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WASHINGTON, D. C.

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NATIONAL GEOGRAPHIC SOCIETY

GEOGRAPHIC ADMINISTRATION BUILDING
SIXTEENTH AND M STREETS NORTHWEST, WASHINGTON 6, D. C.

ORGANIZED FOR "THE INCREASE AND DIFFUSION OF GEOGRAPHIC KNOWLEDGE"

To carry out the purposes for which it was founded eighty-two years ago, the National Geographic Society publishes this Magazine monthly. All receipts are invested in The Magazine itself or expended directly to promote geographic knowledge.

Articles and photographs are desired. For material The Magazine uses, generous remuneration is made.

In addition to the editorial and photographic surveys constantly being made, The Society has sponsored more than 100 scientific expeditions, some of which required years of field work to achieve their objectives.

The Society's notable expeditions have pushed back the historic horizons of the southwestern United States to a period nearly eight centuries before Columbus crossed the Atlantic. By dating the ruins of the vast communal dwellings in that region, The Society's researches solved secrets that had puzzled historians for three hundred years.

In Mexico, The Society and the Smithsonian Institution, January 16, 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, 320 B. C. (Spinden Correlation). It antedates by 200 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. Army Air Forces Expedition, from a camp in southern Brazil, photographed and observed the solar eclipse of 1947. This was the seventh expedition of The Society to observe a total eclipse of the sun.

The Society cooperated with Dr. William Beebe in deep-sea explorations off Bermuda, during which a world record depth of 3,028 feet was attained.

The Society granted $25,000 and in addition $75,000 was given by individual members, to the Government when the congressional appropriation for the purpose was insufficient, and the finest of the giant sequoia trees in the Giant Forest of Sequoia National Park of California were thereby saved for the American people.

One of the world's largest icefields and glacial systems outside the polar regions was discovered in Alaska and Yukon by Bradford Washburn while exploring for The Society and the Harvard Institute of Exploration, 1938.

So excitingly different . . . A South Sea Autumn Vacation in Hawaii

Take equal parts of sunshine and trade winds . . . season with South Sea romance . . . add lovely tropical flowers for aroma and color . . . serve under the bluest of skies . . . and you have the incomparable vacation recipe of Hawaii! You need no passport to savor it . . . you maintain your own standards of living while you enjoy it. ● Folkways of ancient Polynesia . . . surf sports and gaiety at Waikiki . . . shrines, bazaars, exotic customs of the Orient . . . the smoldering volcano, Mauna Loa, and embattled Pearl Harbor . . . the dream-like beauty of tropic isles afloat in sapphire seas . . . these will be among a thousand etchings on your memory! ● Air and steamship lines link Hawaii with San Francisco, Los Angeles, Portland, Seattle, Vancouver. You can go one way by air, the other by sea, or round trip by either. From Honolulu, on the island of Oahu, short flights take you to the other major islands of the Hawaiian group . . . Maui, Hawaii, Kauai. Let your Travel Agent help you plan to visit them all at moderate cost.

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Hawaii invites you with year 'round charm. Come any time . . . come NOW!

The man who put up a monument to 15 minutes

George Carlson builds a monument in his mind every time he walks into his brand-new home, or looks at his fine, new furniture. The inscription on Mr. Carlson's monument reads: "To the most valuable fifteen minutes I ever spent."

Mr. Carlson shivers every time he remembers how easily he might have missed out on those fifteen minutes. He could have been "too busy." He could have been "out" to all callers. He could have refused to listen when an Agent of one of the North America Companies explained how woefully weak Mr. Carlson's property insurance really was.

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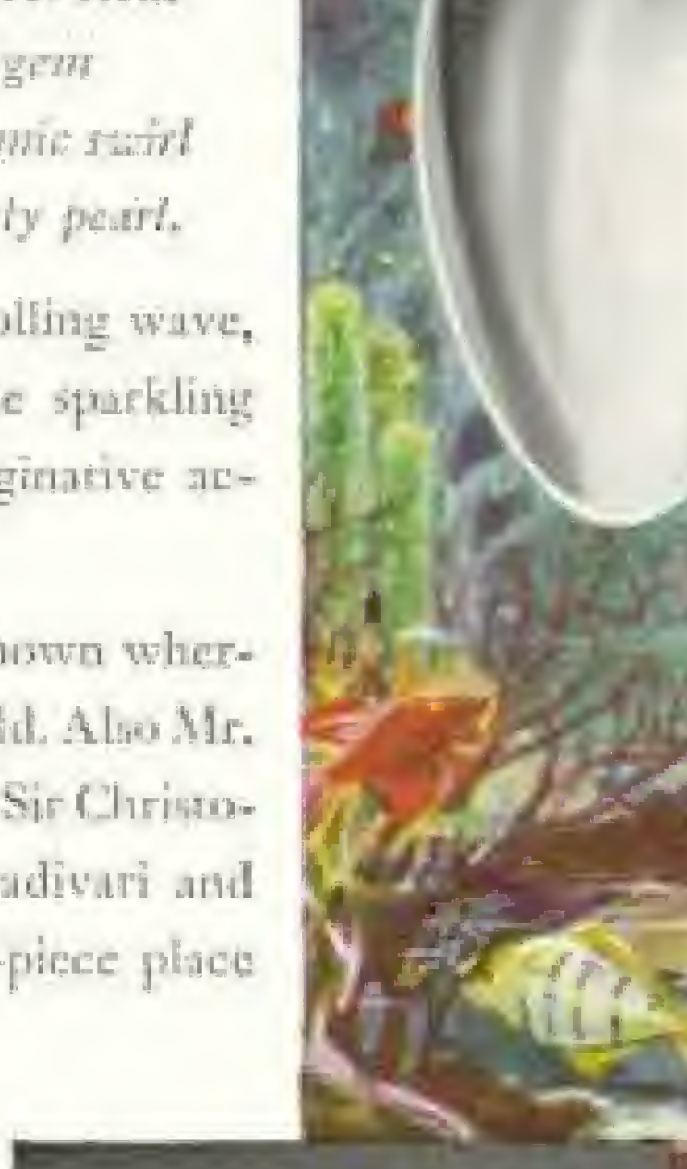
Dynamic and thrilling as it unfolds the true beauties of the mood of adventure found in Nature's fascinating symbols of the sea.

Fully sculptured in "Third Dimension Beauty," the mermaid silhouette is the exact body outline for this enchanting pattern.

And deeply down the silver stem
The motif is the ocean's gem
Gay flora flows in rhythmic swirl
Rich setting for the lovely pearl.

The majestic shell, the scrolling wave, the delicate spray and the sparkling bubbles complete the imaginative accomplishment.

"Romance of the Sea" is shown wherever fine sterling silver is sold. Also Mr. Warren's Grande Baroque, Sir Christopher, Grand Colonial, Stradivari and Rose Point. Prices for six-piece place settings: $27.40 to $37.50.



