile-long reservoir, they trek over Washington's Columbia River on a highway 30 feet wide and 550 feet high. This monster source of water for irrigation and power is 4,173 feet long. Eventually Grand Coulee is expected to reclaim one million arid acres for cultivation. The dam halts the full flood of the Columbia and regulates its flow for 600 miles to the Pacific Ocean. At the peak of construction in 1940, about 6,500 men were employed in its erection.

Staff Photographer Harrison Howell Walker

Keuka, One of the Finger Lakes, Helps Draw Vacationists to Upstate New York

From its main inlet, the lake branches into a Y, flowing on either side of a dividing bluff. Swimmers, boatmen, and fishermen like Keuka's water; its shores are celebrated for their vineyards. From its ice in the winter of 1908 rose the *Red Wing*, one of the early flying machines. Glenn H. Curtiss built it in his Hammondsport, New York, shop. Dr. Alexander Graham Bell was one of Curtiss's associates in this historic pioneering in aviation.

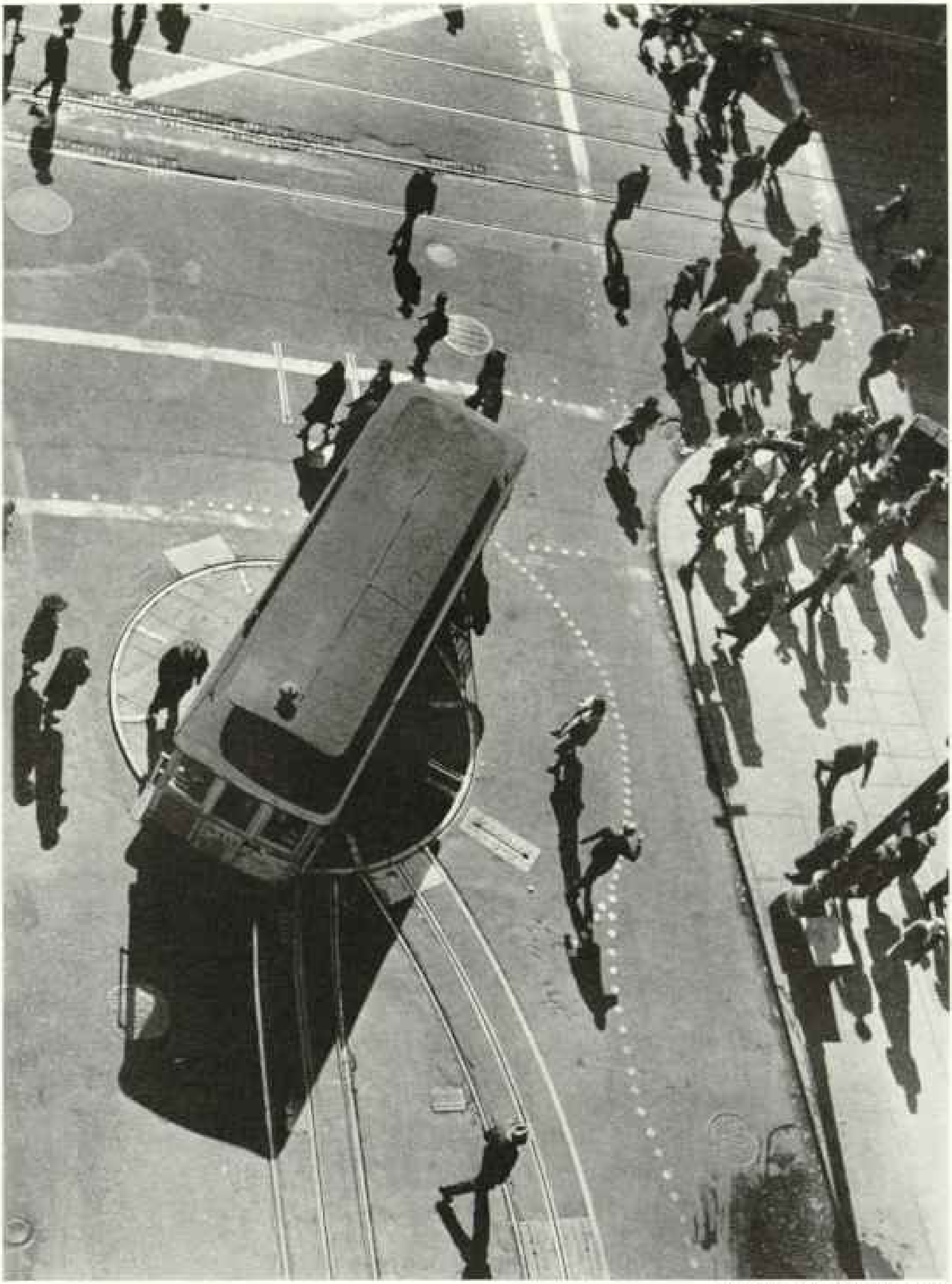
Carl Mansfield

Bracing Early-morning Showers in Cross Creek Dam, Ohio, Make Teeth Chatter

The Spacious Lobby of Washington National Airport's Terminal Building Now Serves

Staff Photographer Edwin L. Wisherd

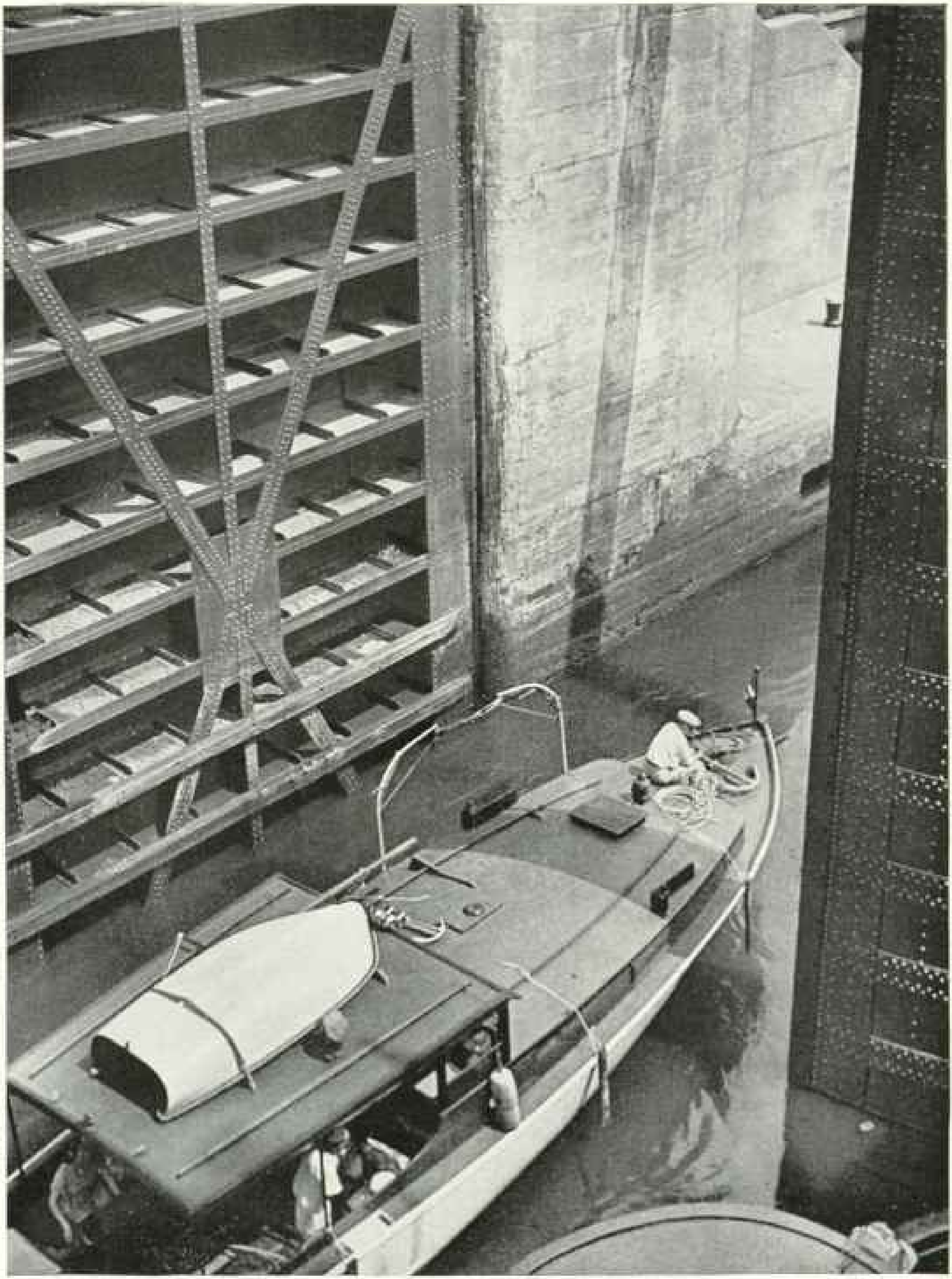
Every Month More Than 110,000 Passengers, Who Are Carried in Nearly 17,000 Planes



Staff Photographer J. Baylor Roberts

Modern San Francisco's Beloved Antique, the Cable Car, Spins on Its Turntable

At the end of the line on steep Powell Street, near Market, it swings around for another climb. In 1873 these cars were the city's answer to hills too steep for horses. Their ascent never fails to interest Golden Gate visitors. A slot between the rails holds the moving cable.



Joseph E. Kubit, Jr.

Yachtsmen Find Placid Cruising on the Empire State's Barge Canal

This cabin cruiser passes through a lock where the Erie and Champlain divisions of the Canal join at Waterford, New York. Here power barges and pleasure craft pass along waterways linking the Great Lakes with the sea via the Hudson River. West of the Hudson, the Canal in general follows the old Erie route.

W. Neal Hale

Chicagoans Enjoy High Winds and Soaring Kites on Outings to Sand Dunes of the Michigan Shore

Jesse T. Carpenter

To a Deep South Farm Urchin, There's No Place Like Home

His world is where his short legs can carry him between meals. Some Sunday afternoon the two incipient fryers will go where the watermelon is going.

Joe Clark from Three Lions

This Tennessee Hill Boy's Traveling Days Will Come Later

Now, with food shortages world-wide, he is better off at home. Most ration tickets went unused among hill folk, for they grew nearly all their own food.

Ray Atkeson

Oregon Indians Take Salmon from Celilo Falls Even as Their Forefathers Did Before the White Man Arrived

Their homeland is a mecca for summer tourists who delight in the scenic glories of the Columbia River Highway. Here, in 1805, Lewis and Clark noted stacks of salmon "neetly preserved." Protected by treaty, the Indians hold perpetual rights to their fishing stands.

Joe Clark from Three Lions

Baptizing Day—a Tennessee Pastor Leads His Converts, Hand in Hand, into a Creek for Total Immersion

Ancestors of these hill folk were among the first Americans "on the move." They were pioneers who stayed in the Tennessee hills when their wagons broke down in Cumberland Gap during the westward migrations of early days. Their English, which contains some Elizabethan forms, reflects generations of isolation.

AP from Press Assn.

"Here We Are in New York!" British War Brides of American Servicemen "Just Can't Believe It"

War's Anglo-American love story began with some 60,000 marriages. Last winter a dozen bride ships began to write a happy ending. One Army transport carried 18,000 disposable diapers. Wacs served baby food and helped blow noses. In New York, wives sang "The Star-Spangled Banner" and fell into their husbands' arms.

Staff Photographer B. Anthony Stewart

College Girls Try Life "Back on the Farm"

Not far from their Northampton campus they help a Massachusetts farmer gather crops. During the war thousands of coeds found time to do their bit in increasing America's food supply by working part time in the fields.

Staff Photographer J. Baylor Roberts

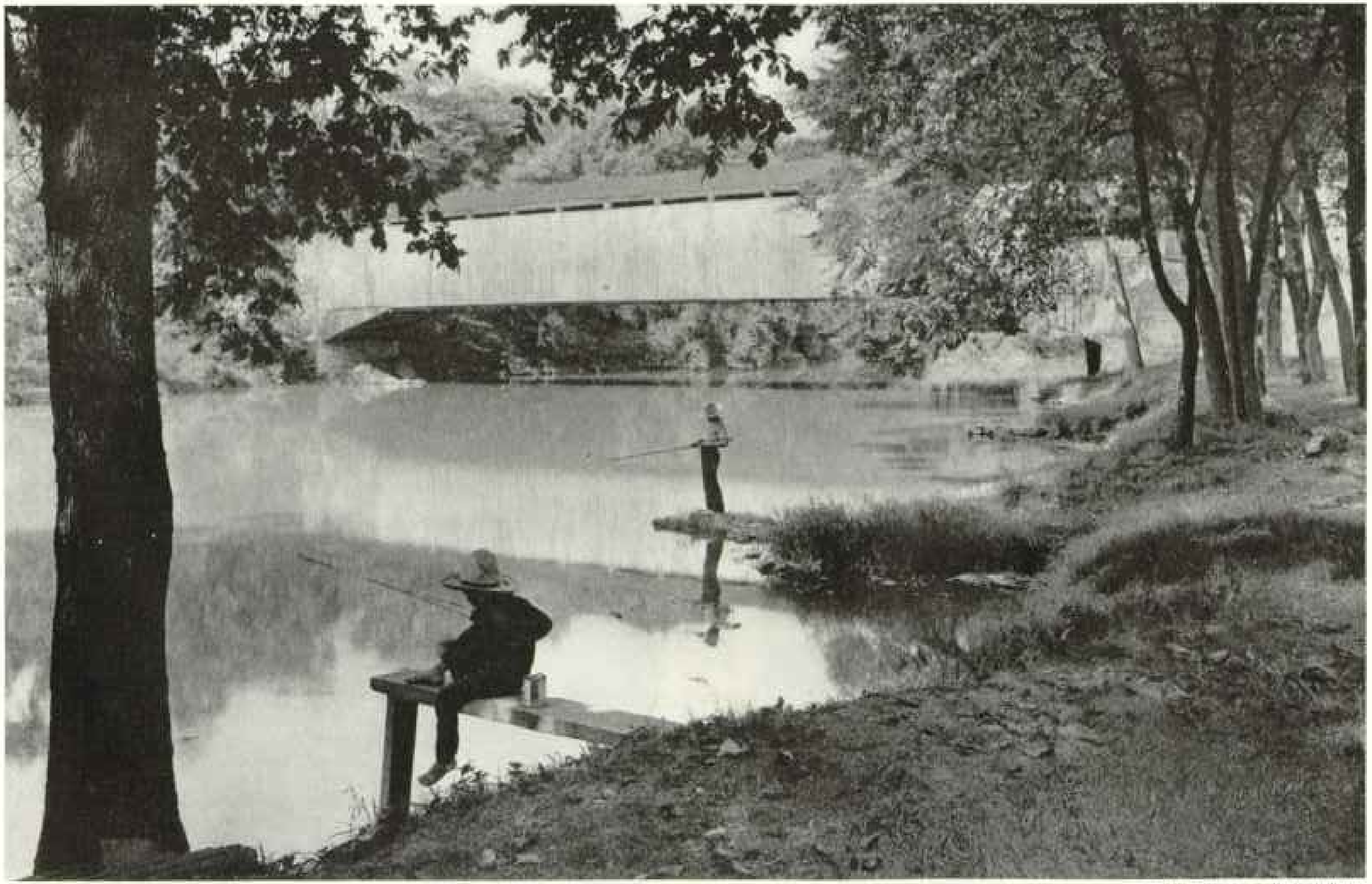
White Man's Papoose Doesn't Like the Ride

Seen in Los Angeles, this family was bound for New Jersey, for the lieutenant's Army discharge. Returned soldiers and sailors, their wives and sweethearts, make up much of "America on the move."

Fish and Wildlife Service, U. S. Dept. of Interior

Flushed from a California Refuge, Pintails Blot the Sky. Ducks Still Sitting Cover the Water

Pintails descend with meteor swiftness, roaring like a gale in the trees. A plane chased one flock at 65 miles an hour. Some fly over 2,000 miles of ocean from Alaska to Hawaii; a few go beyond. California ducks seem to realize when the hunting season opens; many move to Mexico immediately.



Staff Photographer J. Baylor Roberts

Venturesome Youth Seeks New Horizons; Many Older Americans Return to the Scenes of Their Childhood

In vacation time they crave surroundings like this combination of barefoot boy, fishing creek, and covered bridge in Lancaster County, Pennsylvania. Here Conestoga Creek is dammed for a gristmill. Its valley was the home of the Conestoga wagon, six-horse "land frigate" of early American pioneers.

Staff Photographer J. Baylor Roberts

Sons of Migratory Job Hunters Shoot Marbles Anywhere

When the family moves, all they have to do is pick up their marbles and whistle for their dog. Such youngsters love the freedom of their life, leaving problems of schooling for their elders to solve.

Acme

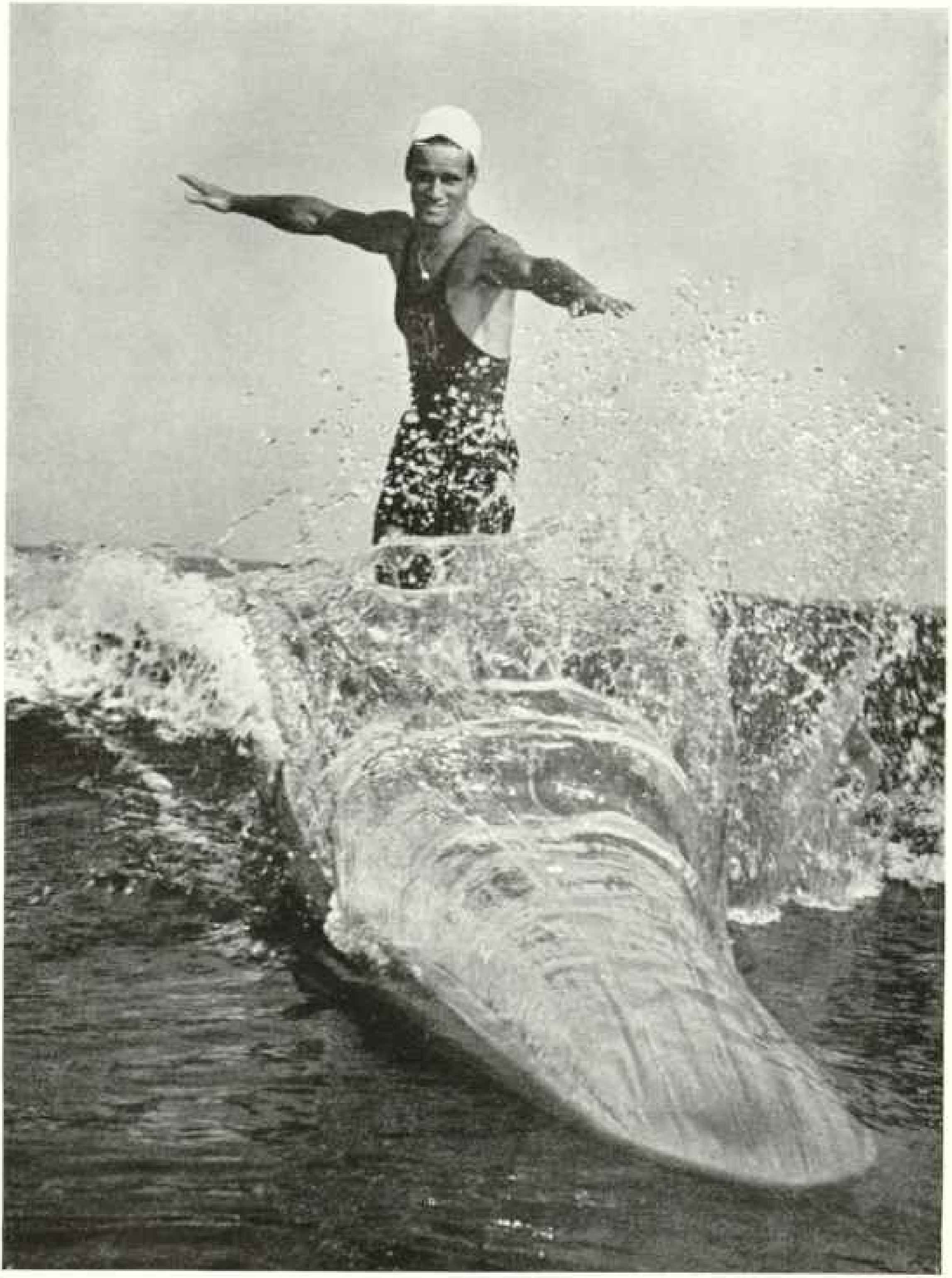
For "Stay-at-homes" in Our Nation's Capital, the Circus Brings Far-off Wonders

Foreign acts are back. Nine herds of elephants trumpet; 400 animals pace their cages. Here Emmett Kelly, sad-faced clown, brings diversion to General Marshall and delight to the war leader's small grandson.

Staff Photographer R. Anthony Kovalick

Up in the New Hampshire Hills Children of Topsy Perform for Summer Visitors

Here Frank W. Baldwin puts them through their paces at Pittsburg. He found Topsy in June, 1933. She has since become the mother and grandmother of numerous members of his trained herd. Mr. Baldwin's deer have traveled to New York and Chicago to perform for gatherings of sportsmen.