WILLIAM S. WARREN
Creator of "Romance of the Sea" and other Wallace designs sculptured in full-formed "Third-Dimension Beauty"...beauty in form, beauty in profile, beauty in back.

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Do you count your daily cups of coffee?

MOST FOLKS DO KEEP track of how much coffee they drink.

It's because they have an uneasy feeling that they might drink *too much* of this delicious beverage.

For they realize that coffee contains caffein—and that caffein can make some people nervous and irritable, keep them awake at night.

Whenever you *are* tense, jittery, sleepless—you naturally wonder if coffee is the cause. Should you cut down on the number of cups you have each day? Should you cut it out altogether? *What* to do?

DRINK SANKA COFFEE

REAL COFFEE - 97% CAFFEIN-FREE

You can go right on drinking the coffee you love so much—just make sure you drink Sanka Coffee!

Sanka Coffee is caffein-free!

Sanka Coffee won't make you jittery—or keep you awake. It just *can't*—because 97% of the caffein has been taken out!

But removing the caffein doesn't detract a bit from Sanka's rich, full-bodied flavor, its tempting aroma. You still get the wonderful taste-goodness—the wonderful sense of satisfaction and bracing cheer that only coffee can give you!

Start drinking Sanka tomorrow. It's real coffee, all coffee, grand coffee—so you have nothing to lose, and possibly a great deal to gain.

Sanka Coffee

Real coffee with the worry taken out.
Drink it and sleep!

Products of General Foods

Welcome Aboard The New Sunset Limited

The Sunset Limited, Southern Pacific's famous streamliner between New Orleans and Los Angeles, has just been completely equipped with new Budd all-stainless steel cars. There are five, fifteen-car trains, altogether, to provide daily service from each terminal. And they are gorgeous.

Interiors range in color from the soft tones of the brooding bayous of Louisiana to the gold of desert sunshine. The brands of pioneer ranches along the route the train traverses are burned right into the leather wall covering in the coffee shop-lounge cars. The Sunset Limited personifies the southwest.

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The Sunset Limiteds are The Budd Company's most recent contribution to railway progress. They give you a new and compelling reason to experience the pleasure of modern travel by train. The Budd Company, Philadelphia, Detroit.

Budd

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With this great new G-E Automatic Dishwasher

...your hands need never touch dishwater again!

Free-Standing Model—Can fit in your existing cabinet space.

Combination Model—Automatic dishwasher built in with G-E Electric Sink.

IMAGINE the wonderful convenience of *never* having to wash dishes again!

This great *new* General Electric Automatic Dishwasher will do the whole job for you—washing and drying your dishes as well! With many *new* G-E features—features you've never seen in any other dishwasher—it's the last word in worksaving efficiency and dependability!

Just look at all these worksaving, timesaving G-E features

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- **New Preliminary Power Rinse**—Flushes food particles off dishes even before washing begins!
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- **Drying by Heated Air**—Calrod heating unit sends up electrically heated air for quicker, better drying!
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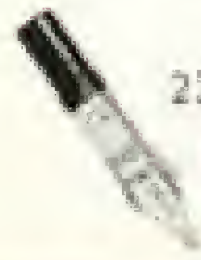

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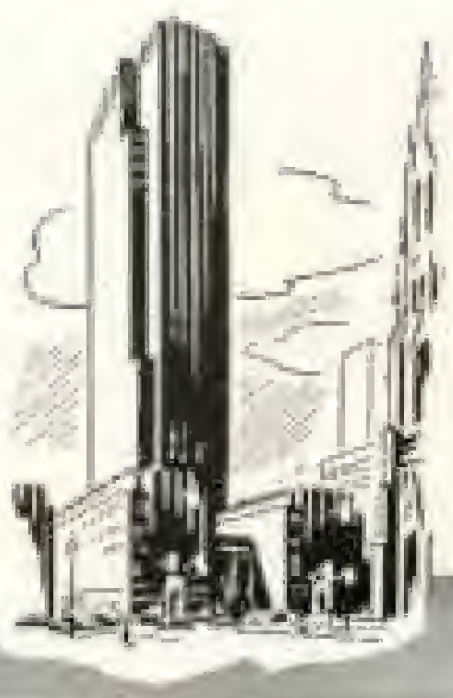

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This map room is CHQ in Sinclair's search for oil. It organizes the information Sinclair's top production planners need to direct drilling and exploration.

To the map room come reports from Sinclair scouts and exploration parties. Here is recorded the location of every well ever drilled in America's great oil fields . . . of all Sinclair geophysical and geological surveys . . . and of acreage owned or leased by the Company. Essential facts are plotted by specialists on three wall maps—maps so large that unrolled and placed end to end they would exceed the length of a football field. Supplementing them is a file of almost 3,000 detailed hand maps.

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Order in quantities as listed. No "split-package" orders accepted. Maximum printing—4 lines, 30 characters per line. Remit with order. West of Denver, Colo., and in U.S. possessions, add 10% to prices. (No foreign orders.) We pay the postage. *Satisfaction guaranteed.*

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125 LETTER SHEETS (size 6¾ x 10½) and 125 MATCHING ENVELOPES, all in Americr paper. A distinctive correspondence paper. All neatly printed.

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17-Inch Rectangular Picture Tube. Built-In FM Radio. Plug-In for Record Player.

You always wanted a Du Mont.
Now here they are—bigger, newer, better than ever-
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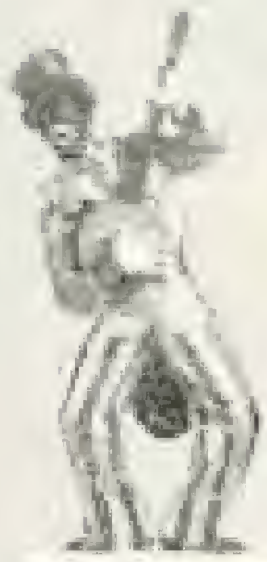

The TARRYTOWN by Du Mont
17-Inch Rectangular Picture Tube. AM-FM Radio
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CABINETS DESIGNED BY HERBERT ROSENGREN

These are Television's finest instruments. Every one of the sixteen new Du Monts has the famous engineering of the laboratories that built the first home television receivers. More than ever, a Du Mont is the greatest value in television.

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You arrive and depart

Down-Town

on the Santa Fe

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When you're going somewhere, you want to *be* there when you arrive.

Go Santa Fe. You leave on your trip when you *plan* to leave.

You arrive relaxed, refreshed, at a convenient station right downtown, close to your hotel or office.

Travel Santa Fe and you choose accommodations to suit yourself. You get privacy as you like it. You have room to roam around when you want it. You enjoy wonderful Fred Harvey meals.