Fritz Pfluger

Surfboard Riding along the Jersey Coast Leads to Thrills and Many Spills

Here, to Atlantic City's seashore, some 16,000,000 people come each year for vacation pleasures. By plane, train, bus, automobile, and yacht they descend on this popular resort from far and near. Atlantic City's year-round population is about 66,000.

New Frontier in the Sky

By F. Barrows Colton

"'IMPOSSIBLE' is now an obsolete word!" So said three scientists to me one day at the great Army Air Forces research center at Wright Field, Ohio.

That is the guiding watchword of the men who today are rapidly opening up the newest, strangest frontier of the earth, high in the vast, cold, blue depths of the sky.

This new frontier lies overhead in the "ocean of air," the atmosphere, which envelops the entire globe as the skin envelops an orange. It extends from the surface up to a height of perhaps 600 miles, to the very top of the atmosphere, where the last few scattered molecules of air merge into the vacuum of outer space.

Most of us, up to now, when we thought about geography, thought only of the land and sea and did not include the atmosphere. But today the Age of Flight has given geography a new third dimension—upward.

You've heard a lot about aviation, but probably not so much about the ocean of air in which it operates. This ocean of air, this new world aloft, is fast becoming as important as the ocean of water. Things are happening in it that will affect your destiny and mine as much, perhaps, as anything down here below on terra firma.

Heroes of Sky Exploration

Until recently nobody knew much about the ocean of air except for the first few miles above the earth, where weather and storms originate and circulate.* It was only a little over ten years ago that daring explorers began to penetrate higher and Captains Albert W. Stevens and Orvil A. Anderson (now respectively Lieutenant Colonel, retired, and Major General) made their historic stratosphere flight in the National Geographic Society-U. S. Army Air Corps balloon *Explorer II*, reaching a record altitude of 13.71 miles.†

Today, with rocket-driven missiles such as the V-2 bomb climbing five times that high (pages 384-86); with radar signals being sent to the moon at frequent intervals (page 382); with world-wide wind belts being charted for the use of airline routes as carefully as ocean currents are for ships; with jet-propelled airplanes crossing North America in four-and-a-quarter hours, and 1,000-mile-per-hour planes predicted, the ocean of air has acquired a new and urgent importance (page 396).

We're finding strange things in this new world overhead. To penetrate it, to learn to live, work, travel, and fight in its upper depths, man has to overcome barriers and difficulties unlike anything ever encountered by earth-bound explorers.

Queer behavior of the air around an airplane when it nears the speed of sound is one mystery of the ocean of air. When Maj. Fred Borsodi of the Army Air Forces put a new fighter plane into a high-speed test dive from 40,000 feet, he was startled to see a strange ripple moving steadily across one wing.

When he reported the occurrence to his commanding officer, the latter only smiled and said, "Fred, those dives are pretty strenuous. Better take a little leave." But, later, motion pictures of these mysterious ripples were obtained (page 405).

Those pictures were the first visible evidence on an airplane of the strange phenomenon of "compressibility," a very real barrier in the sky. As intangible as a gust of wind but as "solid" in its way as a stone wall, it has prevented airplanes from flying faster than the speed of sound.

When Airplanes Vie with Speed of Sound

It so happens that when an airplane reaches the speed of sound, 661 miles per hour in the —67° F. cold at 40,000-feet altitude, particles of air cannot get out of its way fast enough to flow smoothly over the wings and provide "lift" in the usual manner.

Instead, they form "shock waves" that batter at the airplane structure, spoil its lift so that it may fall out of control, and even may tear off parts of the plane. Those shock waves were what Major Borsodi saw and photographed on his airplane wing.

High over the Japanese islands, at 30,000 feet, our B-29s ran into terrific head winds blowing 300 miles an hour, stronger than any winds ever encountered before by our bombers. These winds caused some of the B-29s to fly backwards at times, since they blew faster than the B-29s' own forward speeds.

In the cold, rarefied air at 63,000 feet a man's blood literally would boil because of the reduced atmospheric pressure if he flew to that height without protection.

At 40,000 feet a breath of fresh air is any-

* See "Weather Fights and Works for Man," by F. Barrows Colton, National Geographic Magazine, December, 1943.

† See "Man's Farthest Aloft," by Capt. Albert W. Stevens, National Geographic Magazine, January, 1936, and "Ballooning in the Stratosphere," by Auguste Piccard, March, 1933.

thing but healthful, for it contains too little oxygen to sustain normal life. Lack of oxygen at high altitude may impair a pilot's judgment and intelligence, spoil his coordination, drain away his strength. Worse still, like a drunken man, he does not realize his condition and believes he is as good as ever (page 406).

On a bombing raid over Germany one pilot's oxygen mask became disconnected. Almost instantly his brain began to play tricks. He told the crew over the "intercom" phone that he was coming down, lowered his wheels and tried to land on a cloud bank at 18,000 feet. Then he announced that the airplane was below ground level and he was going to get out! Fortunately the navigator reconnected his oxygen supply before more damage was done.

In this queer, topsy-turvy world aloft, the turbine wheels in the new jet-propelled airplane engines run *red-hot* all the time! Sound does not carry well in the rarefied air, making pilots' voices so weak that they cannot be heard distinctly over the radio above 20,000 feet without special amplification.

But exploration of the new world of the air is being pushed despite all hazards and obstacles. Air commerce is spreading over new routes all around the globe.*

Airlines now are operating primarily in the ocean of air, independent of the land or sea except for radio and the times when planes come down to take on passengers or cargo.

New problems arise in this age of flight.

Cities Must Clean Up Air, Too

Air travel, for example, has emphasized a new reason for doing away with the smoke palls that hang over some industrial cities. Smoke may reduce visibility near some cities, just as some harbors are hidden by fogs, so that an airplane may have to land "on instruments" at an airport, even though visibility is perfect over the surrounding country.

Also, just as hidden reefs and treacherous rip tides have been charted in the oceans, today a special airplane carrying Army and civilian technicians has been scouring the world for areas of bad thunderstorms and the radio static that goes with them.

Deliberately seeking the "world's worst weather," this plane has been surveying regions over the Caribbean, Brazil, North Africa, India, Japan, and some Pacific islands to locate regions of static, the frying, crackling, shrieking noises that often interfere with radio when it is most needed.

In war, the ocean of air is now fully as important as the land or sea. It's hardly too much to say that World War II was won there. Much of the Battle of Britain, often called the turning point of that war, was fought so far above the earth that all participants had to breathe artificially with oxygen masks. If future wars come, they are sure to be largely fought in the ocean of air.†

"High-altitude flight, new methods of weather forecasting, new aerial weapons of war, and other branches of science have progressed so far that we now are studying the 'ocean of air' as a whole, not just the lower part that is immediately around us," Dr. F. W. Reichelderfer, Chief of the U. S. Weather Bureau, told me.

Make-up of the Ocean of Air

Take a look now at what that ocean of air is like (opposite page). There's a lot more to it than white clouds, blue sky, and vacant space. We live at the bottom of that ocean, like fish at the bottom of the sea. This lower region is called the troposphere, the "region of change." Over the Equator it extends up to ten miles, over middle latitudes to about eight, over the poles only from four to six.

The troposphere is the region of air movements, where masses of cold, dry air interact with warm, moist air masses and breed storms and weather. Air in the troposphere, generally speaking, grows steadily colder as one goes higher. It also becomes increasingly thinner, so that around 21,000 feet or so a candle would not burn for lack of oxygen.

As an airplane climbs, its gasoline begins to boil away. Our B-29s, climbing to heights of 35,000 feet, lost as much as 850 gallons of gasoline apiece that way. The gas just boiled off like water on a stove, an unavoidable waste.

Above 30,000 feet the sky begins to look purple, because the thinner air aloft does not scatter sunlight as much as does the denser air lower down where this scattering of light makes the sky look blue.

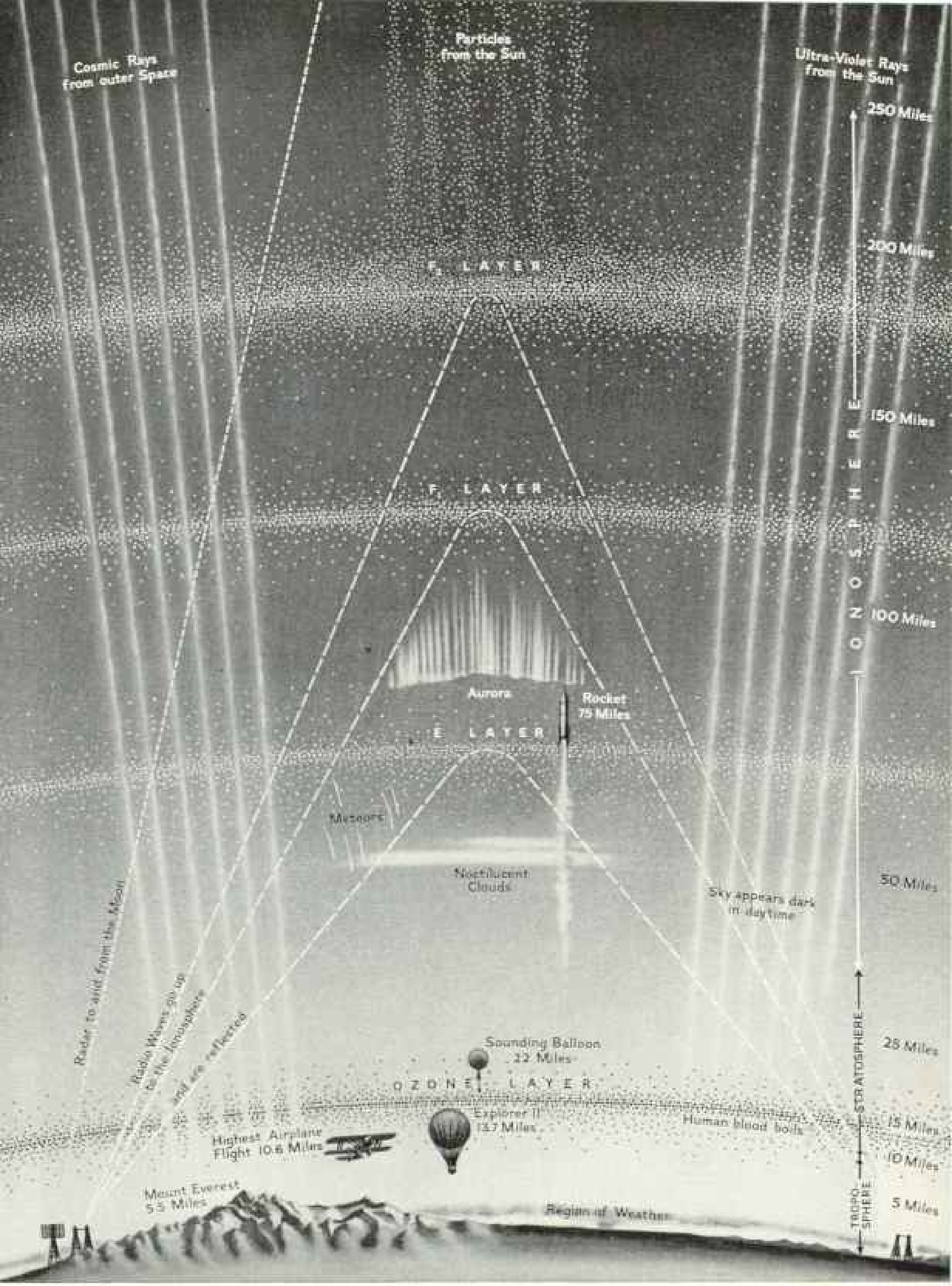
Next above the troposphere is the stratosphere, where the air is clear, free of dust, clouds, and rain. There is no "weather."

About 95 percent of the atmosphere by weight lies below the level of 13.71 miles reached by the balloon *Explorer II*, but the remaining five percent is spread out thinly upward for several hundred miles more.

Centering at about 80,000 feet, around 15 miles, is a tenuous belt of ozone, a lifesaver for all of us, for it protects us against deadly ultraviolet rays coming from the sun. Unlike the beneficial ultraviolet rays of different wave length that fall on you during a sun bath,

* See "Your New World of Tomorrow," by F. Barrows Colton, NATIONAL GEOGRAPHIC MAGAZINE, October, 1945.

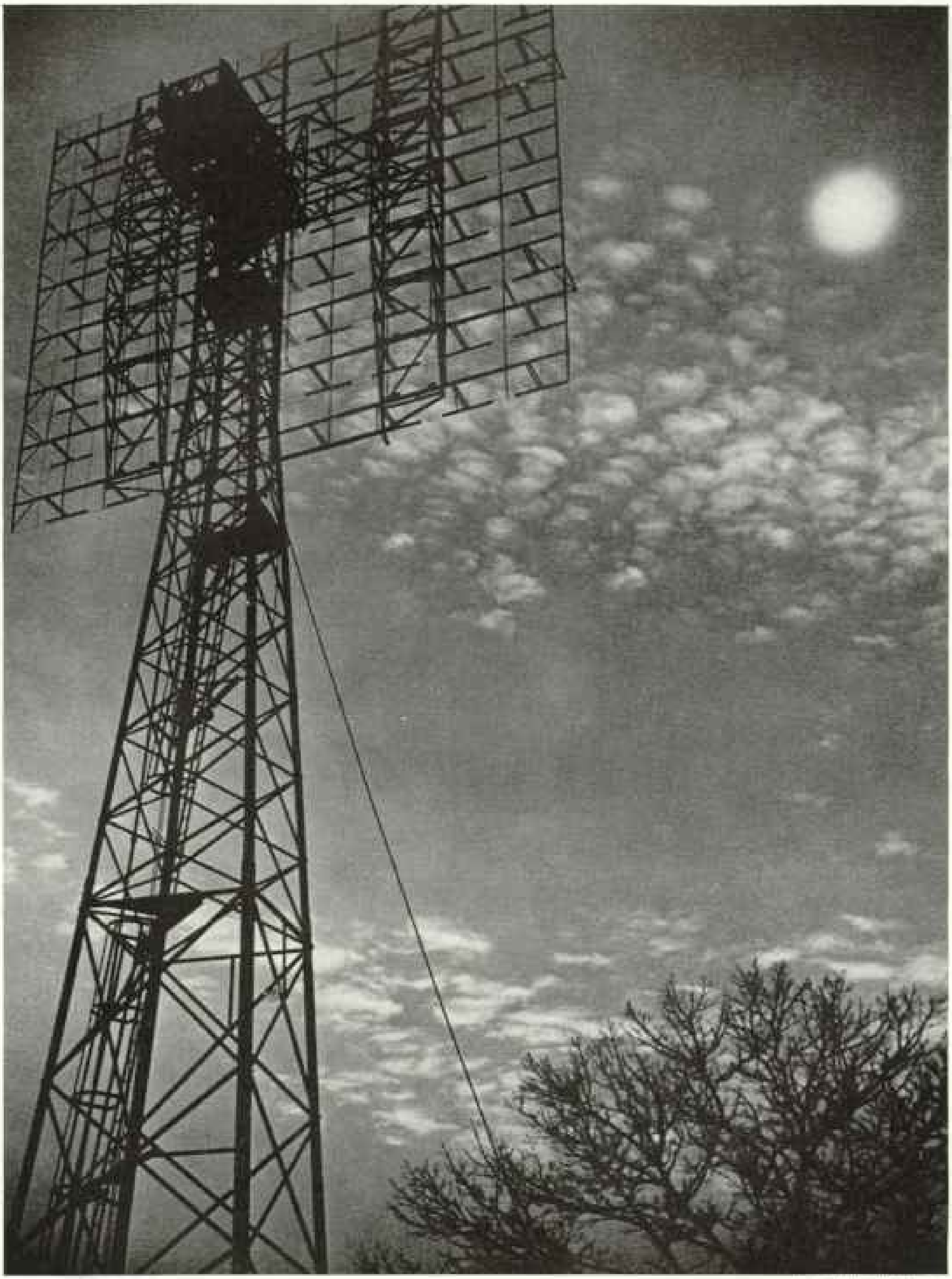
† See "Air Power for Peace," by Gen. H. H. Arnold, NATIONAL GEOGRAPHIC MAGAZINE, February, 1946.



Drawn by Irvin E. Alloman

Diagram of Atmosphere to 300-mile Height Shows New World Aloft Now Being Explored

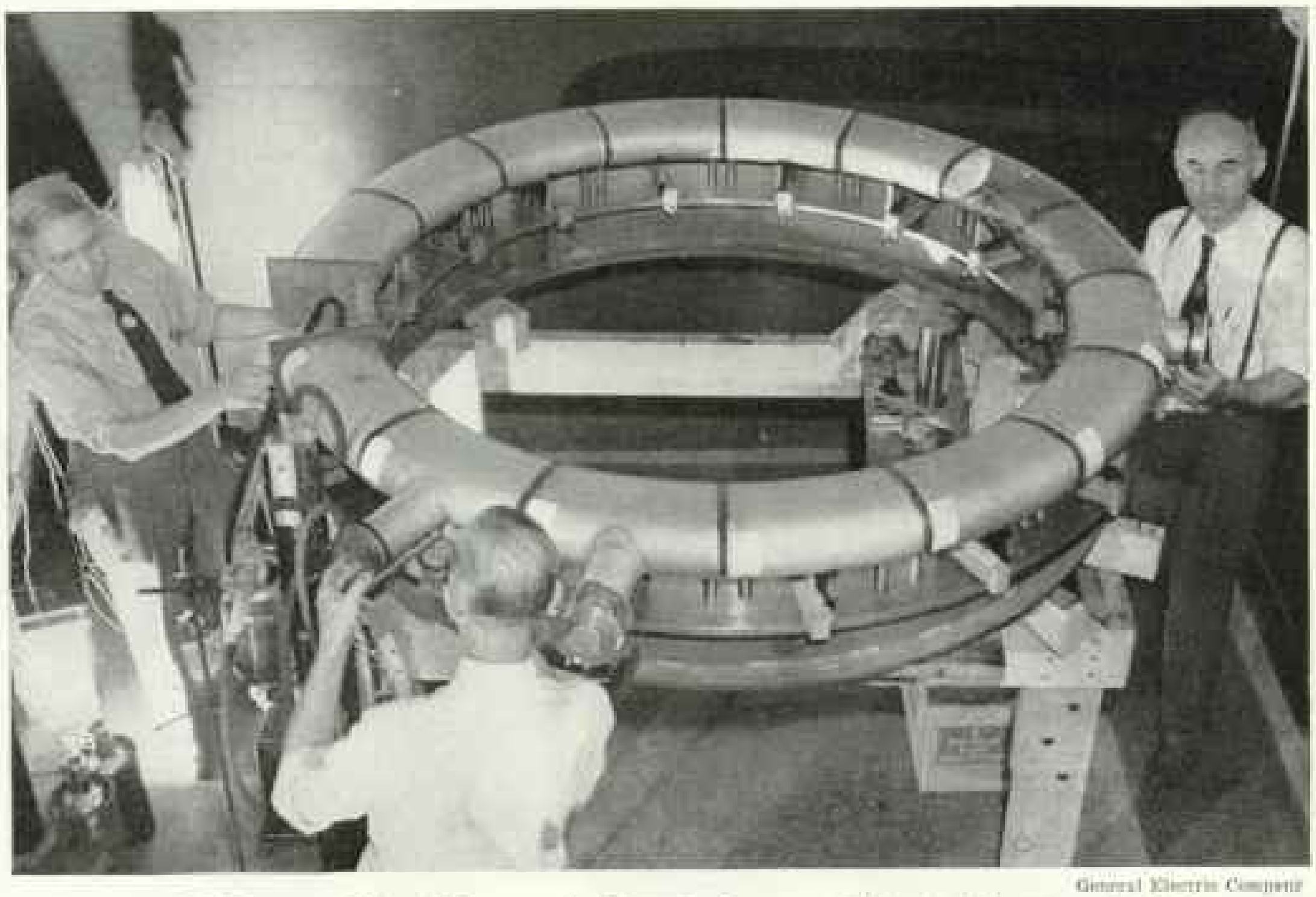
Cosmic rays penetrate to earth's surface. Ultraviolet rays from sun mostly reach only to ozone layer (below). On way down they create reflecting layers of ionosphere (E, F_1, F_2) which bend long-distance radio beams back toward earth. Particles from sun produce aurora and disturb ionosphere. Aurora is seen from 50 to 600 miles aloft, but most often at altitudes shown here. Heights in miles are on a scale decreasing upward.



U. S. Army Signal Corps

Radar Beam Bouncing Off the Moon Was Man's First Direct Contact with Other Worlds

It was the first known time that any man-made signals have actually reached out to touch a heavenly body. The radar beam, consisting of ultrashort radio waves, flashed approximately 238,857 miles from this tower to the moon and back in 2.4 seconds on January 10, 1946. Previous contacts were by telescope or spectroscope.



General Electric Company

"Betatron" Creates First Man-made Cosmic Rays as Clue to Secrets of Universe

Inside this big glass "doughnut" vacuum tube General Electric scientists whirl electrons around like a stone in a sling to generate a 100-million-volt X-ray beam, most powerful ever created. This beam has been used to produce particles which appear to be mesons, one type of secondary cosmic ray formed naturally high in the earth's atmosphere when the primary cosmic rays from outer space strike atoms of air (page 387). Making mesons in the laboratory may help solve the mystery of the origin of cosmic rays.

these rays probably would destroy all life on earth were they not absorbed by that ozone.