You be the judge. Go Santa Fe *all the way!*

Santa Fe

Ride great trains through a great country

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Colorful New World

FROM MORNING TILL NIGHT, the colors of the rainbow are all around you—through plastics. A blue plastic clock wakes you, and you flip on an ivory plastic light switch. You take your clothes from a yellow plastic hanger. Plastic toothbrushes come in colors for every member of the family. Cheerful decorating schemes are enhanced by the beauty of plastic drapes. There's no limit to the colors you can get in these versatile materials!

But this is only the start of the plastic story. Plastics make better clothing possible. Modern furniture and furnishings owe much to plastics. Much of your food is packaged in clean, clear plastics. Plastics add to the safety, durability, and appearance of many of your electrical appliances.

These versatile basic materials are man-made. Organic chemicals are the ingredients of the "unfinished" plastics—called resins. From these resins come the many different forms of plastics we know.

The people of Union Carbide are leaders in the production of plastics, resins, and related chemicals. They also provide hundreds of other materials for the use of science and industry.

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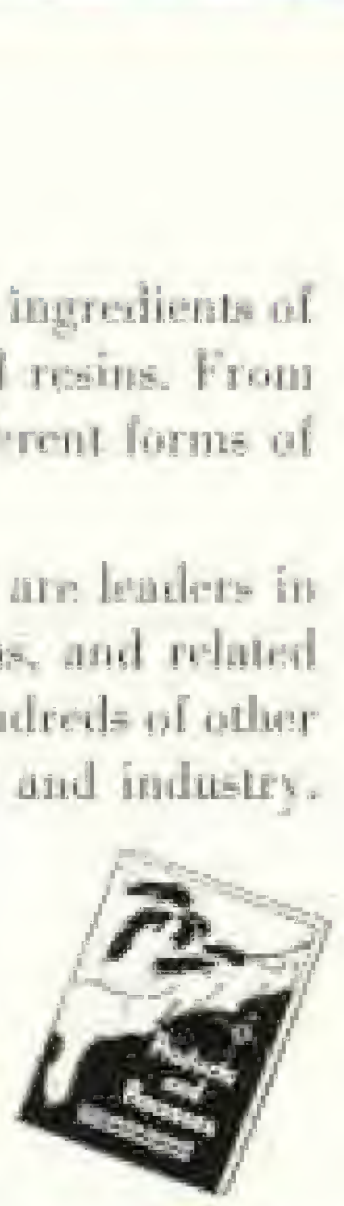

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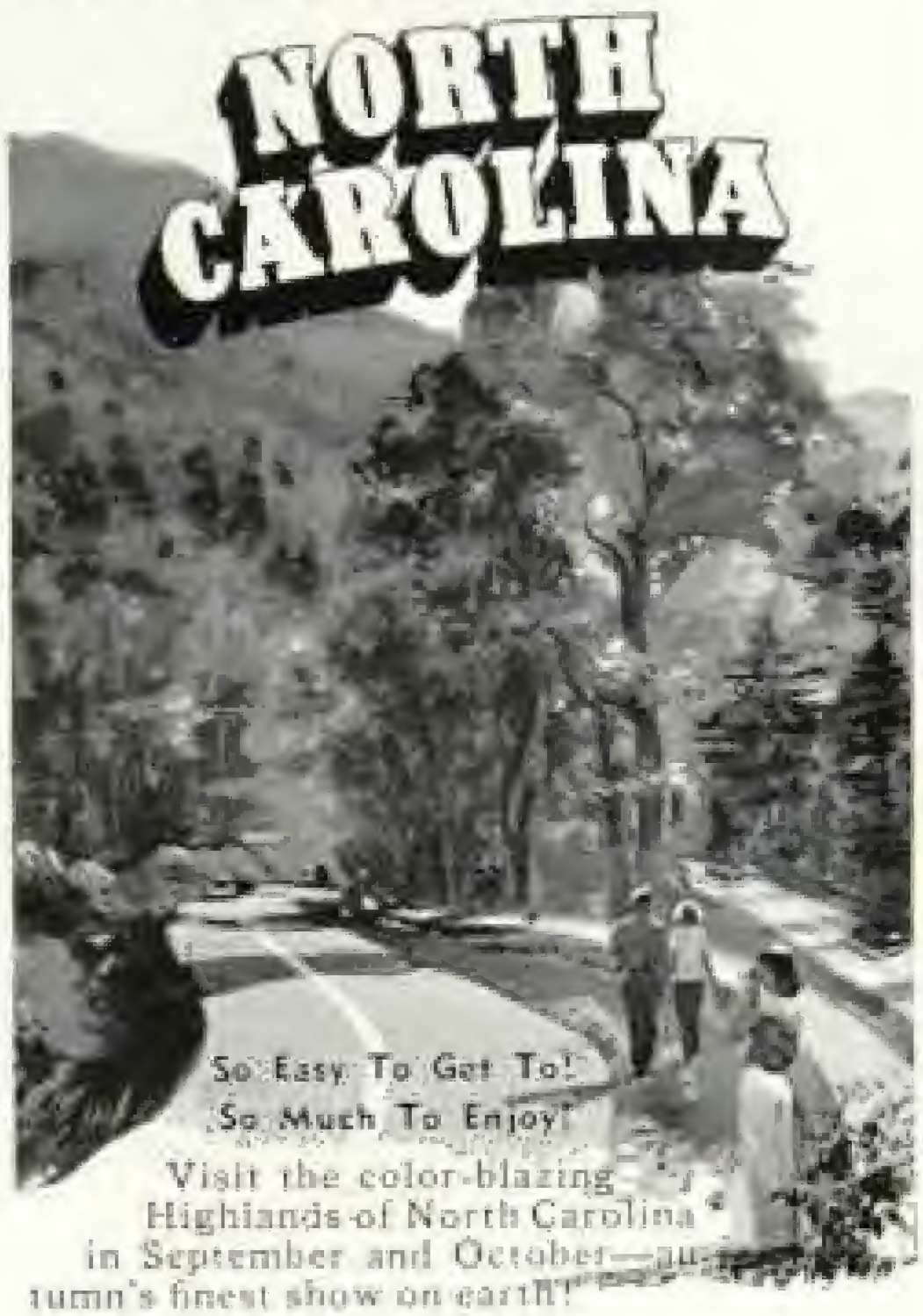

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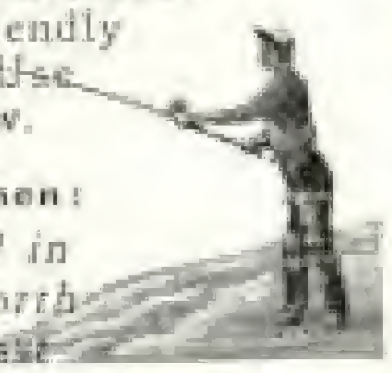
Write today for your free copy of "Color Parade" . . . your guide to nature at its most spectacular in North Carolina—the friendly vacationland. Use coupon below.



Memo to Fishermen:
Fishing's good in the Fall on North Carolina's coast

Department of Conservation and Development
Dept. 27 Raleigh, North Carolina

Please send my free copy of "Color Parade"

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South Africa's spectacular scenery, delightful climate, beaches and lakes will captivate you. Modern cities, Zulu villages, big game hunting, motor, camera safaris . . . nowhere else do so many new experiences await you.

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New RCA electron tube "freezes" movements that occur, and are ended, in millionths of a second!

How to "see" a super fine slice of time!

Now scientists at RCA Laboratories work with slivers of time too infinitesimal for most of us to imagine. Their new electron tube, the Graphechon, makes it possible.

For instance, in atomic research, a burst of nuclear energy may flare up and vanish in a *hundred-millionth* of a second. The Graphechon tube oscillograph takes the pattern from an electronic circuit, and recreates it in an image which can last for a minute and a half. Scientists may then observe the pattern of the burst . . . measure its energy and duration.

With Graphechon we can now watch fleeting phenomena which occur at random, outside our control. It is not only applied to nuclear research, but also to studies of electrical current . . . or in new uses of radar and television. Like so many products of RCA research, Graphechon widens man's horizons.

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Progressive research, like that which gave us the Graphechon tube, accounts for the superiority of RCA Victor's new 1950 home television receivers.

RADIO CORPORATION of AMERICA

World Leader in Radio — First in Television

YOU CAN BE **SURE**..IF IT'S Westinghouse

ULTRA-VIOLET BY THE ROOMFUL

Best way to get your ultra-violet is out under the sun.

Next best way we want to tell you about.

Everybody needs ultra-violet for health. Everybody likes ultra-violet for tan. Most everybody gets too little, particularly with winter coming on.

Now it can be different, because our engineers have come up with a "wow" of an answer.

It's a new kind of sun lamp: Fluorescent. It's long: it's tubular: it bathes a wide area with cool, low-level but effective ultra-violet. It doesn't cost too much to buy and it is very inexpensive to operate because it doesn't waste electricity making heat.

Schoolrooms please note. Also offices, drafting rooms, factories, *and* homes, where, if you wish, you can mount this lamp for high-speed tanning.

That's our commercial, except this: You can buy this tube of sunshine right over the counter. Or, you may obtain more information from our Lamp Division in Bloomfield, New Jersey.

. . . Also except this: It is one more example of the ingenious engineering inherent in our credo . . . You Can be SURE . . . If It's Westinghouse.

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MINNEAPOLIS—SEATTLE	33.90	61.05
KANSAS CITY—DENVER	12.10	21.80
DALLAS—SAN ANTONIO	5.60	10.10
CHICAGO—NEW YORK	17.25	31.05
PORTLAND—SAN DIEGO	16.70	30.10
ST. LOUIS—NEW ORLEANS	12.55	22.60
PHILADELPHIA—MIAMI	22.75	40.95
BOSTON—NEW YORK	4.15	7.50
CINCINNATI—WASHINGTON	9.95	17.95

(U. S. transportation tax extra. Prices subject to change.)

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They cost less! They're full of fun! Greyhound Charter Trips will keep your crowd together . . . take your group direct to hotel, convention, stadium, or anywhere you choose!

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- TO WASHINGTON SESQUICENTENNIAL

See your local Greyhound agent about Charter Service for any club, church, school, band, or veteran's organization. Do it today!

BARGAINS

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Here are just a few examples. The Tours include hotels, transportation, sightseeing — all planned for you!

NEW ENGLAND CIRCLE, 7 Days	$ 44.55
NEW YORK CITY, 3 Days	23.45
FLORIDA CIRCLE, 11 Days	77.10
LOS ANGELES, 8 Days	24.85
GREAT SMOKY MTS., 4 Days	19.50
WASHINGTON, D. C., 6 Days	19.35
LAS VEGAS-HOOVER DAM, 3 Days	9.25
CHICAGO, 3 Days	12.00
EVERGREEN CIRCLE, 3 Days	21.85
MEXICO, 12 Days	124.85
(Escorted tour from San Antonio)	
HAVANA, 3 Days	38.50
(By bus to Key West, air to Cuba)	

In all prices shown, add Greyhound round-trip fare from your city. U. S. tax extra. Prices subject to change.

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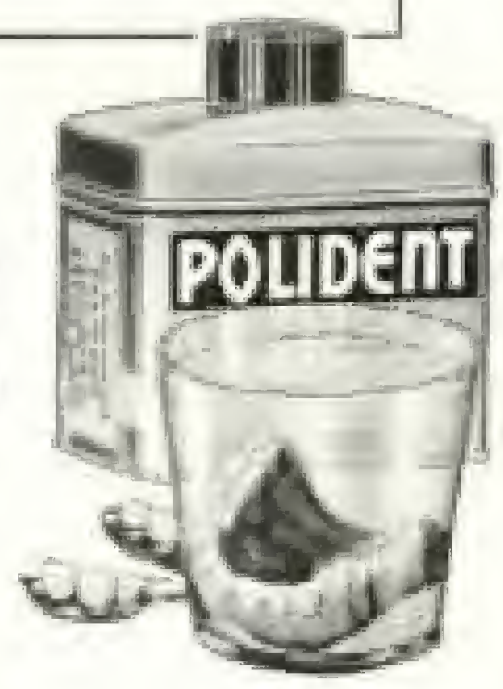

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Since 1900, the life expectancy in our country has increased to nearly 67 years—a rise of about 18 years in less than half a century. This has been occasioned by many advances in medical science.

Today, the doctor has at his command new diagnostic techniques, improved equipment and greater knowledge of the factors affecting good health. There will undoubtedly be many other advances in the future. To get full benefit from these medical developments people have only to take one simple, easy step . . . see their doctors at periodic intervals.

Regular physical examinations do more than provide a check of your physical condition. They give the doctor an opportunity to advise you about your general health habits and daily routine. He may advise on the kinds and amount of food you should eat, on what to do to keep your weight normal, or the types of activities that are best suited to your physical condition and particularly to your heart.

In addition, the physician may be able to discover and correct conditions which might grow more serious if allowed to go untreated. To help him give you a complete and thorough check-up, your doctor may use such modern aids to diagnosis as these:

The X-ray. This is especially valuable in helping to diagnose diseases that often start without any outward warning signs. Use of the X-ray usually enables the physician to detect such conditions *early*, when chances for control or cure are best.

The fluoroscope. It permits the doctor actually to watch the functioning of the digestive system, the heart, lungs and some of the other organs. Aided when necessary by other tests, this direct observation is an important help in diagnosis.