It's cold in the stratosphere, but it does not grow much colder as one goes higher. Stratosphere temperatures do vary from north to south, however, and, strangely enough, the coldest part of it, as low as —112° F., is over the Equator. From a height of 25 to 35 miles the temperature rises again, perhaps as high as 170° F., hotter than it ever gets down on earth in the hottest deserts. Absorption by the air and ozone layer of ultraviolet and infrared rays from the sun and infrared rays radiated back up from the earth is believed to be the cause.

Thin Air Transmits No Sound

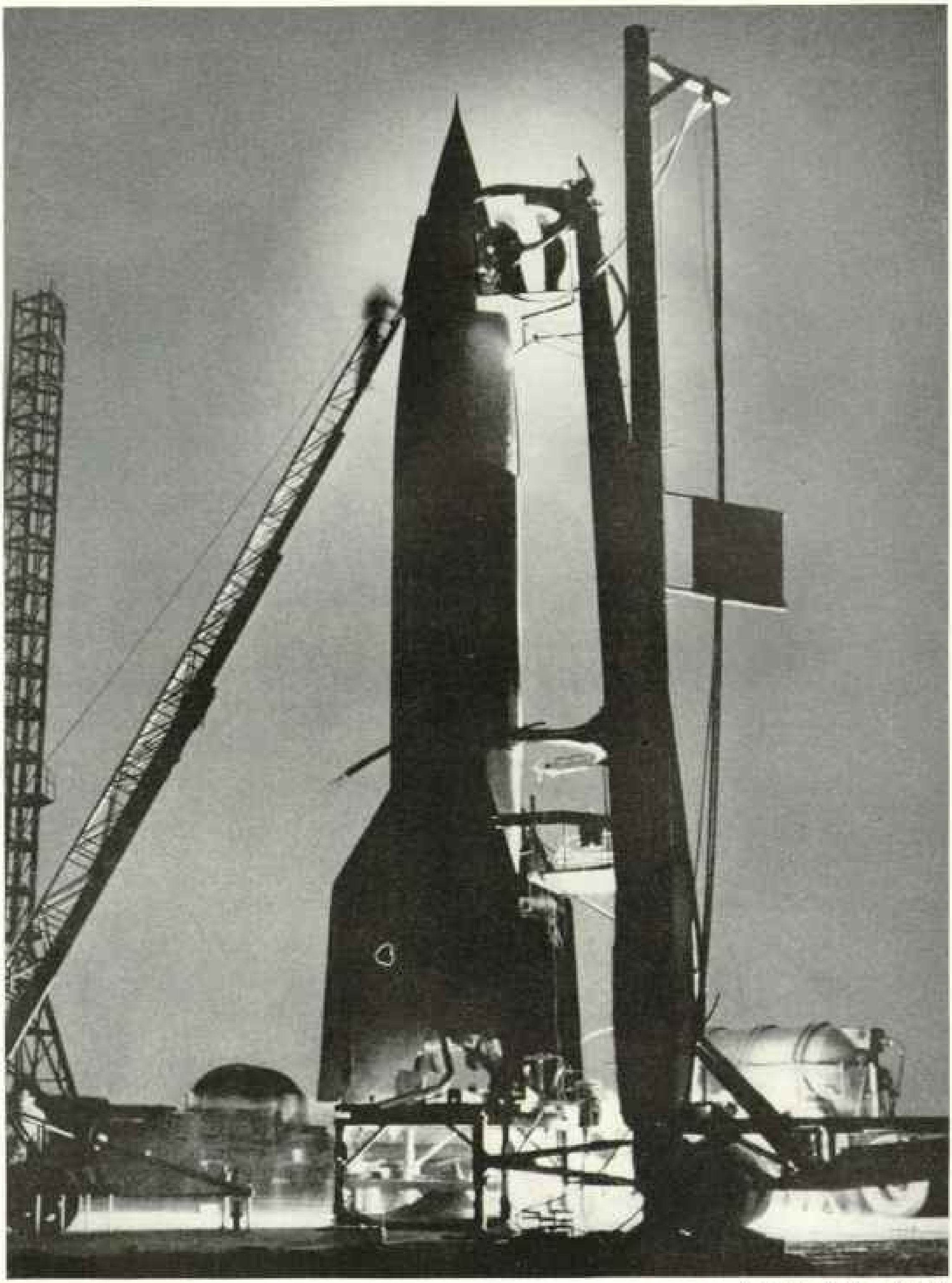
Around 45 miles above the earth almost complete quiet prevails, for the molecules of the air are so far apart that sound waves are not readily transmitted.

From 40 to 60 miles above the earth the stratosphere merges into the ionosphere, the "radio mirror," without which long-distance radio could not operate. The ionosphere is so called because in it the atoms of air are "ionized"—*i.e.*, have some of their electrons stripped off—by ultraviolet rays and charged particles coming from the sun. There may be half a million ions, or mutilated atoms, in a space the size of a marble, though the air at that altitude is as rarefied as that inside a good radio vacuum tube.

Short radio waves used in long-distance communication are reflected by these ions as a mirror reflects light. They shoot up from a sending station, bounce off the ionosphere at an angle, and come back to earth at their destination. Without the ionosphere they would keep on going off into space and be lost.

The ionosphere has three main reflecting layers extending up to a height of as much as 250 miles. The two lower layers disappear at night when the sun has set and its rays no longer disrupt their atoms, but the higher layer stays on through both day and night. It reflects radio better in some seasons and latitudes than others, and reflects radio waves of higher frequency in early afternoon than at other times of day.

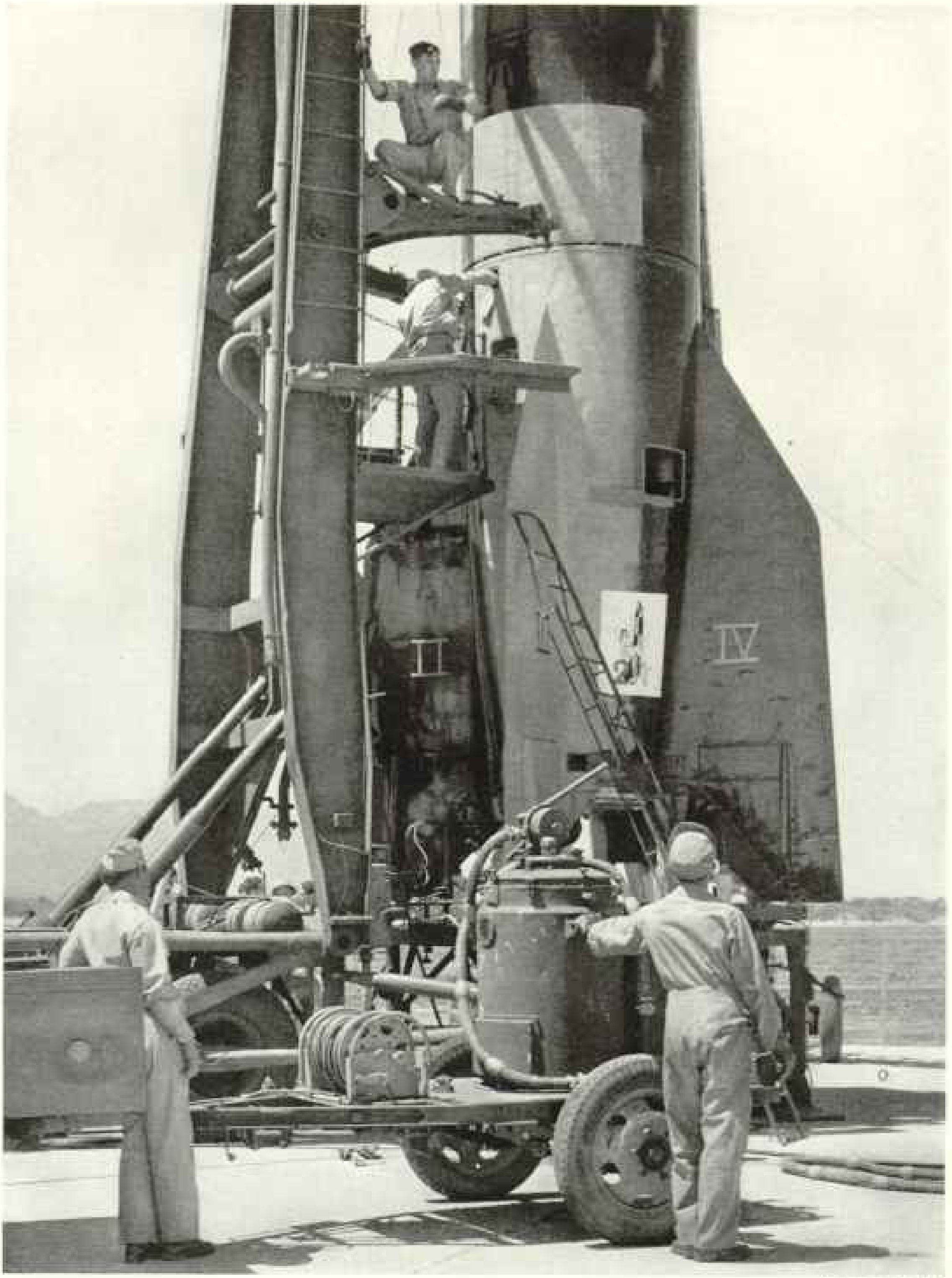
Already man-made rockets, the V-2 weapons such as the Germans used, have climbed up into the lower reaches of the ionosphere, up higher than any balloon or aircraft has risen,



U. S. Army Signal Corps, Official

Preparing a V-2 Rocket for Launching at Night Is Like a Scene from Jules Verne

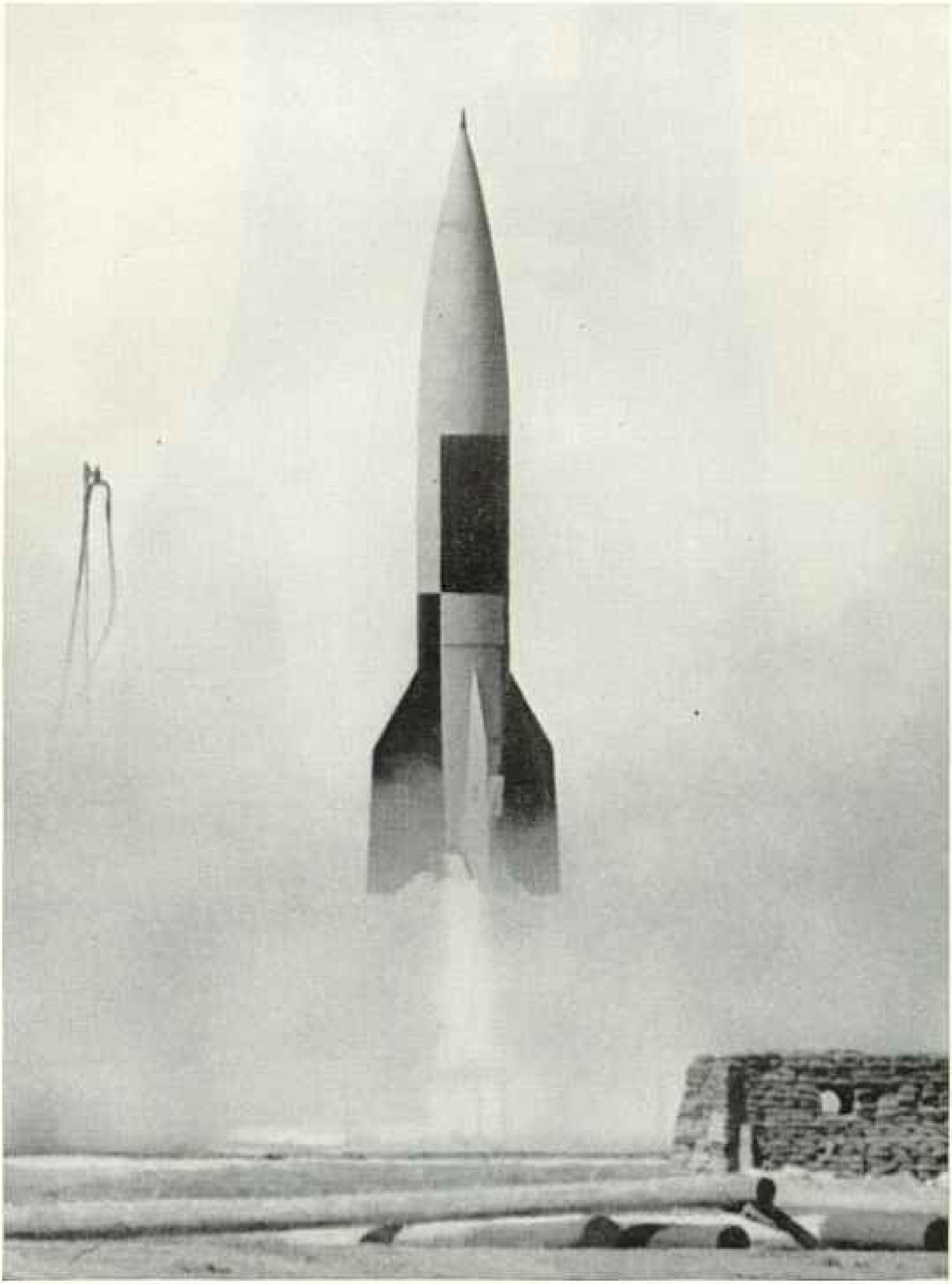
Framework at right raises the rocket to its take-off position. Electric cables hanging from the telegraph pole start the gyro guiding mechanism. The rocket travels a predetermined course on which it is guided by gyro control. Fuel can be shut off during flight by radioing a signal to a robot "brain" built into the rocket.



U. S. Army, Official

Huge Stabilizing Fins on a V-2 Rocket's Tail Hold It on a Predetermined Course

Hydrogen peroxide, which generates steam to operate the fuel pumps of the rocket, is being pumped from the truck in the foreground into the V-2. One fuel tank carries 1,400 gallons of oxygen; the other 1,400 gallons of alcohol. Framework at left raises the rocket to its vertical launching position.



Acme

Spouting Flame, the V-2 Rocket Begins Its Climb Beyond the Stratosphere

Weighing 14 tons, of which nine tons are fuel, the 46-foot rocket starts slowly but reaches a top speed of 3,500 miles per hour. In a climb to 75 miles, the fuel is exhausted after 20 miles and the rocket "coasts upward" another 55 miles by momentum before starting its fall back toward the earth.

beyond the ozone layer, up to the regions where meteors are met with and where the glow of the aurora borealis begins.

From the upper reaches of the ionosphere the ocean of air extends on upward, and just where its "surface" lies nobody knows. It is not a sharply defined surface like that of the ocean of water. Instead, the air gradually thins out more and more until the last few molecules probably merge almost imperceptibly with outer space.

Strange "Rains" from Outer Space

Down from this outer space several kinds of strange "rain" fall into the ocean of air. We see its effects from below.

Part of this "rain" consists of meteors, billions of tiny particles mostly no larger than a grain of sand, which are scattered through interplanetary space. Many of them are the last remains of broken-up comets. As the meteors speed down through the upper air, friction of the air heats them so hot that they glow and quickly burn to ash. You've seen them sometimes, flashing across the night sky. Often they're called "shooting stars," though not actually stars at all.*

Many meteors fall as low as 45 miles above earth, down into the ionosphere, before they burn up entirely. An aircraft flying that high would run some risk of being struck, and even a small meteor traveling many times faster than a rifle bullet would do some damage.

Dust from burned-out meteors is believed to form what are called the noctilucent clouds, about 50 miles high, highest and rarest clouds known. Their name, which means "shining by night," comes from the fact that they are so high they shine at night from sunlight that reaches them from the other side of the earth.

Second type of "rain" falling into the ocean of air is made up of showers of charged particles pouring forth from the sun. This "rain" is not continuous but comes in bursts, like squirts from a hose. Magnetic force around the earth diverts these particles so that most of them fall approximately around the regions of the North and South Poles. As they come down into the air, they collide with air atoms and make them glow.

This glow is what is known as the aurora borealis, or "northern lights," and the equally beautiful aurora australis, or "southern lights," seen most often at about 60 to 70 miles above the earth (page 393). The glow of some auroras has been seen at heights calculated at 600 miles, and that is how we know that at least a little air extends that high.†

Third and most mysterious kind of "rain" is the continuous shower of cosmic rays, so named because they seem to originate in the "cosmos," or universe. These rays are electrically charged particles, coming from far beyond the sun, perhaps from the distant stars or even farther away in the universe. They flash all the way down to the earth, penetrating even into deep mines (page 383).

Cosmic rays represent a release of atomic energy far greater than the energy unleashed in the atomic bomb, although so far this power cannot be harnessed, as is done in the bomb.

When cosmic rays are born, perhaps in the interiors of distant stars, the entire nuclei of atoms are destroyed, releasing huge energy. In atom-bomb explosions, the nuclei are only partially disrupted. Cosmic rays flash through your body about 10 to 20 times each second, though you do not feel them. They have no noticeable effect, but there is some reason to believe that they have caused changes in the eggs of fruit flies, giving rise to different types of flies in later generations.

But cosmic rays may possibly play a part in human affairs, now that high-soaring rockets, operated by remote control, are coming into use both as war weapons and for exploring atmospheric conditions far aloft.

Cosmic rays far above the earth may be strong enough to interfere with the flights of such rockets, or "guided missiles," which can travel even beyond the atmosphere into outer space. The rays might alter the metals or chemicals in rockets enough to affect their operation, Army Air Forces officers think.

National Geographic Society Makes Aerial Study of Cosmic Rays

To help answer this and other questions about cosmic rays, a joint expedition of the National Geographic Society, the Army Air Forces, and the Bartol Research Foundation of the Franklin Institute has made a new study of the rays. A B-29 bomber, carrying instruments to measure intensity of cosmic rays, made a series of flights at altitudes of 5,000 to 35,000 feet between northern United States and the magnetic equator. It carried also certain metals and chemicals used in high-altitude rockets, to learn whether cosmic rays affect them (page 388).

These things that happen high in the mysterious upper reaches of the ocean of air may

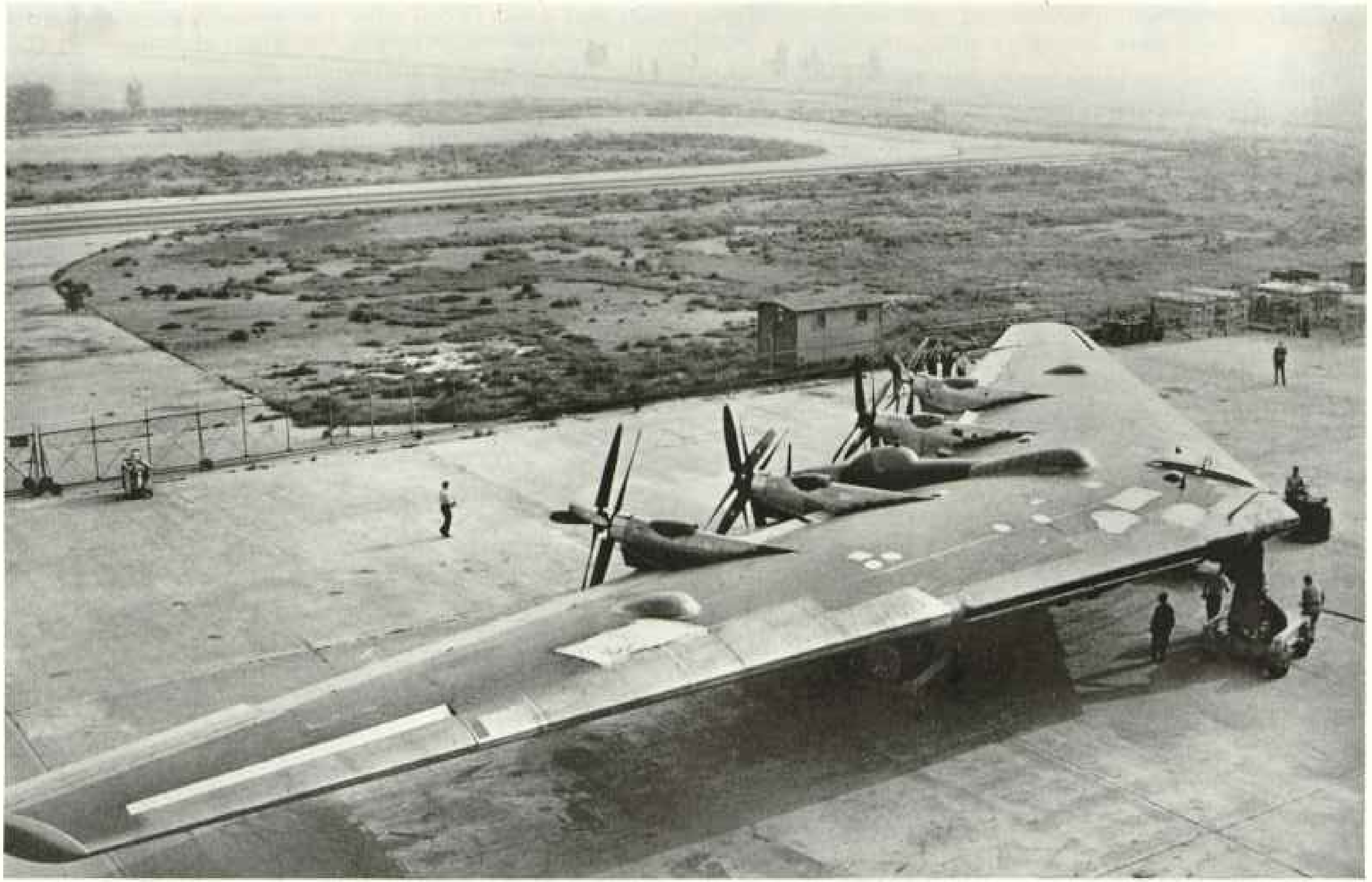
* See "News of the Universe," by F. Barrows Colton, NATIONAL GEOGRAPHIC MAGAZINE, July, 1939.