The electrocardiograph. This records the rate and rhythm of heart action. By revealing variations from a normal pattern, it gives the physician information about the functioning of the heart which is often not otherwise obtainable.

Blood tests. These offer valuable clues to general physical condition and help detect certain illnesses. They may include serologic and chemical analysis of the blood, counts of red and white cells, and determination of hemoglobin content.

Why the robin hops . . . then STOPS

WHEN SPRING COMES rolling round, young Miss Robin begins to show a decided interest in domestic life.

It's no trouble at all for her to find a mate. But bringing up a family—with a nest to build and mouths to feed—could be a bothersome chore were it not for the way the newlyweds work together. And the good ears they have.

Watch robins as they hop about your lawn. They scurry rapidly for a foot or two, then suddenly stop. In this brief moment, the robin is *listening* as well as looking.

For with their extra-sensitive ears, according to some ornithologists, robins can actually hear the soft squirmings of earthworms in the soil. And because they can hear a worm turn, they never have to fret about where the next meal for the fledglings in the apple tree is coming from.

Fortunate is the young couple starting out to raise a family if, like the robin pair, they both have special abilities to help them earn a living for their flock.

But even the best provider needs, in addition, certain, sure protection for that earning power while the family's growing up.

That comes through the right kinds of insurance and enough of each. Through a well-balanced insurance plan, you can guarantee your family a good house, decent clothes to wear, food to eat, and schooling for the youngsters—whether or not you're on hand to foot the bills for them.

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THE NATIONAL GEOGRAPHIC MAGAZINE

Flying in the "Blowtorch" Era

BY FREDERICK G. VOSBURGH

Since the days of man-lifting kites and crude flying machines called "aerodromes," the NATIONAL GEOGRAPHIC MAGAZINE *has published through the years 110 articles on aeronautics. To give its members a clear understanding of this age of phenomenal speeds resulting from jet and rocket propulsion, the National Geographic Society has assembled facts and photographs, primarily in the United States, for presentation in the following article, which has been approved by official sources. The author traveled by air throughout the country to make this firsthand survey.*—The Editor.

FIVE HUNDRED miles an hour, said the air-speed indicator. As our jet plane smoothly gathered momentum, the hand moved up to 510, to 520.

In a mere training plane we were traveling nearly a hundred miles an hour faster than any American fighting aircraft flew in action in World War II.

As the Lockheed T-33 shot through the sunny sky a mile above Eglin Air Force Base, Florida, I felt no sensation of terrific speed. With nothing but wispy white clouds in sight, 520 seemed no faster than I had flown in commercial airliners or in Black Widow night fighters during the war.

"No telephone poles up here to whiz past," said Capt. Don Lopez from the pilot's seat through the throat mike that picked up his voice from his Adam's apple. "If there were, they'd look like teeth in a comb."

Even at 520 miles an hour the turbojet engine behind us drove the two-seater with no vibration and with little noise I could hear above the scream of the outraged air. I could scribble notes as legibly as in a Pullman. The only tremble came when I glanced at that telltale air-speed hand.

"Want to see how she rolls?" came the pilot's voice through the earphones as we slowed down to 500.

"Sure," I gulped.

The duplicate control stick before me moved to the left, and the earth changed places with the sky twice while the hurtling plane stayed steady as a rock. Throttled back, we glided down to a smooth tricycle landing.

Now I knew what a jet jockey meant when he said, "It's like riding in a 1950 Cadillac after a Model T."

Fastest Planes Keep Pace with Sun

On a 7,000-mile swing around the United States I was seeing the revolution taking place in aviation. Jet and rocket engines have given flying literally "a blowtorch in the tail," as today's pilots refer to the fierce, hot blast of their jets.

Though I saw no flying saucers, new sky craft seemed almost as strange to this old Air Force relic of the days when our fighting planes were pulled by fans. Most of them now are blistered along by a stream of hot gas.

In this era of rocket and jet propulsion, speed of flight has so increased that flyers in today's fastest planes could briefly perform Joshua's miracle of making the sun stand still.

Pilots sealed inside the Bell X-1 rocket ships have flown so fast over California's Mojave Desert that if they were headed west the sun above them would appear not to move—in fact, it might go backward. In their two-and-a-half minutes of full power they can reach or even exceed the rate the world goes round at that latitude—852 miles an hour.

Now with retirement of the X-1 *Glamorous Glennis* to the Smithsonian Institution, her

Plane Builders Compete in Designing Jet Fighters; Here Are Two of the Newest

Built as rivals in an Air Force design competition were McDonnell's XF-88 Voodoo (lower), North American's YF-93A (upper), and Lockheed's XF-90 (page 290). "May the best plane win," said the Air Force in effect, after specifying speed, range, altitude, and other requirements. All are big, heavy fighters, with swept-back wings. Unlike its twin-jet competitors, North American's entry packs its power in a single jet engine. All three have the emergency extra-power device known as an "afterburner" (pages 289 and 310).

place is to be taken by the Bell X-1A built to go 1,700 miles an hour in 4.2 minutes of rocket blast. Up and up goes the curve of speed, faster since the war than ever before.

Less than three years have passed since Air Force Capt. Charles E. ("Chuck") Yeager, in the *Glamorous Glennis* named for his attractive wife, became the first man in the world to fly faster than sound travels—about 660 to 760 miles an hour, depending on temperature (page 502). During that time X-1 planes and the Navy's Douglas-built Skyrocket have surpassed the speed of sound again and again, at altitudes ranging from several miles in the air to within 50 feet of the ground.

When flying low, "on the deck," the jet- and rocket-driven Skyrocket, with incredibly tiny backswept wings, approaches as silently as a big white fish, which it faintly resembles. Its mighty roar, outstripped by the source, trails behind and is heard after the plane has passed.

Such planes are packed with instruments, from "swordfish" test boom (page 309) to tail. Guidance they give designers helps shape the future in the air.

Stratojet's Thin Wings "Wave at You"

Among the latest to be tested against Father Time and the laws of aerodynamics is the new Air Force delta-winged plane built by Consolidated Vultee. Its wings are triangles and it has no tail, just a fin on the back of the fuselage (page 315).

Tailless, too, is the Navy's rakish new Chance Vought Cutlass carrier fighter (page 289). Remarked an Air Force officer, "It

Harold G. Martin (below)

A New Fighter Tries Oddly Shaped Wings; Another Dumps Fuel from Wing-tip Tanks

Most wings taper toward the ends, but those of Republic's XF-91 (top), experimental high-altitude Air Force interceptor-fighter, are widest and thickest at the tips. They slant sharply backward and can be turned up or down in flight to increase or lessen their lift (pages 287-8). That stout tail is designed to hold both jet and rocket engines; top speed is a military secret. Over Long Island a Navy carrier-borne jet fighter, the Grumman F9F Panther, shows how it jettisons fuel instead of dropping costly wingtip tanks before combat.

looks as if it's going about 800 miles an hour just sitting on the ground."

Flexible swept-back wings of Boeing's B-47 Stratojet bomber are so thin that they droop when the plane is at rest. They bend the other way when they carry the weight of the six-jet bomber, as big as a Superfortress (page 294). In flight they flex like a fly rod, as much as seven feet at the tips.

"You sit there and watch 'em wave at you," grinned Bob Robbins, former B-47 project pilot and now an assistant project engineer. "They take up a lot of the shock and give you a nice smooth ride in rough air."

Much of the necessary strength is in the aluminum alloy "skin," up to five-eighths of an inch thick.

This newest operational Air Force bomber is a good example of how the contributions of many men make a modern plane. Experimental models wore out brakes and tires, so "hot" was the plane in landing.

"Look, why don't you use a chute to slow her down?" drawled an Air Force test pilot, Maj. Guy M. Townsend. "We used to toss out our chutes during the war when our brakes were shot out, and it worked fine."

The result was the parachute brake, now standard on the Stratojet (page 308).

Little Herbert Joins the Crew

Another result of flight tests was "Little Herbert," who got his start in a junk yard.

Test-flying the Stratojet at Larson Air Force Base, Moses Lake, Washington, pilots found that it sometimes had a "Dutch roll," swinging one way, then the other, like a waltzer on skates.

U. S. Department of Defense

Planes Spawn Artillery: Howitzers with Parachutes Tumble from Fairchild C-82's in a Demonstration for President Truman

Jeeps that pull the 105-mm. howitzers were dropped a few seconds later from the big propeller-driven transports with their sawed-off-seeming bodies. Each cannon weighs 4,980 pounds, each jeep 2,560. Ninth Air Force troop carriers and the Army's 82d Airborne Division put on this show at Fort Bragg, North Carolina.

A "Light Bomber" in Today's Air Force, the B-45 Tornado Far Outweighs World War II's Famed "Heavy," the Flying Fortress

North American's four-jet bomber can carry a bigger bomb load than the "Fort"—and at more than twice the speed. The Air Force rates it "in the 550-miles-per-hour class." Tornadoes can attack targets 800 miles away. This one thunders over California's high Sierras near Mount Whitney, left background.

"One day," recalled Robbins, "the boys over at Moses Lake came back here to Seattle and raided a junk yard down the street. They took the gyroscope from the autopilot of a wartime B-29 and rigged it up with a motor and control they got from the same place. They called the result 'Little Herbert,' just a device that senses the change of direction and counteracts the tendency to turn.

"Little Herbert is now a stowaway in the back part of the fuselage of every B-47 built. He makes it a steadier bombing platform."

This bomber has outrun at least one jet fighter and has averaged over 607 miles an hour in a flight across the continent. Yet, here at Boeing's Seattle plant, a bigger and potentially even better "bomber of the future," the secret XB-52, is being built as a possible successor to the huge B-36 (pages 300-301). Visitors are barred from the enclosure in which the new giant is taking shape.

U. S. Strives to Keep Its Lead in Quality of Planes

"We have to maintain the No. 1 Air Force of the world, with a heavier punch than anybody else, or the war will stop being cold," said four-star Gen. George C. Kenney, in Seattle to inspect the embryo bomber. (This was before the shooting started in Korea.)

"Numerically, we're behind. Technically, I think we can keep ahead. If we ever fall behind, there won't be time to catch up. No American airplane took part in World War II that wasn't already ordered into production at the time of Pearl Harbor."

Uncle Sam's money finances much of our progress in the air; nobody else could afford it.

Dollars spent for military planes keep the Nation's aircraft industry alive, solvent, and full of competitive enterprise. They pay for the great basic research in air-frame design, power plants, and missiles carried on by the National Advisory Committee for Aeronautics in ultramodern laboratories at Langley Air Force Base, near Newport News, Virginia; at Moffett Naval Air Station, near San Francisco; at Cleveland Airport (page 510);

← Up Pops a Human Jack-in-the-Box from a Plane Flying 555 Miles an Hour

Capt. Vincent Mazza of the Air Force explodes 60 feet high within a second in a test of the ejection seat used to enable flyers to escape from high-speed planes. Catapulted by a powder charge, seat and man both shoot skyward; then the seat is released and the flyer descends by parachute (page 311).

"If there is an unpleasant part to it, it is gone before you have time to realize it," said Captain Mazza, daring volunteer from the Air Force's Aero Medical Laboratory, Dayton, Ohio. He and Staff Sgt. Victor A. James made test ejections from this Lockheed T-33 jet trainer at air speeds ranging from 405 to 555 miles an hour last year over San Pablo Bay, California.

U. S. Air Force, (Official) 308

Four Engines, Eight Fans, Drive the World's First Turboprop Flying Boat

Twin propellers, turning in opposite directions, absorb the 5,500 horsepower of each Allison gas-turbine engine. Unlike the turbojet (page 314), the turboprop harnesses the jet of hot gas to turn a turbine that drives propellers. Escaping, it also gives some jet thrust. Built for the Navy by Consolidated Vultee, the 60-ton flying boat XP5Y-1 takes off in a calm in less than 50 seconds. Top speed is "more than 350 miles per hour." Turboprop power is now being tried in transports (page 321).

and at Wallops Island, on the Virginia coast.

Results of all this research go to the armed services and to plane manufacturers.

Ultimately, the lessons learned reflect themselves in the planes of peace. This has been the story after both World Wars—in fact, ever since 1909 when the Wright brothers sold the first military plane to the Government and got a $5,000 bonus for exceeding by seven miles the specified speed, 40 miles an hour.

Some planes now have wings that can be altered in flight. I saw one type on the XB-51, racy three-jet light bomber made by Martin for the Air Force (page 304). On the ground the thin wings droop like a baby robin's.

"I still thrill every time I go out to look at the XB-51," said veteran plane-maker Glenn L. Martin.

Extend your arm from the shoulder, then turn it. That's how these "variable incidence" wings can be turned in flight—one way for most lift, as in take-offs and landings, the other for least drag at high speed. Thus the bomber combines the speed of a fighter with the ability to fly from smaller fields than a

plane so big and fast would otherwise need. Republic's radical new interceptor-fighter, the XF-91, also has adjustable wings (page 283).

Sharply backward-slanting wings, found best for today's phenomenal speeds, mark the Nation's newest jet fighting and bombing planes. First of these in production was the North American Sabre, which two years ago set an official world's record of a shade over 670 miles an hour (page 505).

"Will it fly faster than sound?" I asked a Sabre pilot.

"She's rated at .95," he replied, "but I believe she'll go over the Mach."