† Much new knowledge of the aurora borealis has been gained from a study made by Dr. C. W. Gartlein of Cornell University under the joint auspices of the National Geographic Society and Cornell. A report on these findings will be made in an article by Dr. Gartlein in a forthcoming number of the NATIONAL GEOGRAPHIC MAGAZINE.

Staff Photographer J. Baylor Roberts

Seeking New Knowledge of Cosmic Rays, This B-29 Soars Aloft for Research Which Your Society Helps Sponsor

Scientific instruments instead of bombs are carried by the aircraft in the project in which the National Geographic Society, Army Air Forces, and Bartol Research Foundation are cooperating. The plane made new measurements of cosmic-ray intensities at various heights up to 35,000 feet and tests to determine whether the rays may affect high-altitude rockets and guided missiles (page 387).



U. S. Army Air Forces, Official

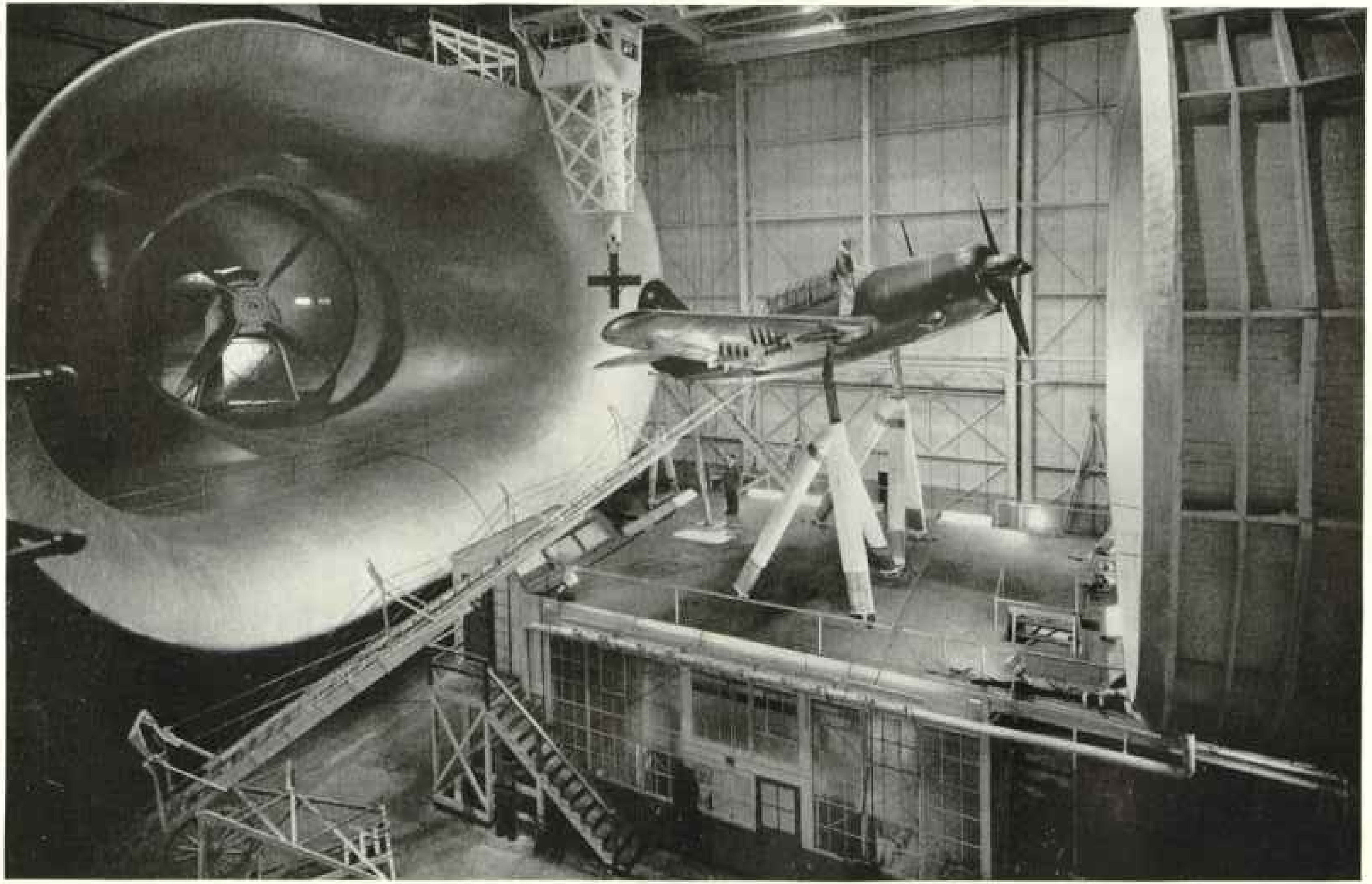
Shaped Like a Boomerang, the Futuristic "Flying Wing" Has No Fuselage or Tail

Army's new flying wing bomber, the Northrop XB-35, has four pusher-type propellers mounted in the rear. Flying-wing design eliminates the drag of the fuselage and gives the airplane greater lift. Crew, engines, fuel, and armament or cargo are carried within the thick wings.

U. S. Navy, Official

Ominous Clouds of a Hurricane, Photographed by a Navy Plane at 6,000 Feet, Typify the Storm's Awful Power

This is the outer edge of the hurricane, a doughnut-shaped storm in which 100-mile winds blow around the circle. Torrential rains are falling from the dark clouds. White clouds below form a circular "shelf" around the storm. Navy and Army planes fly around hurricanes at intervals to report on their speed and direction.



National Advisory Committee for Aeronautics

Man-made Gales of Hurricane Speed Roar Through This Giant Wind Tunnel to Test Behavior of Airplanes

Artificial winds moving up to 120 miles per hour are blown against planes such as this SB2C Curtiss Helldiver while undergoing tests in the tunnel at National Advisory Committee for Aeronautics laboratory, Langley Field, Virginia. The plane is mounted on struts that register its reactions on scales beneath (page 407).

Louis Bukaty

Charting Winds over Russia with Pilot Balloons Aided U. S. Bombing of Germany

A soldier and a girl auxiliary of the Red Army, left and right, with an American soldier, prepare to release a balloon for measuring the speed and direction of winds aloft at a base in the Ukraine. U. S. bombers landed here after flights across Germany from the British Isles and Italy. The Russian holds a stop watch to time readings on the theodolite (mounted on post) through which the flight of the balloon is observed. From these readings are computed the horizontal speed and direction of the balloon as it ascends.

seem remote, but we actually used the ionosphere to help us win the war.

Here's how it was done. Those same bursts of particles from the sun that produce the aurora also spoil the reflecting power of the ionosphere. When this happens, the ionosphere doesn't reflect radio waves any better than a broken or tarnished mirror reflects light. Long-distance radio signals cease to work well.

If you have advance warning of ionosphere trouble, you can alter plans for bombing raids that need good radio reception, for example, or postpone flights of planes that use radio to guide them across the ocean.

It is possible to get such advance warning in two ways. One is by watching the behavior of sunspots, flare-ups in the sun's corona, and disturbances in the earth's magnetism which indicate the approach of bursts of particles from the sun toward the earth. In this way, ionosphere trouble during the next day or two can be predicted.

The other way is to send radio signals up into the ionosphere to measure its density and see which wave lengths are reflected back to earth from it, and which of them go on through, out into space. From this it can be calculated how the ionosphere will behave several weeks or months hence.

To obtain this information, we kept a close watch on the ionosphere during the war from about fifty stations in the United States, Alaska, Canada, Australia, Newfoundland, and other places.

One station was at a Hudson's Bay Company post on Baffin Island where only one ship a year called with supplies. When the cook got appendicitis, a doctor was dropped by parachute from an airplane. Another sta-

Theodore Taddis

Glow of Aurora in the Sky Helps Measure Extent of Air above the Earth

Displays of the aurora borealis, or "northern lights," are caused by showers of charged particles from the sun which strike atoms and molecules of air high in the atmosphere and make them glow (page 387). Height of one aurora was calculated as 600 miles, showing that some air extends that high, since the aurora would not be visible if no air were present. Around the Antarctic regions there is aurora australis, or "southern lights," a counterpart of the northern aurora.

tion was in Spitsbergen, which changed hands between the British and the Germans several times during the war. Each time new equipment had to be set up there, replacing what the enemy destroyed.

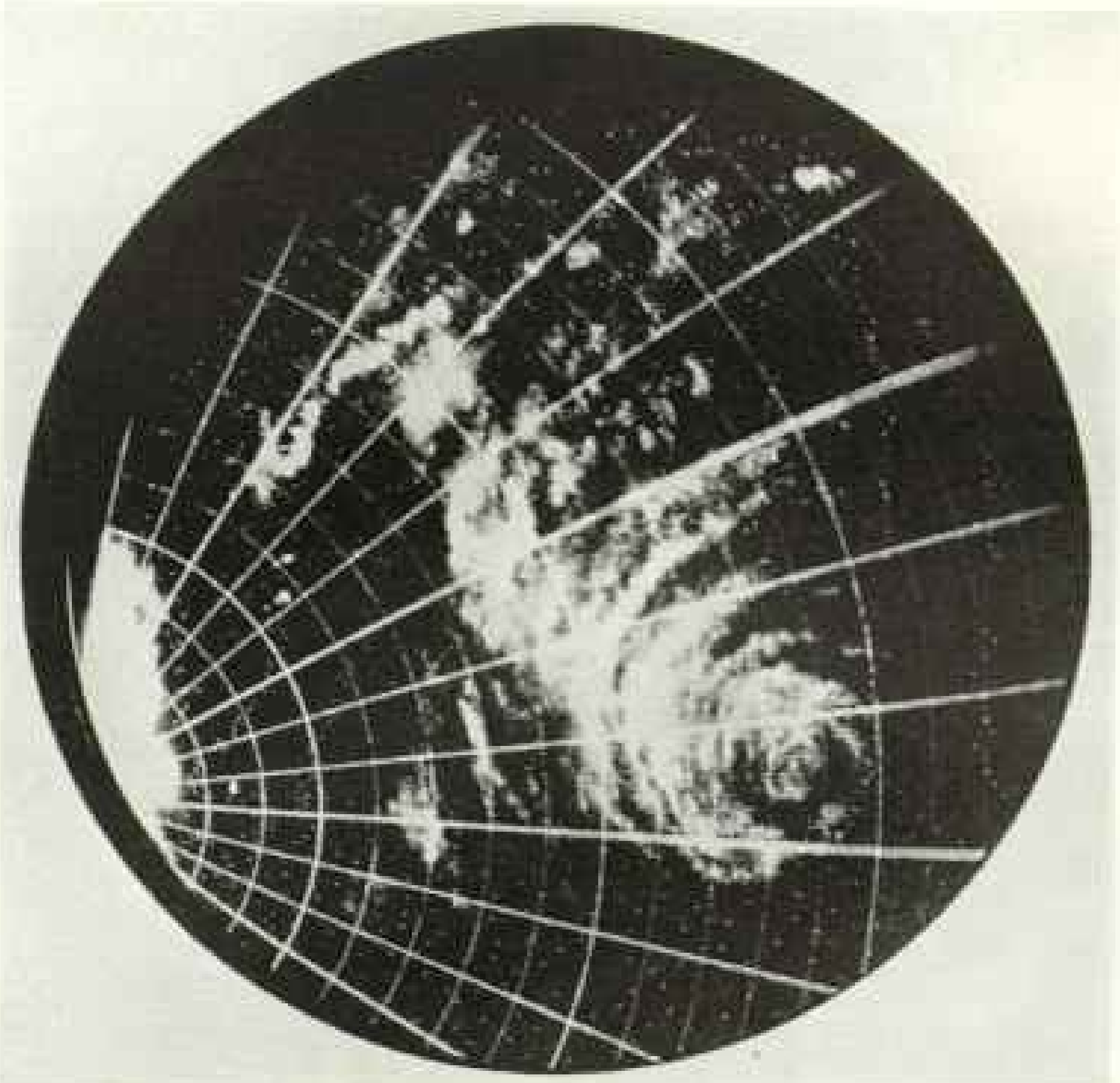
Forecasts for Radio Reception

Using data from the observations of the sun and from these far-flung stations which constantly checked on the density of the ionosphere, scientists of the Interservice Radio Propagation Laboratory at the National Bureau of Standards issued a daily forecast of how the ionosphere would behave during the next 24 hours, and also made forecasts of what radio frequencies would work best during the next two weeks and the next three months.

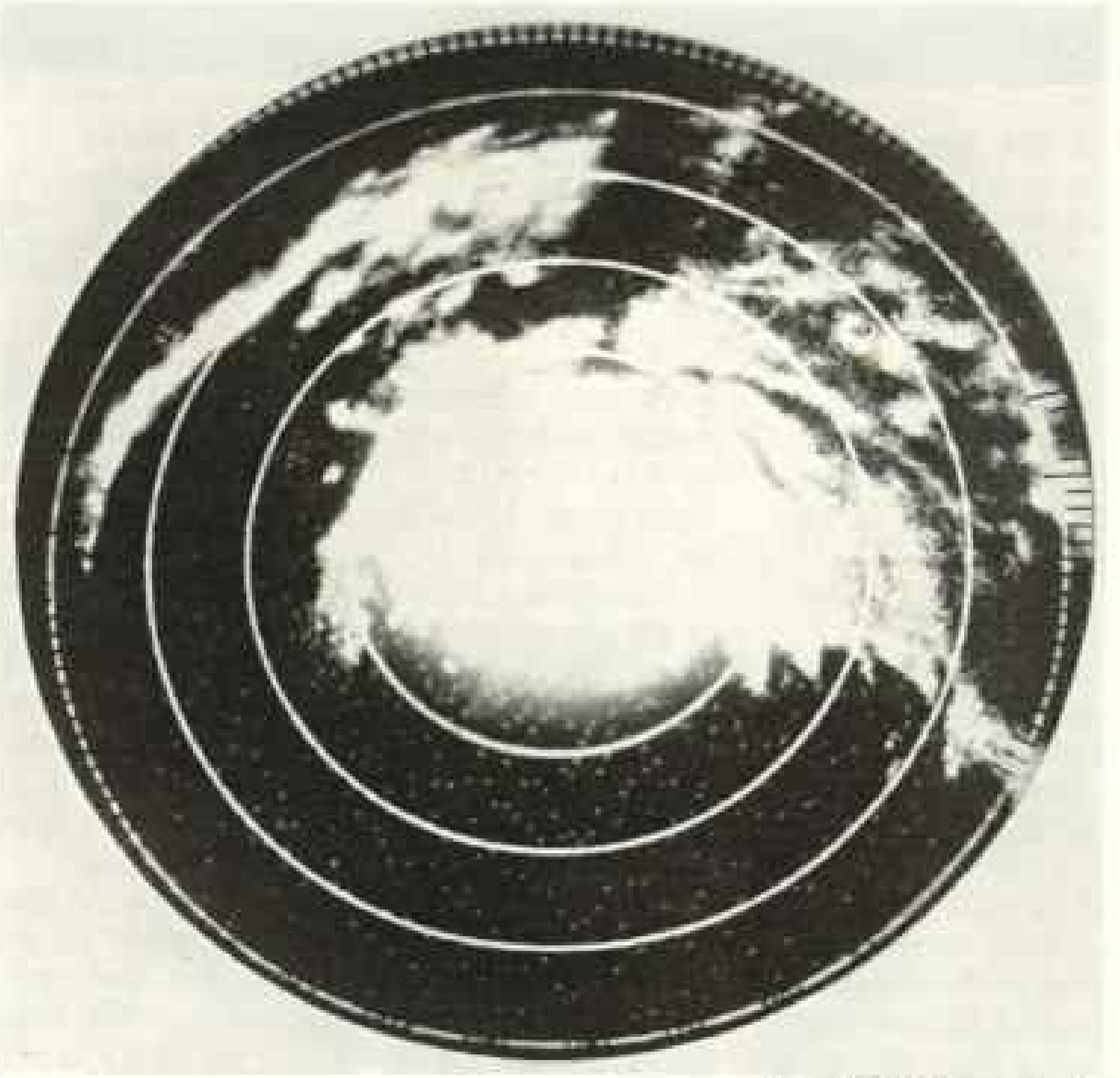
These forecasts were amazingly accurate. With their aid our Army Air Forces were able to plan raids for days when radio was likely to work well, and our submarines on far-ranging patrols in the Pacific had a pretty good idea of what days would be best for radioing to their home bases if they needed to do it in an emergency.

Meanwhile, in the lower reaches of the ocean of air the growing flood of airplane traffic has given new importance to weather. Today the air is a busy, almost crowded region. Less than 20 years after Lindbergh made history by flying the Atlantic, airplanes during World War II were leaving to cross that same ocean on an average of one every 15 minutes.

The Army's Air Transport Command alone carried more than four million people all over the earth by air during the war and ran a weekly round-the-world schedule. We transported whole armies by air, as in the Burma campaign, and supplied them entirely by air as well.



Radar Scope Shows Hurricane Nearing Orlovista, Florida



U. S. Army Air Forces, Official

Same Hurricane as It Passed Ten Miles from Orlovista

Two Pictures Show How Radar Spots a Hurricane and Charts Its Progress

Radar can detect storms at a distance because ultra-short radio waves transmitted by radar are reflected from rain clouds.

An Army Air Forces radar set at Orlovista, Florida, picked up a hurricane about 140 miles away, September 15, 1943, at 2:30 a. m. The upper picture shows what appeared on the radar scope. Orlovista is the bright patch at the left. White patches in the center are dense rain clouds on the approaching side of the hurricane, curving around the "eye," or center, of the storm.

Lines radiating from Orlovista are put on the scope as a guide to the direction from which the storm is coming, and concentric circles indicate distances outward from the town.

The lower picture shows how the hurricane looked on the radar scope at 5:30 p. m. when its center was passing within ten miles of Orlovista. In the center the large white patch is produced by radar waves reflected from the 17,000-foot cloud bank around the hurricane's central eye. The eye itself does not show because it contains no clouds to reflect radar waves.

Charles Fenn from Three Lions

How's the Weather Up There?

Instruments to measure wind direction and velocity are mounted on this beheaded coconut palm which an observer climbs at a Royal Air Force station on a coral reef in the Indian Ocean. It was part of the world-wide network of Allied weather stations that supplied material for forecasts in World War II.

U. S. Navy, Official

Navy's Ram-jet Engine, Which May Drive Planes 1,000 Miles per Hour, Takes Off from a Launching Rack

The "flying stovepipe" has no moving parts. Air is scooped in at the front, compressed, heated, and burned with fuel. The engine is driven forward by its reaction against the exhaust gases streaming out the rear.

U. S. Army Air Forces, official

A Barrage of Rockets Is Released by an Army P-47 Fighter

Ten 5-inch missiles loaded with high-explosive charges fired from the plane leave trails of fire as they speed toward the target at 1,800 feet per second.

U. S. Coast Guard, Official

Capture of German Weather Observers in Greenland Shows How Global Air Movements Now Help Fight Wars

Far from battle fronts, these Nazi meteorologists (with hands raised) were important cogs in the German fighting machine. Their radio reports of weather over the North Atlantic, which affects weather in Europe, were essential to German war planning. U. S. Coast Guardsmen made the capture after a surprise night landing.

On some great bombing raids over Europe as many as 10,000 men at once were flying so high that all were breathing with oxygen masks.

Weather Helped Win the War

In this global war we put weather to work on a global basis. The U. S. Army Air Forces alone had about 900 weather-observing stations outside the United States scattered over the world in almost every country in the Northern Hemisphere and in many others. From their reports, plus those from regular national weather stations, we knew what the weather was at any given moment over more than half the globe. Some stations were in lonely, isolated regions accessible only by air.

"Some of the men got so they were talking to seals," said one officer, "and one or two complained that the mountains were crowding in on them, moving a little closer each day. In some stations near the mouth of the Amazon men couldn't stand it for more than three months at a time because of the heat, malaria, and other diseases."

Less lonely—but more dangerous—was the work of the reconnaissance aircraft which explored weather conditions over the North Atlantic during the war, and charted safe routes for delivery of bombers and fighter planes from the United States and Canada to the United Kingdom.

Flying over the ocean in the worst kind of weather, they skimmed down through the fog perilously close to the surface of the sea, or climbed many thousand feet up to look for dangerous icing conditions and to measure the strength and direction of winds. Once in a while they almost ran into an iceberg in the murk. They took off and landed at fields in Labrador and Newfoundland under conditions in which no other airplanes would be allowed to take to the air.

Weather reports they radioed back to bases enabled inexperienced young pilots to fly across the Atlantic on routes free of dangerous conditions and thus keep up the urgently needed flow of aircraft for the bombing of Germany and protection of our invasion bases in the British Isles. Part of the all-important weather information for the invasion of Normandy was supplied by a weather-reconnaissance crew which flew a battle-scarred B-17 out over the ocean from Newfoundland.