The modern airman's term "Mach," pronounced "Mock," comes from the late Ernst Mach, Austrian scientist. Instead of a speed in mere miles per hour, each plane now has its "Mach number." Mach 1 indicates the speed of sound; Mach .95 is 95 percent of it; Mach 2 would be twice it; and so on.

Strange Effects at Speed of Sound

As they approach Mach 1, pilots notice strange buffeting effects.

"The left wing gets heavy," said a fighter pilot, "the controls get mushy and stiff, and the nose begins to tuck under. That's where I quit."*

Why do such effects occur at the speed of sound?

"When you move your hand through the air, or when a plane flies at less than sonic speed, it sets up pressure waves like the waves from a stone tossed into a pool," explained Dee Wyatt, of the NACA's Lewis Flight Propulsion Laboratory at Cleveland. "They warn the air that something is coming, and the molecules start to move out of the way.

"These pressure waves travel at approximately the same speed as sound; so, when a plane flies as fast as sound, the air ahead has no warning. The result is a very abrupt change. We get shock waves as the airplane hits the molecules and the air flow changes its pattern."

"After you go through the sonic wall, everything's as smooth as a kitten's ear and as quiet as a mouse," said Gene May, Douglas test pilot, who has made many supersonic flights in the Navy Skyrocket. "All you can hear is the air stream and any noise that originates in the cockpit. You get the same effects coming out as you do when you go in."

Since a plane is made up of many surfaces, some more streamlined than others, the air flow may be supersonic over some parts and subsonic over others.

"It's as if," said May, "you had an automobile with four men in it and four engines, each driving one of the wheels. The effect is about like you'd get if one driver was trying to go 35 miles an hour, another 20, the third 25, and the fourth maybe 10."

Racy streamlining of high-speed planes reduces the difference in rate of air flow over their various parts and helps them get through the wall with a minimum of buffeting.

Supersonic Test Pilot a Grandfather

May belies the popular impression that a man must be young to fly at such speeds. Though he looks as fit and aggressive as a welterweight boxer, he is 45, gray at the temples, and a grandfather. In the Skyrocket's pressurized, air-conditioned cabin he wears only chute and helmet in addition to ordinary street clothes.

"It's as comfortable to fly at supersonic speed at 10,000 feet," he says, "as it is to fly 300 miles an hour. The average person wouldn't know the difference. But if you're flying close to the deck, the ground looks like a grinding wheel turning under you."

I asked if he wasn't ever—well, a little bit perturbed.

"Once I was plenty scared," he said. "In the Skyrocket at Muroc I was flying an air-speed calibration test at 575 miles an hour at control-tower altitude, checking the instrument's indicated speed against the actual speed over a measured course.

"Suddenly the two red fire-warning lights went on and the fire horn in the cockpit sounded. I went to 2,000 feet to kill my speed and to get enough altitude in case I had to bail out. I decided I didn't have time to make a normal upwind landing.

"'Clear the decks down there,' I called to the tower. 'I'm landing downwind.'

"I cut the engine, pulled the fire extinguishers, sideslipped in, and made a downwind landing at 240 miles an hour, blowing out a tire. The fire-warning lights were still on and the horn going.

"Then we found it was a false alarm, a short in the system!"

Nature's Gift to the Air Force

Eleven-mile-long, 7-mile-wide Muroc Dry Lake, 60 miles north of Los Angeles, is Nature-made for testing high-speed planes.

With the vision that later made him famous as commanding general of the Nation's aerial legions during World War II, the late General of the Air Force H. H. Arnold long ago saw the priceless possibilities of the enormous

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

Kodachrome by Rudy Arnold

Tailless, with Swept-back Wings Far Aft, Navy's Twin-jet Cutlass Carrier Fighter Shows the Eerie Shape of Things to Come

So strange in appearance is this "new look" plane that some bewildered newspapers printed its picture upside down. Speed is given by the Navy guardedly as "in the over 600-mile-an-hour class." Fuel sprayed into special stainless-steel tail pipes called "afterburners" gives bursts of superpower for quick take-offs and combat.

That the Cutlass, or F7U-1, is designed to fly at or near the speed of sound is shown by its knifelike slanting wings, so far back they seem almost an afterthought. At such tremendous speeds the turbulent wake of the wings may buffet the tail, so Chance Vought engineers omitted it completely. Instead, fins rise from the wings' trailing edge. Slats on the leading edge add lift for take-off and landing. Wheels nest in fin stubs under the wings.

The swordfish nose spike of this prototype is a boom carrying test instruments; spikeless are production models now roaring up from Chance Vought's Dallas, Texas, plant to join the Nation's first line of defense.

Needle-nosed for the Ultimate in Streamlining, This Single-seat Fighter Weighs Almost as Much as a 13-ton DC-3 Airliner

Swept-back wings and rakish tail of Lockheed's experimental F-90 are eloquent of sonic or near-sonic speed. The twin-jet heavyweight slugger test flying over the Mojave Desert was designed for the Air Force for deep penetration of enemy territory. Afterburners have now been added for terrific spurts of speed when needed.

A McDonnell Jet Parasite Fighter, the XP-85 Goblin, Trundles down a Loading Ramp for Test-flight Attachment to a B-29

The midget was made to ride in a B-36 bomb bay and hook onto the mother plane after fighting off attackers. Other forms of fighter protection now are favored.


58589
58568
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Most Numerous of All American Jets, Lockheed F-80 Shooting Stars Shine in Formation Flying

Jet pilots of the "Hat-in-the-Ring" Squadron, the 1st Fighter-Interceptor Group's 94th, flash over the Los Angeles area in an echelon-left formation with the planes stacked down from the leader. In such tight flying, wings are often only three or four feet apart.

Since the picture was made, the Group's squadrons have been shifted from F-80's to the newer, faster F-86 Sabre (page 303). Speed has increased some 300 miles an hour since Capt. Eddie Rickenbacker led this squadron in World War I.

Wide operational use of jets has disproved the early belief that they were not well adapted to formation flight and that only pilots in their twenties had quick enough reactions to fly them. The Acrojets, crack F-80 team from the Fighter School, Williams Air Force Base, Arizona, average more than 30 years old.

"It's largely experience," said one of them.

"You can fly even tighter with jets," said another. "You haven't got any big propeller out there chewing the air."

F-80's were the Nation's first operational jet fighters. Since their debut near the end of World War II, Lockheed has turned out more than 1,700, each successive model showing increased speed and performance. The plane has what aircraft makers call "stretch"—it lends itself to constant improvement and development of offshoot types (page 316). Streamlined wing-tip tanks contain fuel for extra range.

Big as a Superfort Fast as a Fighter New B-47 Bomber Rockets Skyward

With 18 rockets aiding its six jet engines, the 600-mile-an-hour Boeing Stratojet bomber takes off "like a homesick angel," as airmen say. RATO (rocket-assisted take-off) is used only on short fields. Tandem-type wheels fold into the fuselage, smaller outrigger wheels into the twin-jet pods beneath the sharply swept-back wings.