They flew for nine hours, although one engine was cut out and the ship became loaded with ice and ran into turbulent air currents which battered it unmercifully.

Before we could bomb Japan successfully we had to set up an enormous network of weather stations in China, because weather over Japan moves down out of Mongolia and Siberia, hits the Tibetan mountains, then swings down into China and on eastward. This was an epic of geography in itself.

Col. Richard E. Ellsworth of the Army Air Forces, 10th Weather Squadron, told me how he dropped weather men of the Army and Office of Strategic Services by parachute or flew them secretly to a makeshift landing field hidden in remote mountains, and kept them supplied by air as well.

Some of his men actually operated behind the Japanese lines in China and Manchuria, keeping constantly on the move, hidden by friendly Chinese. The Japs knew they were there but couldn't find them. These men sent in regular weather reports by radio to central points where forecasts were drawn up for raids on Japan and other war operations in China and the Southwest Pacific. The Navy had men reporting from Chinese coastal areas.

When our B-29s ran into the 300-mile-per-hour winds over Japan that made accurate bombing impossible, we pushed our weather stations farther inland, back into the oases of the Gobi and the fringes of Tibet, along Asia's old silk route, and as high as 11,000 feet up in the Himalayas. From their reports these winds were forecast.

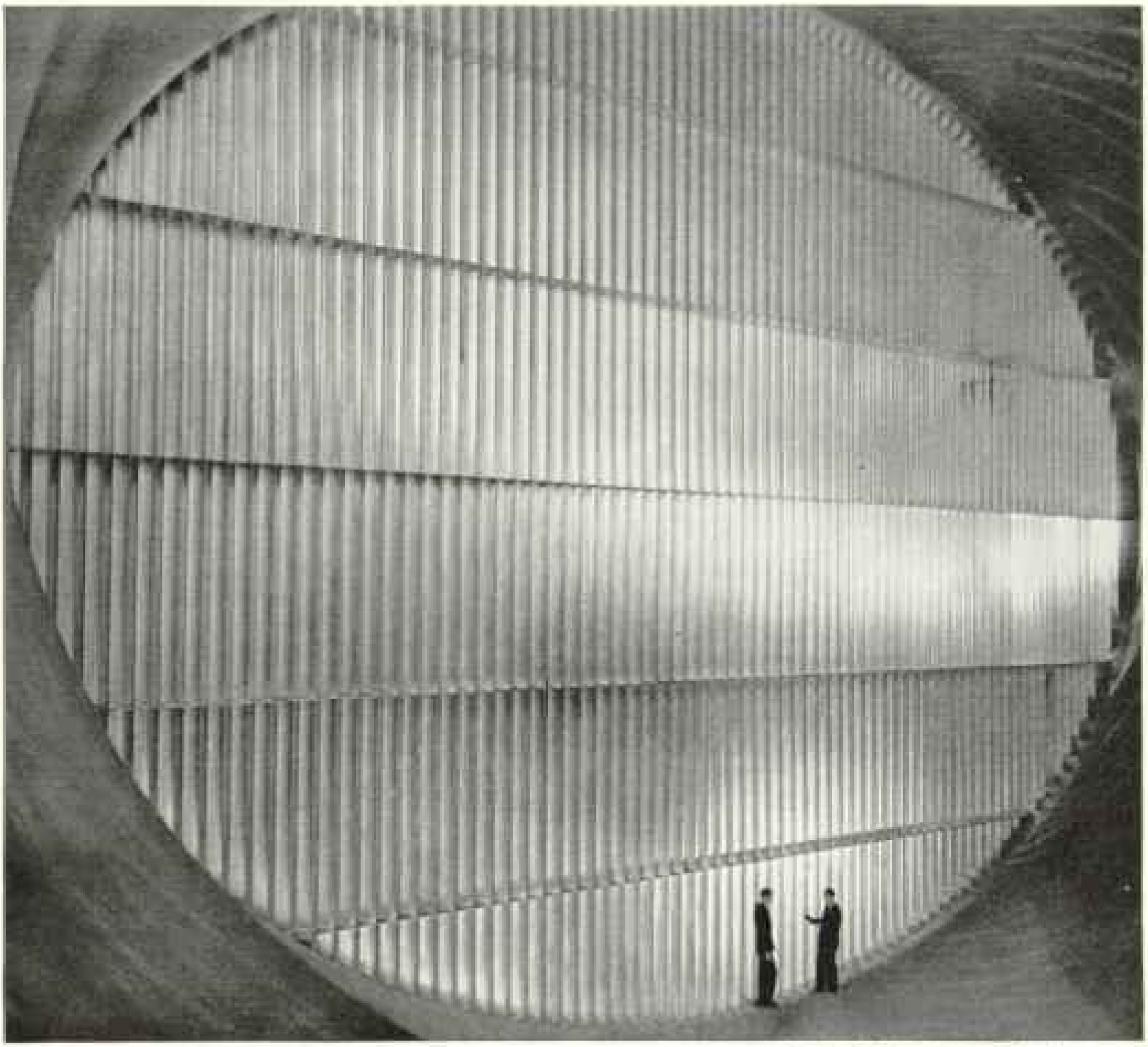
Our weather men landed in places where people had never seen an airplane, and some were put in jail by suspicious local chieftains. Every man, every radio, and all supplies were flown over the "Hump," mostly by Colonel Ellsworth himself, who lost count of the number of times he made the trip.

This job was done by 1,000 men of the Army and OSS, assisted by thousands of Chinese and by China's own military and civil weather observers.

Hardship and loneliness also were the lot of the men who ran the weather-observing network in Canada and Alaska along the route flown by American planes being delivered to Russia by way of the Bering Strait and Siberia. In Europe reports from regular national weather stations and from agents in enemy territory enabled our bombers to make shuttle raids over enemy country between England, Italy, and Russia (page 392).

The Arctic Weather Factory

The great military system of weather stations will keep on working to help the world-girdling flights of commercial airlines in peacetime. Stations in foreign countries are being turned over to local governments to operate; those in United States territory will be run by the Weather Bureau, Army, and Navy.



National Advisory Committee for Aeronautics

Wind Tunnel Vanes Guide Rushing Air Smoothly Around Sharp Right-angled Turn

Vanes are curved to make the air negotiate the corner without becoming turbulent. This is part of a "pressure wind tunnel" where air under pressure is blown at high speed past model airplanes for tests. Results are the same as in flying a full-sized plane at high speed, but are obtained under more carefully controlled conditions than is possible in actual flight. Air flows from this large section of the tunnel, 60 feet high, into a 19-foot section which greatly increases its speed at the point where models are tested.

"Weather secrets of the Arctic, one of the world's greatest weather factories, are now being intensively explored," Col. Donald N. Yates, chief of the Army Air Forces Weather Service, told me. "We are ready to send B-29s on daily flights from Alaska out over the Arctic Ocean, almost to the North Pole, to check the weather.

"Flying above 30,000 feet, the crew will drop rasondes, automatic weather-reporting gadgets, by parachute. As the rasondes float downward, they report automatically by radio the temperature, pressure, and humidity at various levels, giving a complete picture of conditions from six miles or more up in the stratosphere down to the surface of the Arctic Ocean. On land, we send the rasondes upward from the ground by small balloons. Either way we get the same result.

Flying Weather Improves in Arctic

"Not only does Arctic weather affect the rest of the world, but weather in the Arctic itself is of greater importance than ever before. Flying weather actually improves as one goes north in the Arctic. The worst storms are found primarily on its fringes where cold air masses collide with warmer air from the south, although these 'fronts' are also encountered at times at the Pole itself.

"Airplanes now fly across the Arctic regions as easily as across the ocean, for the stormless stratosphere hangs so low there that they need to climb only to about 20,000 feet to be

Staff Photographer J. Baylor Roberts

With Radar He "Sees" Planes 40 Miles Around in Fog or Dark and Guides Them In

Army's new airdrome traffic-control device helps direct about 45 aircraft per hour to safe landings when visibility is poor. Girl locates planes in the air as they appear on the round radar scope or screen before her (opposite page) and places markers to show their positions on the larger tablelike scope in front of the "sky control" officer. By voice radio he then tells pilots what course and altitude to fly to avoid collisions and reach a "turning point" 12 miles from the field. Another officer, also using radar, then directs them to a point from which they can land.

above all weather. The Arctic is sure to be the route of any future attack on the Western Hemisphere from Europe or Asia.

"We plan other B-29 flights over both the Atlantic and Pacific Oceans, to send in weather reports from areas where ships do not regularly operate. Crews of the bombers will get valuable training in overwater flight at the same time."

Already the Army and Navy are sending weather-reconnaissance planes out over the Caribbean during the hurricane season to chart the course of these gigantic storms and find out what goes on inside them. This work is so dangerous that some veteran combat pilots have turned it down (page 390).

Flying into the terrific winds that circle a hundred miles an hour or more around the center of the hurricane, the reconnaissance planes are tossed about like corks, sometimes upward, sometimes downward, so violently that the crew has to fight to keep control. Crew members are dashed against the roof and walls as their plane is pitched about.

Despite their wild rides, which make it difficult even to read instruments at times, the weather-reconnaissance crews have gathered useful new knowledge of the behavior of hurricanes. By radio they send data on the speed and direction of travel of these dreaded tropical storms which have made possible warnings that saved many lives.

Before long we'll do even better than that, some Army Air Forces officers think.

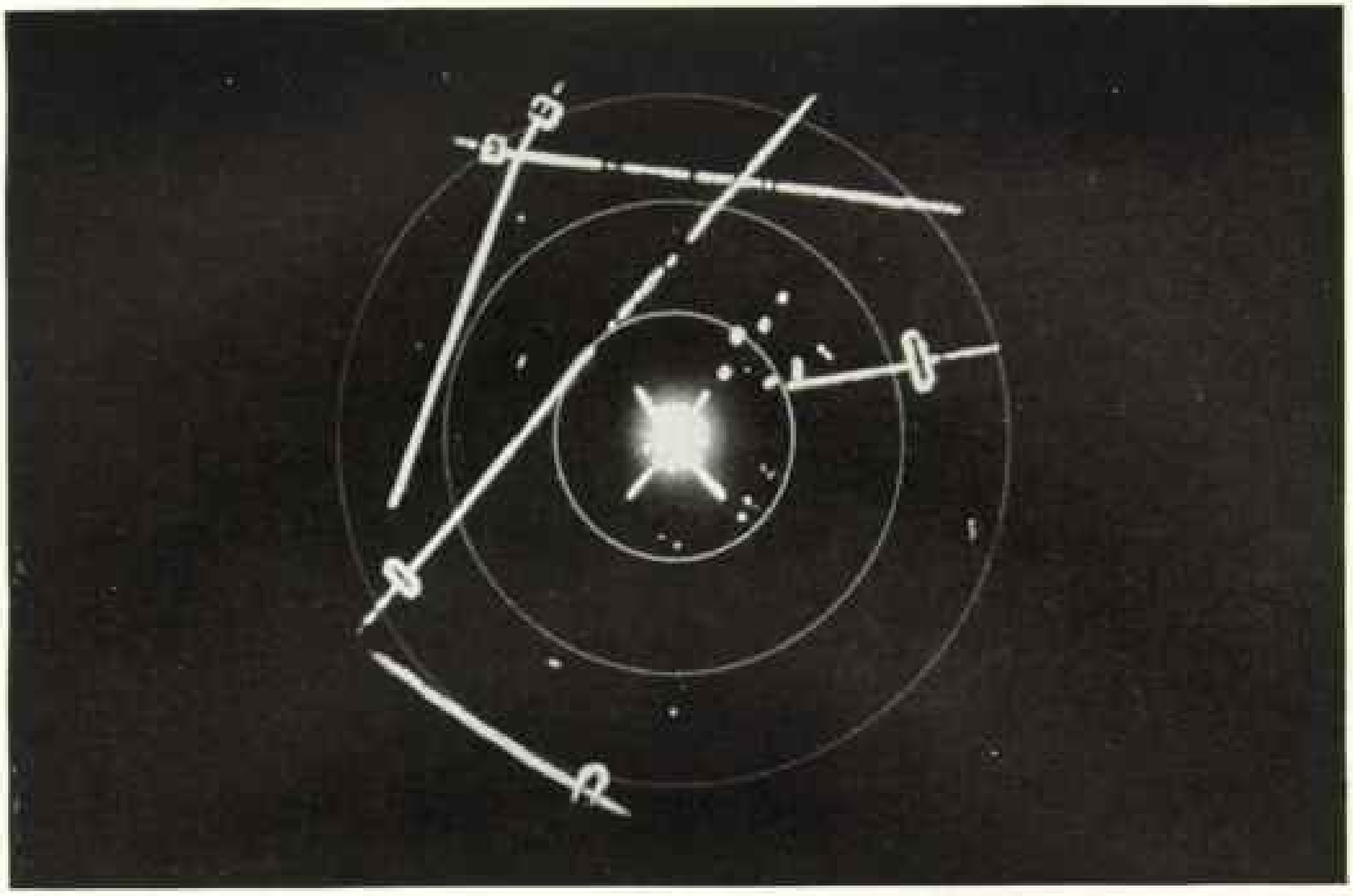
"I can see a time," said one, "when a forecaster in Seattle, for example, wanting to know what kind of weather is coming to him from the Aleutian Islands, will send out a small robot airplane, operated by remote control.

"This robot will record automatically what conditions prevail along the path over which it is sent, radio back a report, and then return to its base."

Charting Wind Currents by Balloons

Knowing "which way the wind blows" at different levels in the ocean of air is as important for airplane pilots as was a knowledge of currents in the ocean of water for skippers of old-time sailing ships.

Just as ocean currents sometimes have been



Staff Photographer J. Baylor Roberts

Dots of Light on This Radar Scope Show Positions of Planes in 40-mile Radius

This is a close-up of the radar scope on the opposite page. Glow of light in the center is the field. Lines crossing in the glow are the runways. White dots are airplanes circling at various distances and altitudes as directed by voice radio by the "sky control" officer. Four dots in line at the upper right are four planes coming in toward the end of one runway to land. Long white lines show positions of radio ranges which guide planes to and from other fields near by. Concentric circles mark distances of 10, 20, and 30 miles outward from the field in the center.

charted by drifting bottles, we now chart wind currents aloft by drifting balloons. The balloon method is far better. Instead of waiting, as with ocean currents, for a bottle to be found on some distant beach, the balloons can be followed by radio as they go, giving an accurate up-to-the-minute picture of how the upper winds are blowing.

Radio waves sent back from the balloons or radar waves bounced back from them show where and how fast they're drifting after they're out of sight or concealed by clouds.

How important it is to know the way wind currents blow was graphically shown in the early days of the war when Allied forces in North Africa urgently needed fighter planes. We flew them across the South Atlantic, but they could carry so little gasoline that some were lost before we learned the heights at which to fly them where helping winds gave them enough extra boost to cross safely.

When the Japanese sent their famous bomb-carrying balloons drifting across the Pacific to the United States, our knowledge of wind currents over the Pacific enabled us to trace their course backward and tell where they must have been launched in order to land where they did.

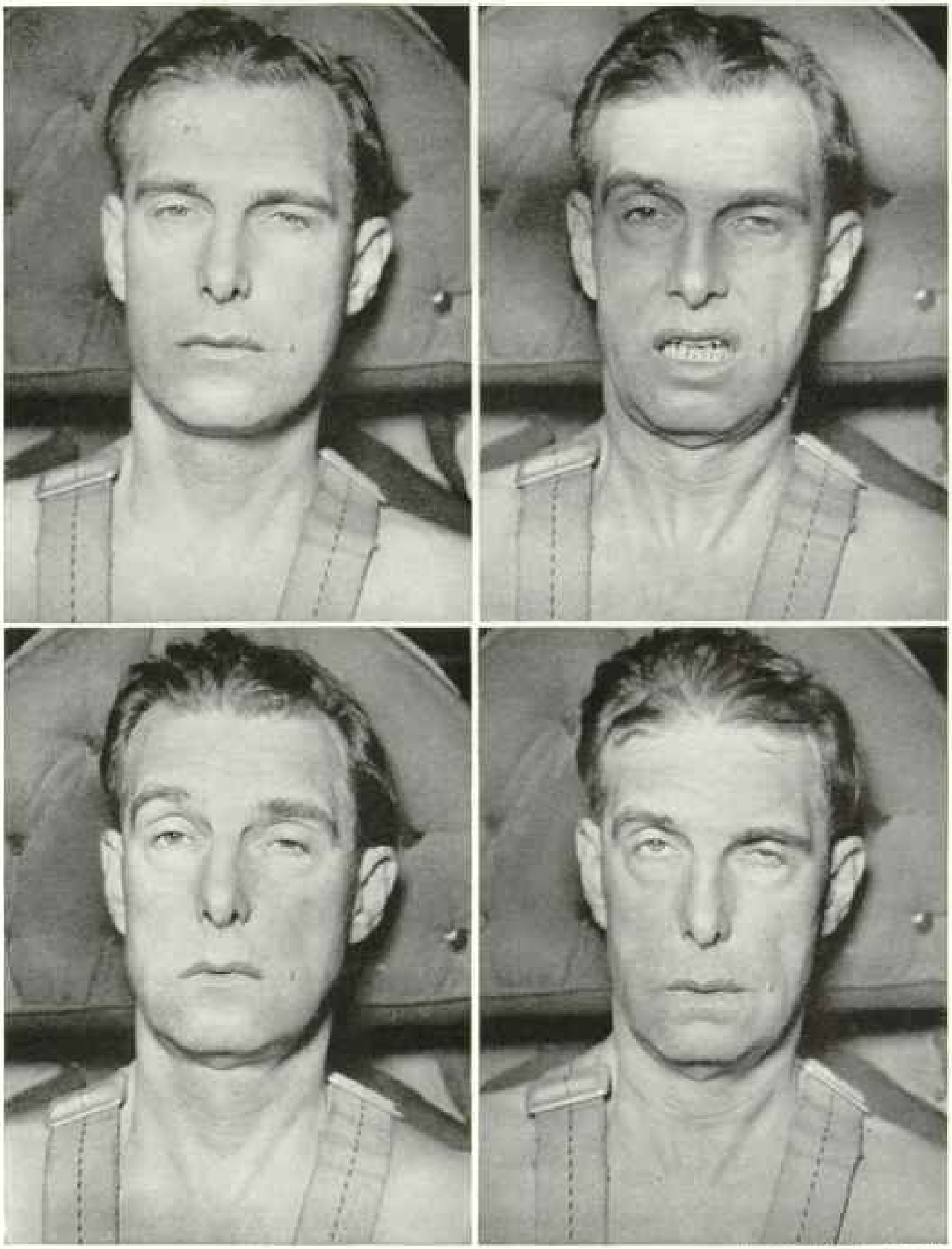
We already have charted winds far aloft occasionally by watching which way they blow the fiery trails left behind by meteors. There's talk of doing the same thing by sending up rockets which will leave trails of smoke by day or of fire by night, then noting which way those trails are blown.

Radar Tracks Storms

Radar, developed for war purposes, is now making it possible to detect storms at great distances, follow their progress accurately, and issue warnings of danger. A network of radar stations in the West Indies already is on the lookout for hurricanes.

In the near future the entire United States will be covered by a similar radar network. Last year one radar station "tracked" a hurricane so accurately that its arrival off Orlando, Florida, was within three minutes of the time predicted.

Hurricanes, typhoons, thunderstorms, tornadoes, rain squalls, and showers all can be picked up at distances of 100 to 200 miles by



U. S. Army Air Forces, Official

Pilot in Simulated Airplane Dive "Blacks Out" as Brain Loses Blood Supply

A volunteer "guinea pig" undergoes a test on the Army Air Forces human centrifuge. Resembling a high-speed merry-go-round, the machine duplicates what happens when a pilot pulls out of a dive (page 408). As the man whirls at increasing speed, centrifugal force increases the pull of gravity on his body, reducing the brain's blood supply and causing temporary blindness or "blackout," or even unconsciousness. Pictures from upper to lower left, to upper and lower right show how the man's facial tissues sag as the drag of gravity on his body gradually increases from two to six times normal. In the last picture he is fully blacked out, though still conscious.

radar, because the radio waves sent out in the radar beam are reflected back by the water drops suspended in the clouds or falling as rain. A partial image of the storm appears on the radar "scope" (page 394).

Birds in flight also reflect radar, and Prof. Maurice Brooks of West Virginia University plans to study bird flight and migration with a radar set on a mountaintop. Birds were picked up by radar both in Great Britain and the Pacific during the war. In Britain one night they were mistaken for ships of an invasion fleet and an alarm was sounded.

Weather troubles are minimized, however, by "push-button flight," a new Army gadget, which will fly a plane without human control on any desired course. You need only push a few buttons to set this automatic mechanism to do what you desire. It will release the brakes, take the plane into the air, retract the wheels, put the plane on the desired course, fly it to its destination, put down the wheels, land the plane, and set the brakes again! The pilot merely goes along in case anything goes wrong.

"When and if push-button flight comes into general use, it ought to make flying as dependable as train riding," I said to the Army Air Forces officer who described it to me.

"No," he said, smiling. "It will make flying as dependable as walking!"

But weather is really just a minor disturbance down near the bottom of the ocean of air. It extends not much more than six to ten miles up into the atmosphere's total depth of perhaps 600 miles. High-speed, long-distance aircraft today are flying higher and higher "over the weather."

Rocket Power and Jet Propulsion

As planes go higher, more and more will they use rocket or jet power, eventually perhaps even atomic power. Rocket- and jet-propulsion planes work better at high altitudes than propeller-driven aircraft, because the air is too thin to give propellers enough "bite."

Atomic-energy engines, with eight million times the power that gasoline can produce, some day may be used in airplanes, experts say. Meanwhile, rocket power and jet propulsion, which until yesterday you read about only in the futuristic comic strips, are already here and working pretty well.

Rocket engines are essentially simple. Oxygen and a fuel such as oil or alcohol are mixed and burned in the engine and produce a very hot gas under pressure. The gas shoots out through a nozzle in the rear with tremendous power. The airplane reacts against this backward push and moves forward with high speed. No propeller is needed.

Jet-propulsion engines work on almost the same principle, but they carry only oil and get their oxygen by scooping up air as they go along. Jet-propulsion engines are in use today on the latest Army and Navy fighter planes. New jet-driven fighters and bombers are being developed. Germany had a rocket-driven fighter plane in World War II and used rocket power to propel its V-2 bombs.

Even jet engines fail at heights where the air is so thin that they cannot scoop in enough of it to provide the oxygen they need. But true rocket engines can fly at any altitude, even in the vacuum of outer space, since they carry their own oxygen with them and don't depend on the outside air. If we ever fly to the moon, we'll do it with rocket engines, because all but about 600 miles of the 238,857-mile trip would be through space where there is no air at all.

Flight at Cannon-ball Speed

Flying more than 590 miles per hour—nearly ten miles a minute—one new jet-propelled fighter plane is almost as fast as some Civil War cannon balls! But at such speeds airplanes are getting close to the speed of sound, which has been an insurmountable barrier to faster flying. The higher you fly, too, the sooner you run into that barrier, for the speed of sound varies with temperature. It's only 661 miles per hour in the cold of 40,000-feet altitude, while down near warmer sea level it is about 760.

Up to now airplanes have come close to the speed of sound only in dives. When they do approach it, their wings lose "lift," drag increases, and the plane may get out of control, become nose-heavy, and crash.

One scientist puts it this way: Below the speed of sound an airplane wing slices smoothly through the air like a sharp knife cutting a well-baked loaf of bread, but near the speed of sound it suddenly becomes like a dull knife trying to force its way through moist dough.

Artillery shells and bullets can travel faster than sound because they have sharp noses, have no projecting rudders or ailerons, and have tremendous power behind them. To make airplanes fly faster than sound we may build them with that same shape, with long, narrow, receding wings like those on the paper darts you made in school, or with wings sharp and thin as a knife blade. We may use rockets to get the necessary extra power. Any military airplane faster than sound will have an advantage over one that isn't.

Even beyond the speed of sound, however,

Staff Photographer J. Baylor Roberts

To Escape from Disabled High-speed Plane, Pilot Shoots Himself Out, Seat and All!

A dummy pilot, strapped to the seat, is literally shot out of a fighter plane in an Army Air Forces demonstration. The "ejector seat" was developed because modern fighters are so fast that the pressure of the air stream makes it difficult for the pilot to leave the cockpit to bail out. By squeezing a trigger he is shot out of the airplane while seated in his cockpit chair. Then another explosion releases the chair from the pilot, and he falls free until a third explosion automatically opens his parachute at an altitude where the air is safe to breathe (page 408).

there seems to be a limit to the speed of flight *inside* the ocean of air. An airplane moving 1,500 miles per hour will get so hot from the friction of the air against its metal skin that nobody can fly in it without artificial cooling. But outside the atmosphere, where there is no air to cause friction, that problem wouldn't bother you! Out in space there is no practical limit on speed.

Some fighter planes now in existence are so fast that heat produced by air friction outside and compression of air entering the cockpit makes it necessary to cool their interiors artificially, even when they're flying at altitudes where the outside temperature is already many degrees below zero!

On the walls of a laboratory at Wright Field I saw queer-looking tentative designs for airplanes of the future. One was a giant rocket with a fighter plane mounted on its nose. Firing the rocket would hurl the fighter plane up to a great height at very great speed, in time to intercept fast oncoming bombers. Once aloft, the plane would cut loose and fly by itself.

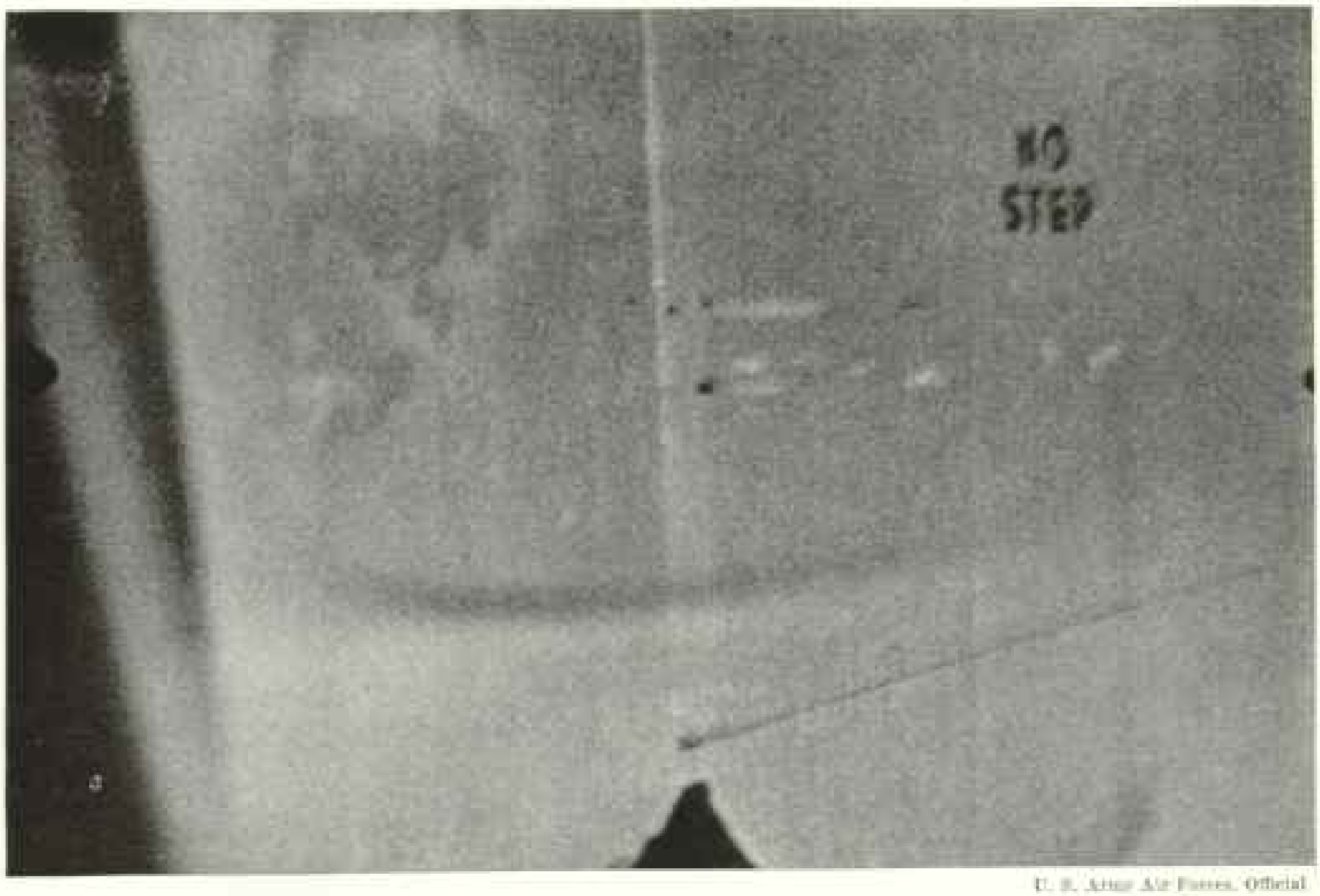
Other designs had backward-swept wings, upswept tails, and even backward-bent propeller blades to help them overcome the speed-of-sound barrier. To cut down air friction at high speeds, their surfaces would have to be smooth as glass, with no rivet heads protruding even a tiny fraction of an inch.

Bombing Invisible Targets

Aircraft plying the ocean of air can "see" and "feel" their way by radar and radio anywhere regardless of clouds, fog, haze, or distance (pages 400-401). Three-quarters of all our bombing of Japan was done under conditions when the bombardiers could not see the targets. Radar penetrated clouds and darkness and showed them a clear pattern of the invisible ground below.

When our B-29s signaled "Bombs away" over Japan, the message was relayed so fast around the earth that Army Air Forces officers in Washington received it within less than five minutes.

What a far cry from the days when Commodore Matthew Calbraith Perry sailed his fleet of war vessels to open up Japan to the outside world in 1853! Then he could send



U. S. Army Air Forces, Official

As a Plane Nears the Speed of Sound, a "Shock Wave" Ripples over the Wing

This wave in the air, visible because light strikes it at the right angle, was photographed moving across the wing of an Army P-51D fighter during a test dive in which the airplane reached an air speed of approximately 640 miles per hour. As an airplane approaches the speed of sound (661 miles per hour at the temperature encountered at 40,000 feet), the air flowing over the upper curve of the front of the wing moves even faster, exceeding the speed of sound. Then the air slows down over the rear of the wing, and the difference in pressure of the air moving at the two different speeds produces the shock wave. Resulting stresses may damage an aircraft or throw it out of control (page 379).

home word of it only by mail in the slow-moving ships of that day.

Though we can build airplanes that will fly far up in the ocean of air, the human body was designed to live and operate down at sea level or not more than a few thousand feet higher. A small community of Chilean sulphur miners live and work at 17,500 feet in the Andes, but they are acclimated through long residence there. Most people cannot function normally above 10,000 feet without the aid of oxygen.

To enable man to keep up with and operate the fast, high-flying airplanes he has built, a brand-new branch of medical science, aviation medicine, has developed in recent years. This new science has enabled men to fly far higher than Nature ever intended them to go.

It Takes Young Men to Fly High

So advanced was the U. S. Army in training pilots to take care of themselves at high altitudes that the Germans were amazed to find that many American flyers they captured knew more about how the human body behaves in flight than some medical officers of their own Luftwaffe!

Good physical condition is a "must" for high-altitude flyers. Young men can fly higher without harm than older ones. Exercise before flying increases a little the height to which a man can fly safely. Abstaining from alcohol, tobacco, and heavy meals before flight helps. So does eating sugar. But flying above 20,000 feet without oxygen to breathe soon brings on anoxia (the medical term for lack of oxygen), unconsciousness, and death to the best of men.

Breathing pure oxygen under ideal conditions a man can fly with safety to 40,000 feet, eight miles. But breathing oxygen through a mask is uncomfortable, awkward, and a handicap if you want to move around inside an airplane. Moreover, above 40,000 feet even pure oxygen will not sustain life, for the atmospheric pressure is so low that not enough oxygen is pushed from the lungs into the blood stream.

Scientists conquered this obstacle with the "pressurized" airplane.

U. S. Navy, official

Navy Air Cadets Learn They Need Oxygen to Think Straight at High Altitudes

Cadets are seated in the pressure chamber at Pensacola Naval Air Station in which air has been rarefied to the equivalent of 30,000 feet altitude above the earth. Breathing oxygen through masks, they can identify accurately the airplane models held by the instructor (left), but had difficulty in doing so at the lower altitude of 18,000 feet without oxygen. Lack of oxygen above 10,000 feet weakens a flyer's mental and physical faculties. Instructor's mask feeds oxygen through the nose only, so that he can talk freely.

In the cabin or cockpit of such a plane air is pulled in from outside and compressed so that the atmospheric pressure is maintained close to that at sea level, and the air contains the usual amount of oxygen so that normal breathing is possible without wearing an oxygen mask.

Experience gained in the sealed gondola of the stratosphere balloon *Explorer II* was one step in this development (page 379).

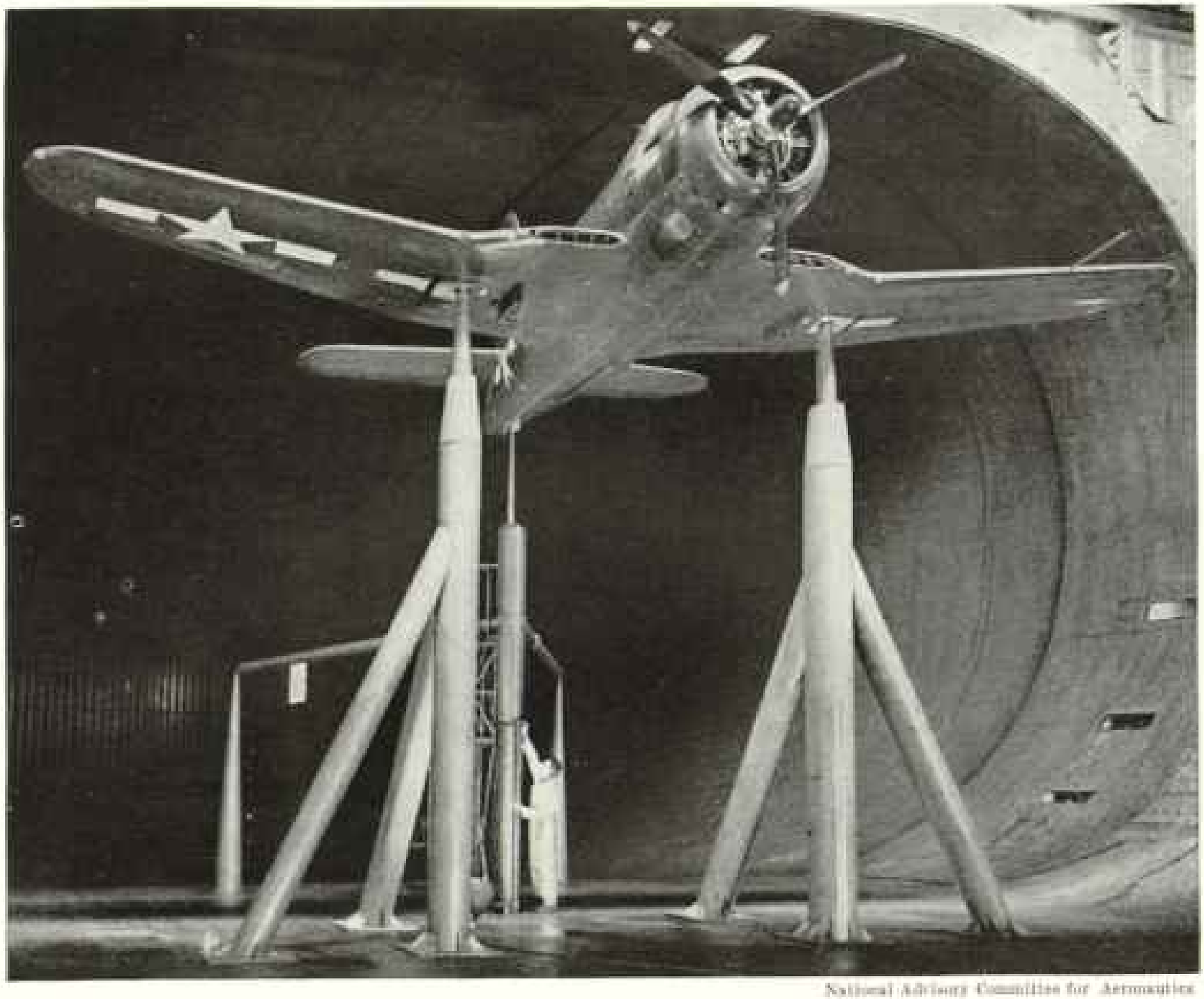
Our B-29s have pressurized cabins, enabling them to operate even above 40,000 feet. Newer commercial airliners have them, too. In this way man takes his sea-level environment with him up into the high air.

Inside the pressurized cabin the pressure is kept at, say, 12 pounds to the square inch, not much less than that at sea level. Outside, at 40,000 feet, the pressure is only about three pounds. If something suddenly pierces the wall of the cabin, such as an antiaircraft shell or even a low-flying meteor, what happens is like something out of Jules Verne.

Pressure in the cabin drops instantly from 12 pounds to three. With the sudden release of pressure, gases inside a man's body expand greatly and the air in his lungs rushes out so fast that sometimes his lips flap. Scientists call it "explosive decompression."

Aviators Get the "Bends," Too

Once when a B-29 turret blister gave way 30,000 feet over Japan, a crew member was blown out of the plane by the suddenly released pressure and hung by a safety harness out in the terrific cold until pulled back in. Surprisingly enough, a man can stand that sudden drop of pressure without harm, but he must reach quickly for his oxygen mask and put it on, for otherwise he would soon



National Advisory Committee for Aeronautics

Airplanes "Fly" Nearly 250 Miles per Hour Without Moving in Big Wind Tunnel

An air stream is blown at that speed past planes undergoing tests to simulate flight conditions while the aircraft's reactions are measured more exactly than would be possible in flight. Six huge fans, each driven by a 6,000-horsepower motor, blow 24 million cubic feet of air through this tunnel at National Advisory Committee for Aeronautics laboratory, Moffett Field, California. Plane being tested is a Ryan FR-1 Navy carrier fighter driven by a combination of propeller and jet-propulsion unit (page 391).

lose consciousness from anoxia at 40,000 feet.

Of course the airplane must fly down to lower levels as fast as possible, lest the crew suffer from "bends." This is the same trouble that sometimes afflicts divers in the sea.

Divers get bends when they come up too fast from the crushing pressure beneath the sea to the lesser pressure at the surface. Flyers get it in the below-normal atmospheric pressure at high altitudes. In both cases nitrogen in the body forms bubbles in the blood and tissues that cause severe pain. Painful gas pockets form, too, in the knees, elbows, and other joints. You can see them in X-ray pictures.

As airplanes fly faster and faster, they put another kind of strain on the human body that aviation medicine has had to overcome. That strain does not come from straightaway speed, for every minute of our lives we're spinning with the earth about 1,000 miles an hour and don't even notice it.

The strain comes from accelerating suddenly from a standstill to high speed, or slowing down equally fast, or from the centrifugal force in fast, sharp turns. Airplanes can take it, but pilots' bodies cannot.

When a pilot pulls up out of a fast dive, or makes a sudden, sharp turn, or is suddenly catapulted forward, the force of gravity pulling on his body quickly increases from normal to several times that much.

Where a Man Weighs Half a Ton

That has the effect of greatly increasing his weight. A 160-pound man suddenly weighs half a ton. His blood becomes as heavy as molten lead. His heart simply isn't able to pump enough of that heavy blood up to his brain. Blood already in his brain

drains down into his abdomen. Deprived of blood, his brain ceases to function normally. He becomes temporarily blind, then deaf, then unconscious.

In the Aero Medical Laboratory at Wright Field our flight surgeons built a "human centrifuge," a sort of high-speed merry-go-round. On this machine human volunteers were whirled around and around, simulating what happens in pulling out of a dive. Instruments attached to their bodies registered pulse, blood supply to the brain, and brain waves, and made electrocardiograms. Movies were taken of their faces (page 402).

Weird things happened to men on these wild rides. Their heart rates and circulation of blood in the brain dropped way down, then adjusted to the new condition and returned almost to normal. Centrifugal force dragged down the tissues of their faces until they looked 20 years older.

On that machine you can whirl a man at 100 miles per hour until the force of gravity pulling on his body is 20 times normal, more than enough to kill him by anemia of the brain or suffocation from inability to breathe against the drag of the increased gravity.

"Gravity Suit" Makes Flyers More Mobile

Out of the ordeals of the men who rode the centrifuge we learned how much extra gravity pull and acceleration the human body can stand. Out of this, in turn, came the "gravity suit," or "G-suit," which helped American flyers win many air battles in World War II.

The G-suit consists of bladders of light rubber strapped on the abdomen, thighs, and legs of the wearer. Inflated with air automatically when a pilot makes a sharp turn or comes out of a dive, these bladders exert pressure enough to reduce the drainage of blood from out of his brain.

Wearing a G-suit, a fighter pilot can stay conscious under seven to nine times the normal pull of gravity and can turn faster than he otherwise could without losing consciousness.

Pilots who wore the suits reported they were able to maneuver into positions to shoot down both Jap and German planes which otherwise would have escaped them.

Another great problem of high-altitude flight is getting out of a disabled airplane and returning safely down to earth. It's almost as difficult, in some ways, as getting out of a submarine deep under water.

At 40,000-feet altitude you can't just jump out of a plane, pull the ripcord of your parachute, and float gently to earth. For some mysterious reason parachutes at high altitudes open with a tremendous shock, 40 or 50 times the force of gravity.

This shock is enough to knock a man unconscious, injure him seriously, or even break the parachute harness.

Moreover, he would die of lack of oxygen and cold before he could float down to lower levels. Heavy clothing and a "bail-out" cylinder of oxygen to breathe on the way down reduce these dangers.

Nevertheless, the Army Air Forces now advise men who bail out at high altitudes to fall free, without opening their parachutes, until they get down to about 15,000 feet. That way they're exposed to cold and possible failure of their oxygen supply for only two or three minutes, and the parachute opens with a comparatively mild jerk.

A new parachute made of wide ribbons to reduce the shock of opening has been designed. It can be set to open automatically at a predetermined altitude, in case the wearer is unconscious from anoxia.

Getting safely out of a high-speed fighter plane is even more of a problem. At a speed of 300 miles per hour or over, the wind forces a man back into the cockpit when he tries to get out. It rams down his throat like something solid, flattens his nose, pushes his eyeballs back into his head. In World War II the Germans solved the problem with an "ejectable seat" (page 404).

Pilot Shoots Self Out of Plane

When a fighter pilot had to bail out, he pressed a button and a small explosive charge under the seat blew the seat and him with it right out of the plane. After he detached himself from the seat, he opened his parachute.

But today fighter planes are climbing to altitudes where their cockpits have to be sealed and pressurized to keep the pilot alive. If he opens the cockpit to get out, he will die from the low pressure and lack of oxygen. So now the Army and Navy are talking about fighter planes with ejectable cockpits.

When such a plane became disabled, the pilot would press a button and the entire cockpit, with him inside, would be blown clear. Within this protecting cell he would fall free to safe lower altitudes, then open his parachute and land.

How much higher can man fly? Will he ever penetrate to the top of the atmosphere, out to the very limits of the ocean of air? The same scientists who told me that "impossible" is an obsolete word helped answer these questions for me, too. "We now are seriously studying," they said, "the problems of flight in outer space."

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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, 1939, 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 300 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 $23,000, 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.

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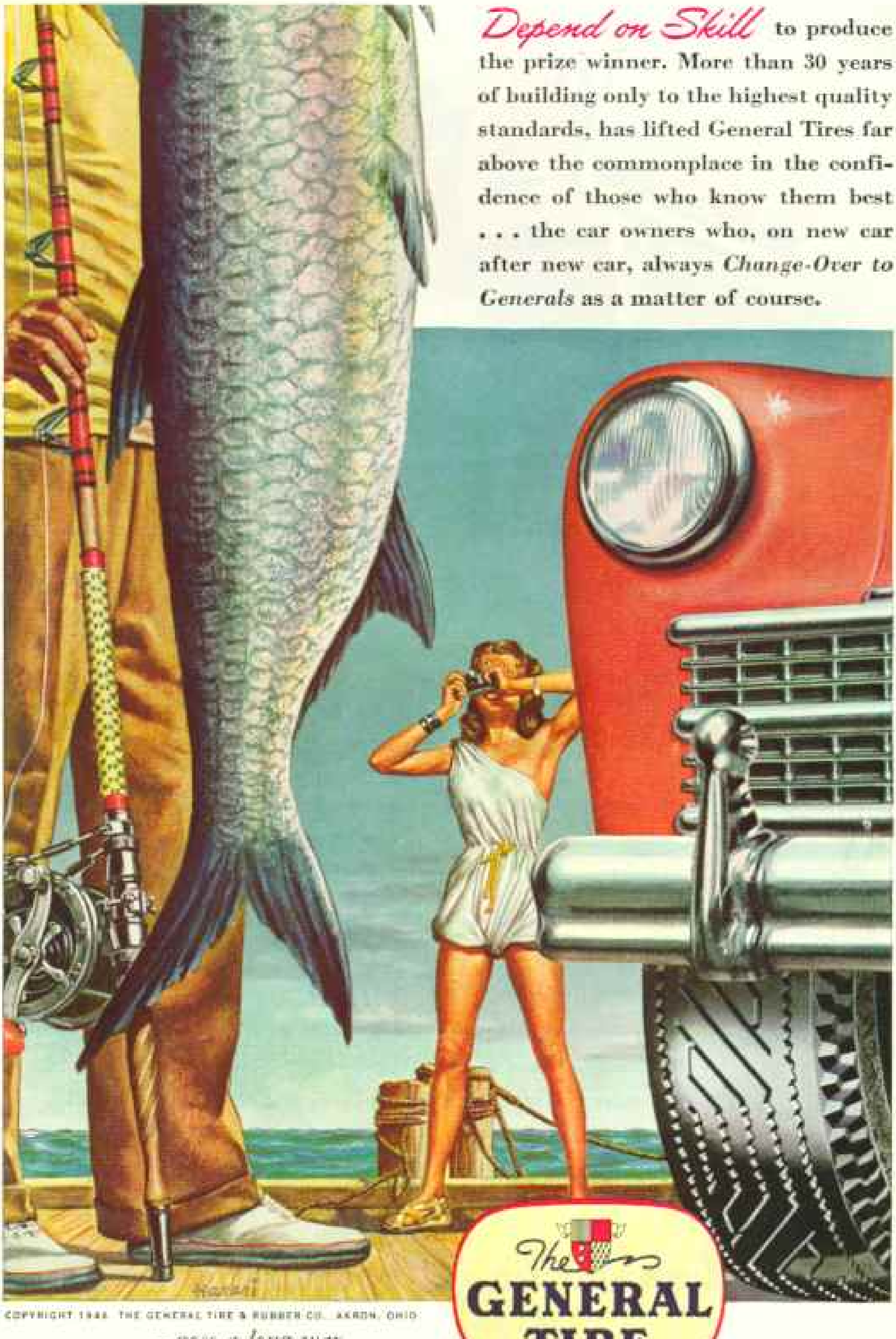

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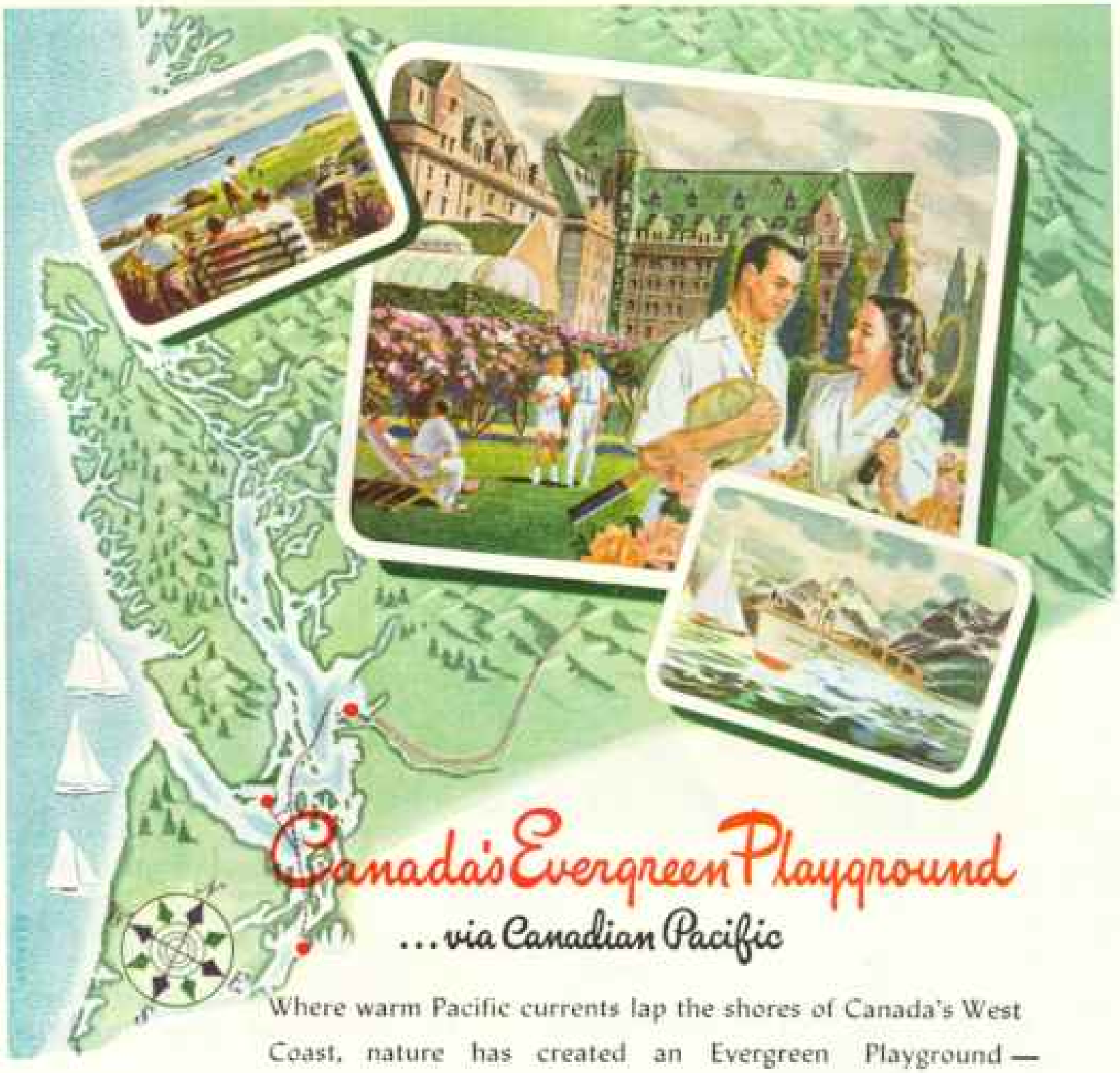

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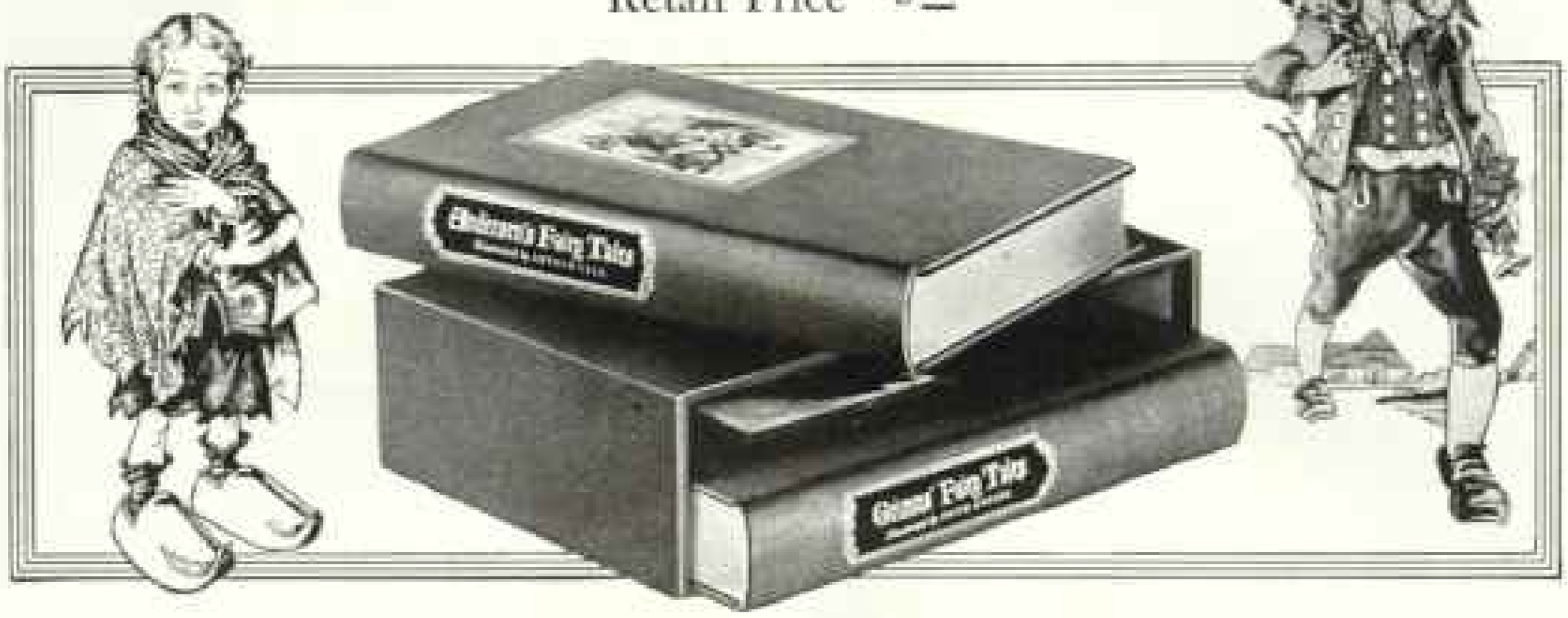

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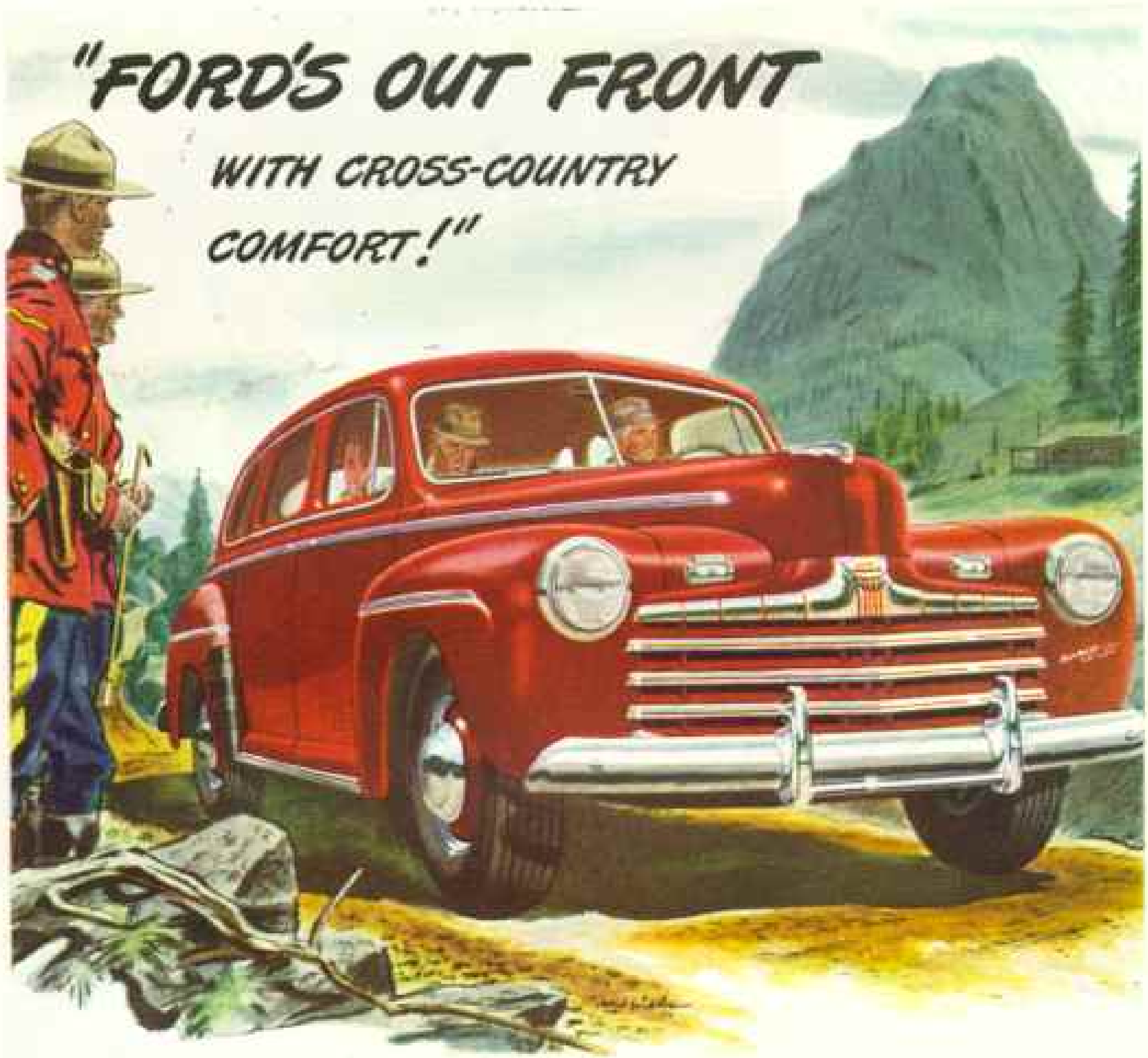

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Look for these utterly new dress fabrics now, in garments bearing the tag you see below . . . made crush-resistant and shrink-resistant by Resloom, yet retaining all their natural softness, strength and resilience.

In increasing quantities, you'll find garments with the Resloom tag at your favorite store . . . your guide to fabrics new to man, *and a joy to woman!* For special descriptive folder, "Resloom and You," please write:

MONSANTO CHEMICAL CO.
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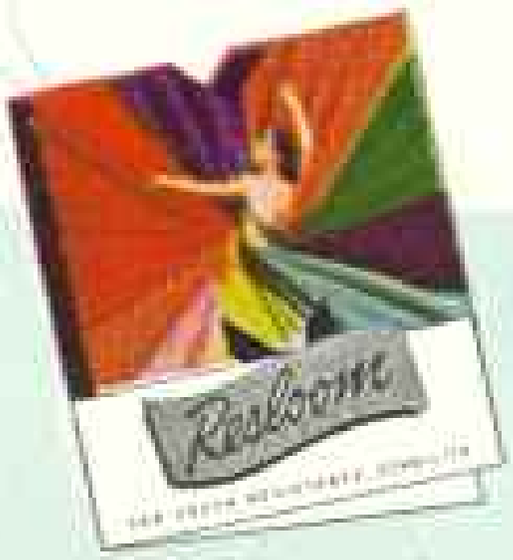
Mr. Albert Sands of Sanco Piece Dye Works, one of America's leading textile finishers, says: "Resloom as applied by Sanco gives a truly crush-resistant finish that is the answer to the dreams of millions of active people. *This indeed is the fabric of tomorrow . . . beautiful, shrink-resistant and crush-resistant.*"

Resloom: Reg. U. S. Pat. Off.



You can find this tag now on dress fabrics at many leading stores.

Fabrics above from: Concordia-Gallia Corp., Frankly Fabrics Corp., Joseph Berlinger Co., Cantor-Greenspan Co., Inc., Oscar Hayman, Mallinson Fabric Corp.

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The kid with a four-leaf clover

He's one of one million, seven hundred thousand 4-H members — junior citizens with a job to do, a will to learn, and a warm, quick answer for that old question, "What's the younger generation coming to?"

They could tell you about the boy — with a single calf as a start — who built a flourishing dairy business and a $20,000 stake by the time he reached eighteen. Or the girl who sewed *241* garments while she "grew up"!

Behind such youngsters and their success is a four-leaf clover symbol which signifies *head, heart, hands, health.* It's the emblem of the 4-H Club, and to young folks on farms everywhere, it brings something far more than luck. It brings them *equipment for living.*

The real value of 4-H Club work is not, indeed, to be reckoned in dollars and cents, nor even in immediate results. It lies in the development of new leaders for the nation's future. We at National Dairy are proud to salute those who choose dairying as a life's endeavor, especially now when greater milk production is a challenging need. Here is opportunity for Youth in towns and cities, too.

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NATIONAL DAIRY
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Grandmother Never Saw This!

Years ago, when Grandmother looked through her stereoscope at the scenes of the Southland, she didn't see views of modern industries and large cities like these.

For Grandmother's South was the land of song and story . . . of picturesque plantations and broad fields . . . of moonlight and wisteria . . . of romance and beauty. It was also the land of opportunity for industry and business . . . although she never guessed it.

Since Grandmother's day, huge industries have grown up in the Southland. And they're still growing . . . fed by nearby sources of limitless raw materials . . . nourished by rich, expanding markets close at hand . . . manned by skilled workers . . . and favored by a mild climate, abundant power and fuel — and the efficient, dependable, economical transportation of the Southern Railway System that "Serves the South."

No, Grandmother never saw these unlimited industrial advantages. But others did. And you will, too, if you "Look Ahead — Look South."

Ernest E. Norris

President

LOOK SOUTH LOOK AHEAD

SOUTHERN RAILWAY SYSTEM

The Southern Serves the South

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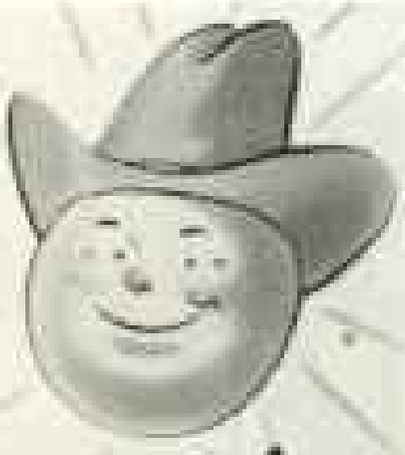

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For Santa Fe feels a great debt to nature for the colorful,
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a real responsibility to our patrons, to take them
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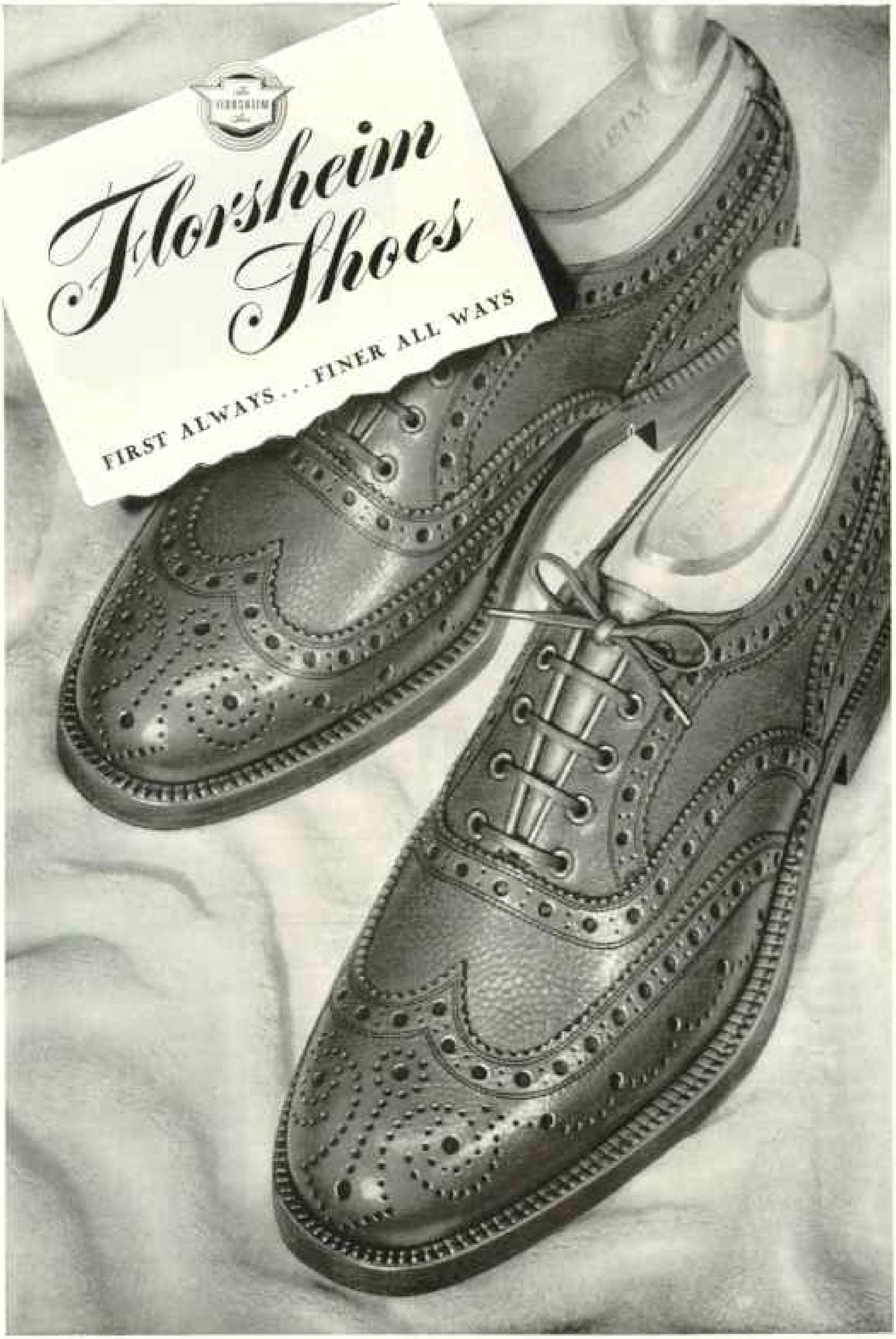

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In every city, town and village, there are names newly wreathed with honor and heroism.

Let those names be heard in your community, let them be remembered as days turn into years, through the noble, glowing tones of Carillonic Bells. Ringing in remembrance, Carillonic Bells speak, as no other tribute can—raise in cresting waves of music an abiding message of faith and commemoration.

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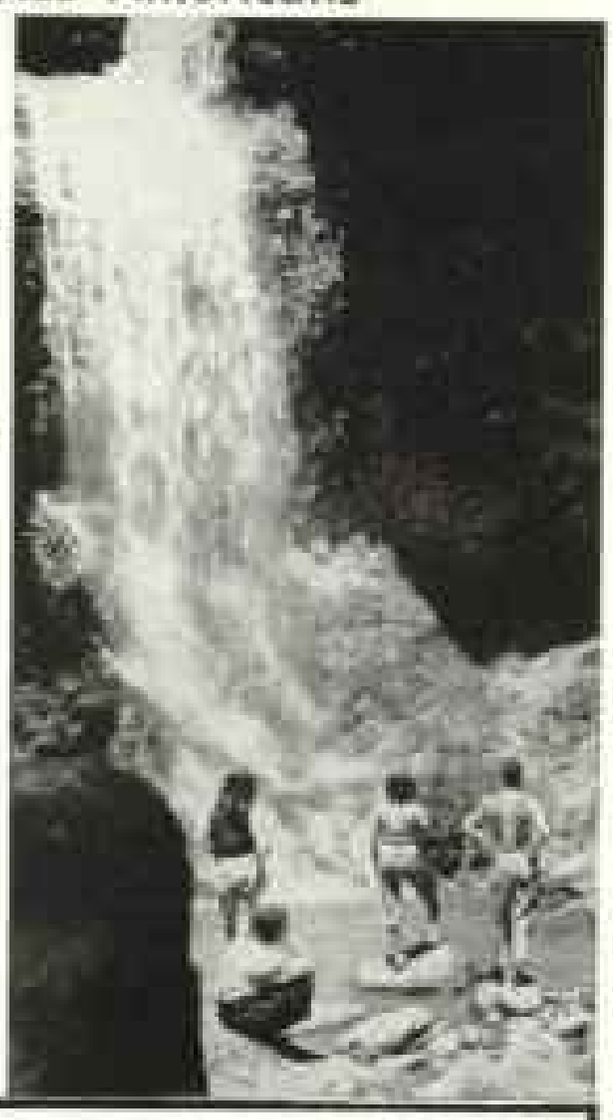

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"I'm coming to visit you... all alone!"

DEAR GRANDMA:
Mama has to staY home on Account of my nEw brother and Daddy can't leave his offis now, but they say Pullman will take caRe of me just like they wouLD. So I'm coming To visit you all alonE.
Love, Jeannie

AND SHE HAD A WONDERFUL TRIP...

1. **"More fun** than a movie!" promised the Pullman conductor. It is. There's no grander picture than America's changing scene. And the grandest way to see it is through a Pullman window!

2. **"Here's where** you wash your hands," explained the Pullman porter. Seasoned travelers, as well as little girls, are delighted by all the comforts and conveniences that make Pullman trips so pleasant.

3. **"As comfy** as my own!" dreamed Jeannie, in her Pullman bed. Her folks at home slept soundly, too, for there are no wakeful worries about weather, roads or mountains when your loved ones go by *train!*

Make your trips as pleasant as Jeannie's...

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To lighten the burden of a loved one left alone—that is the wish of every man who looks ahead and decides to select a family monument—now.

It's a wise decision. Because it not only saves a world of worry and perplexity later—it assures you of getting exactly the type and design of monument you both want, and that is an important point. For in choosing a monument, you are choosing not for today, but for all time. You want it to be faithfully expressive of the individual. You want it to be beautiful and eloquent. And you want it to last for a long, long time—forever if possible.

That is why we suggest that you consider your choice of a Rock of Ages Family Monument—now!

"How to Choose a Family Monument," a large illustrated book, is available without charge or obligation. Simply write to Rock of Ages Corporation, Barre, Vermont. Or ask for a copy from the Rock of Ages Dealer in your community.

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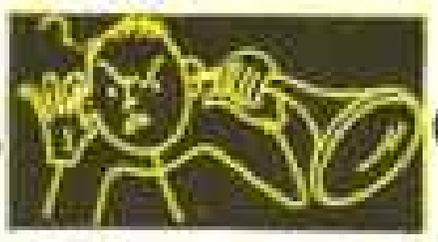
It pays to know <u>when</u> to relax!

If you set too fast a pace in work or play... worry too much...or often get upset emotionally, you waste your energy, and *fatigue* sets in.

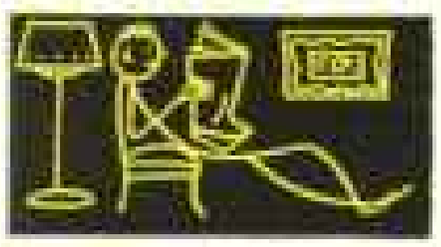
Conserve your energy by avoiding such conditions. Store up *more* energy by getting enough sleep, food,

rest, and fresh air.

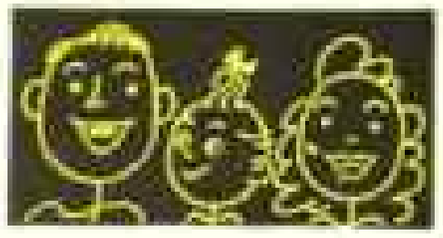
If you are *continuously* tired or listless, see your doctor! It may be an early sign of a serious ailment or an infection, or be due to poor eyesight, hearing,



or posture.



You can usually avoid harmful fatigue if you'll just *remember to relax!*



Metropolitan's free booklet—"Fatigue... What To Do About That 'Tired Feeling'"—contains many helpful suggestions on how to relax and keep fit. Write today for booklet 96-N.

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What John Ledyard discovered in Siberia's "icebox"

In 1787, an American explorer named John Ledyard spent the early winter in the Siberian outpost of Yakutsk.

In this particular section, the winters are so exceedingly long and cold that it has been called "the icebox."

Ledyard was interested in the way the natives of "the icebox" lived during the months of bitter cold.

The Yakuts had no wells, he noted in his diary, as the subsoil never thawed, even in summer. So the Yakuts cut ice from the river Lena and piled their winter's water in the yard like firewood. He found them using thin sheets of ice for windowpanes. And, according to the explorer, the Yakut milkman delivered milk at the door in frozen chunks which kept perfectly, outdoors, until needed.

It seemed to Ledyard that the Yakuts adapted themselves well to some very difficult conditions. They succeeded, pretty well, in their efforts to protect themselves against a period of scarcity and hardship—an effort which man has been making for a good many thousands of years.

But it is only recently—in the last 100 years or so—that this effort has really been crowned with success. Today, modern man has finally learned how to do considerably more than get through a long, hard winter. He has, at last, discovered how to protect his family and himself against hardship—*for life*.

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For neither accident, old age, nor even death itself can bring financial hardship and need to the family of a man who has an adequate, well-balanced insurance program.

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Brandied Fruit Cake

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And convenient. Schedules are frequent to points all over the United States and to dozens of foreign countries. Go where you like.

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As for cost, air fares have been so drastically reduced that in many cases you actually save money by taking a plane.

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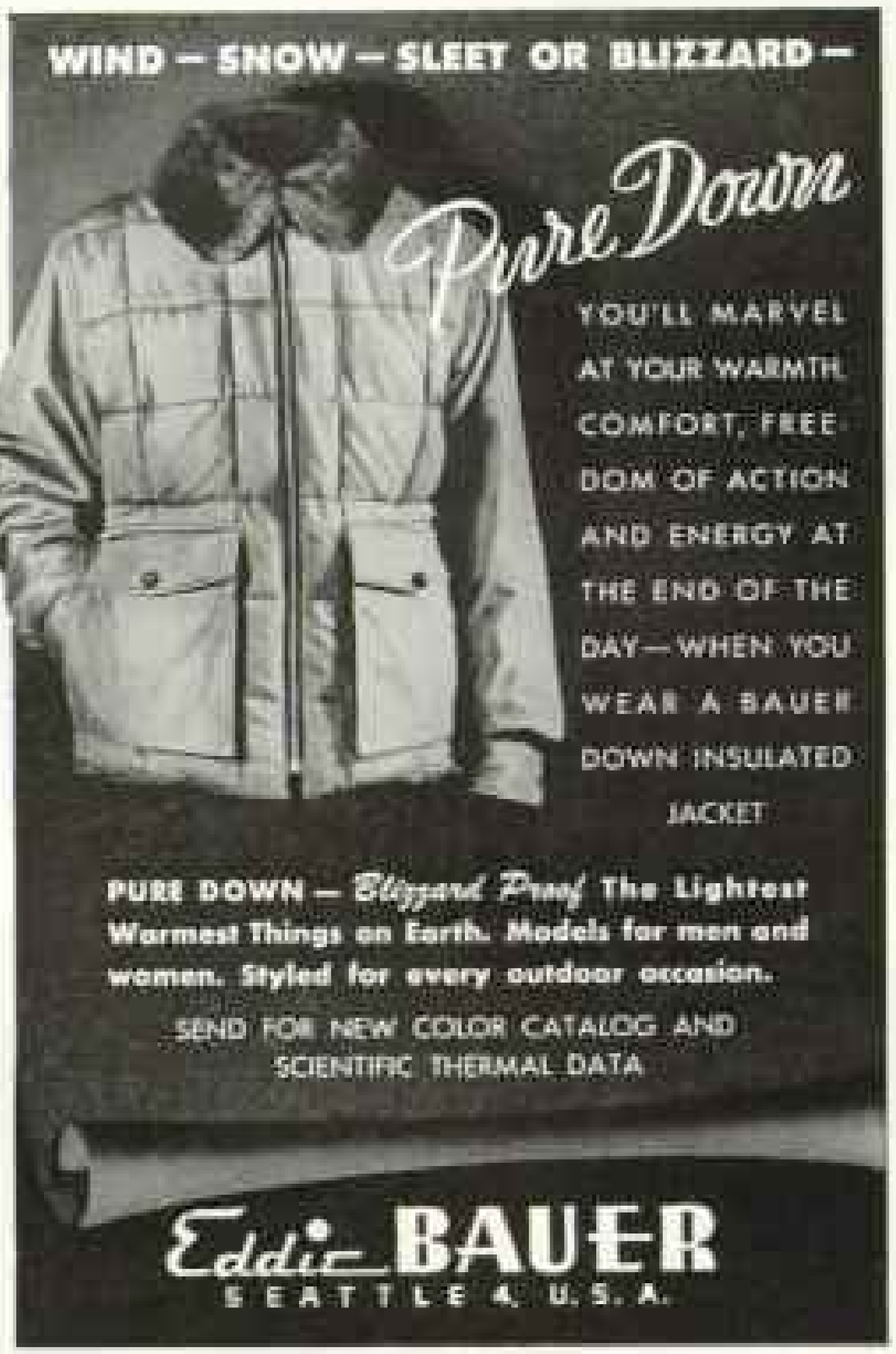

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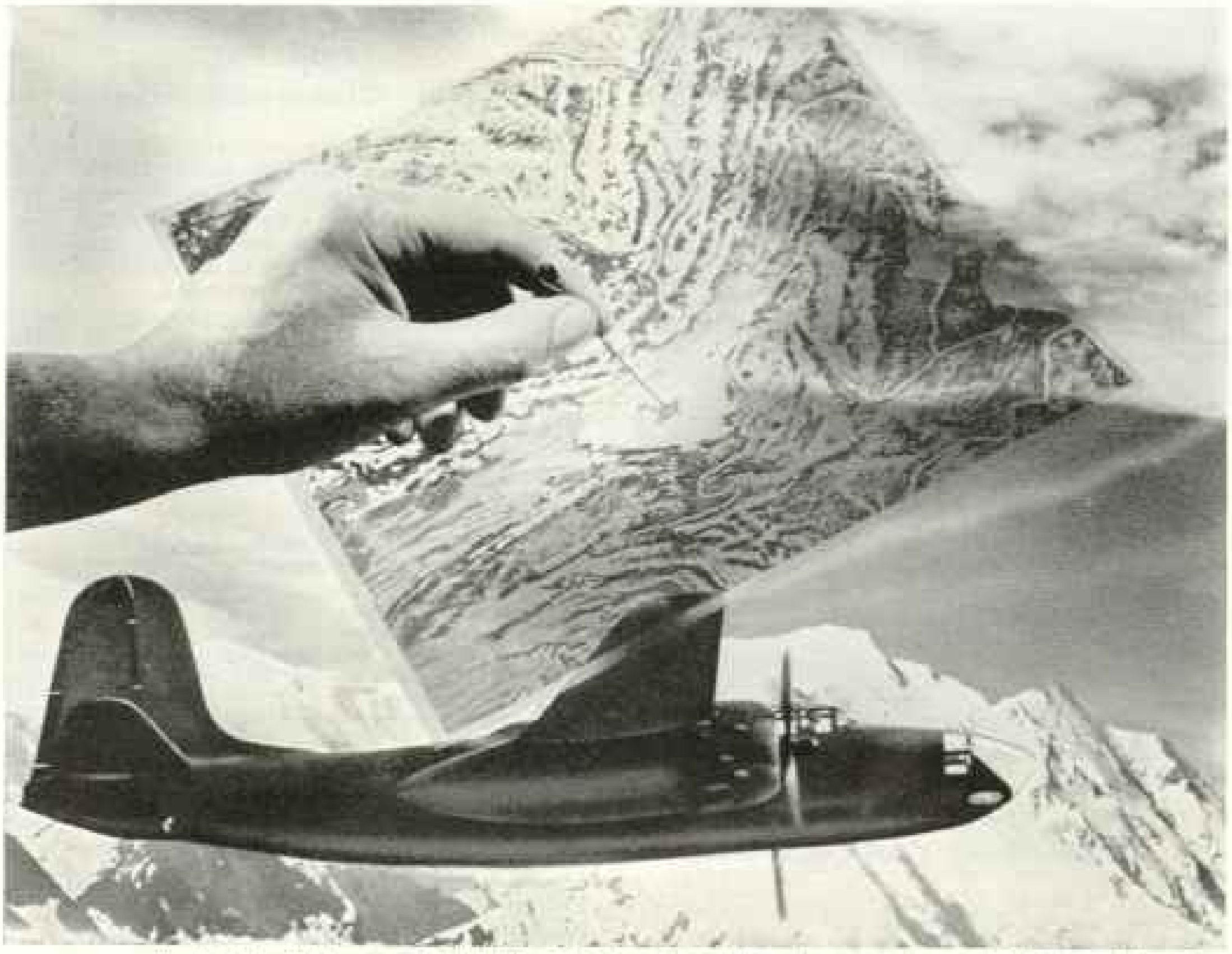

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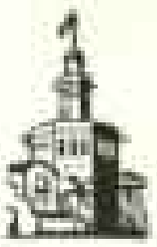

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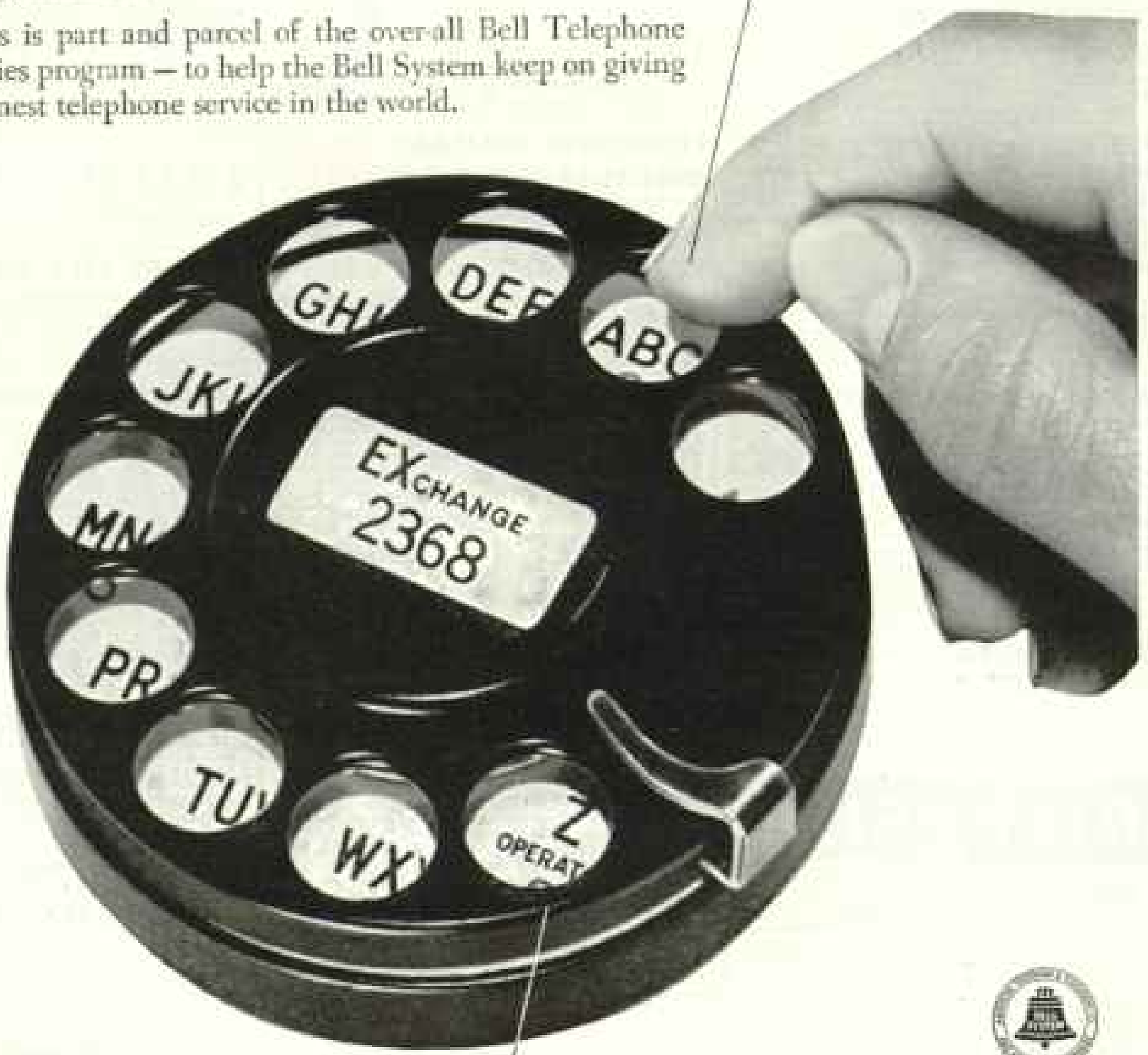

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