This is the sensational plane that last year crossed the continent from Moses Lake, Washington, to Andrews Air Force Base, Maryland, in 3 hours, 46 minutes, at an average speed of 607.8 miles an hour. The production type has 30 percent more powerful jet engines for even greater speed and load-carrying ability.

Though it can carry ten tons of bombs, the normal load of the B-36, the B-47 takes a crew of only three compared to 11. Its high speed makes elaborate gun protection unnecessary. Fewer lives endangered, ever-greater dependence on machines instead of men—such is the trend exemplified by this "bomber of the future," now coming off the assembly line at Boeing's Wichita, Kansas, plant.

Acres of Drawings and Months of Work with Drop-test and Wind-tunnel Models Precede the Birth of a Modern Fighter or Bomber

At the Lockheed plant, Burbank, California, a craftsman checks the tail assembly (left) of a drop-test model of the F-90 (page 290). Before engineers were satisfied, six $10,000 steel-and-plastic models were dropped from planes at 25,000 feet, automatically sending flight data by radio as they dived to the desert at more than 600 miles an hour. At right Boeing engineers check high-speed wind-tunnel-test models of the nacelle, or pod, holding two jet engines of the B-47 bomber (opposite).

Civilian Flyers Still Rely on "a Fan in Front Instead of a Blowtorch in the Tail": Planes of Many Purposes Are the Ryan Navion (Above) and Piper Pacer (Below)

On a fishing trip in Idaho, Norman Kuhn lands an 18-pound steelhead trout to Pilot Glen Eichelberger, of Boise, who landed the Navion on the small Indian Creek strip on the Middle Fork of the Salmon River. Racy lines and blunt tail and wings show the Navion's kinship to the World War II Mustang fighter. Down on the farm near Mill Hall, Pennsylvania, the four-place Piper Pacer, with back seat removed, carries milk cans for Farmer R. W. Fredericks in its 40 cubic feet of cargo space.

Kodachromes by Gordon Vinson and Associates

Chattering Rivet Guns Attach the Door to a Barrel Section of a "Connie"

Eleven such sections are combined to form the fuselage of Lockheed's big four-engine Constellation airliner. Two more barrel segments will be needed next year when a new model, 18 feet longer, makes its bow.

Navy's Banshee Fighter Can Reach an Altitude of Almost Ten Miles

Last year one climbed to 53,000 feet over Washington, D. C., setting a new high-altitude record for American jet planes, and incidentally taking spectacular photographs of the Capital.

The McDonnell Banshee, or F2H, has a reported speed of close to 600 miles an hour, an initial rate of climb of more than 9,000 feet a minute, and a maximum range of over 2,000 miles with droppable wing-tip tanks.

Twin jet engines in the thickened wing roots gulp enough air every minute to fill 42 railway freight cars. At full throttle before take-off they suck in air at 250 miles an hour and blast hot gases out the tail-pipe at 1,200.

The Banshee can fly on only one engine, a valuable safety factor in overwater operation.

Here the pilot peers through his bulletproof windshield on a test flight over the Mississippi River from the McDonnell plant at St. Louis. Hundreds of Banshees are being built there for service on Navy aircraft carriers. A useful feature is their "kneeling" ability. This permits the nose of one Banshee to be run under the tail of another. Thus crewmen can stack 25 percent more planes on a carrier deck.

On Such a Raft, Ditched Flyers and Passengers Could Live for Days

Canopy and spray curtain protect against the elements, and a gutterlike flap catches rain water for drinking. Transocean airliners and the armed services use such life rafts, which inflate with carbon dioxide in a few seconds. A Coast Guard Catalina crew demonstrates rescue from a 16-passenger Airline Raft now made by McLean Mfg. Co., of Sussex, New Jersey. It will also make 15- and 20-man sizes. Accessories include rations, compass, Bible.

Biggest Warplane in the World, the 10,000-mile B-36 Packs America's Long-range Punch

Crews trained in dropping all type bombs are ready to counter any attack with this intercontinental bomber. The Consolidated Vultee giant can hold 42 tons of bombs, or take five tons 5,000 miles, drop them, and return.

Four Jet Engines Are Being Added, Making This Flying Battleship a Ten-engine Bomber

Jets in pairs beneath each outer wing will add 20,800 pounds of thrust to the piston engines' 21,000 horsepower, greatly increasing its speed of "over 350 miles an hour." Ceiling is more than 40,000 feet. Radar finds unseen targets.

In the Rocket Ship Called the Bell X-1, Men Have Flown Hundreds of Miles Faster than Sound

First to penetrate the sonic wall—weird region of superspeed where air ceases to flow smoothly and piles up in buffeting shock waves—was Air Force Capt. Charles E. Yeager (left), father of three. He named the bullet-like plane *Glamorous Glennis* after his wife.

Since that historic date, October 14, 1947, the Air Force's *Glamorous Glennis* and her National Advisory Committee for Aeronautics twin, above, have punched repeated holes in the barrier, with a succession of pilots at the controls.

Powered by four liquid-oxygen and alcohol rockets, the X-1 usually is launched by dropping from a B-29, and was designed to hit 1,000 miles an hour in its two and a half minutes of full-power flight. The Air Force has announced that "many times" the Bell X-1 has flown "hundreds of miles" an hour faster than the speed of sound, which varies with temperature from 766.5 miles an hour at 59° Fahrenheit to 661.6 miles an hour in the cold, thin air above 35,000 feet. This is not a military airplane, but a flying laboratory for high-speed research.

All supersonic flights of the X-1 and the Navy's Douglas Skyrocket research plane have been made above Muroc Dry Lake, Edwards Air Force Base, California. There a helmeted pilot squeezes into the tiny X-1 cockpit while his companion holds the door.

World-record-breaking F-86 Sabre (Below) Now Has a Potent Shark-nosed Sister

First swept-wing fighter in the Air Force, North American's Sabre set a world speed mark of 670.981 miles an hour at Muroc, California, on September 15, 1948, with Air Force Major Richard L. Johnson at the throttle. Though research planes (opposite) had flown faster, they had not done so over measured courses under international speed test rules.

Radar for all-weather, 24-hour-a-day detection of enemy raiders gives the shark nose appearance to the Sabre's new sister plane, North American's F-93 high-speed, high-altitude interceptor. Before a test flight, the man at right checks the afterburner nozzle. The high grill in front of the nose is an intake guard to keep ground crewmen from being sucked into the powerful jet engine. It also serves as a ladder for mechanics servicing the plane.

Behind the Towering "T" Tail, Crewmen Stow an XB-51 Jet Bomber's Parachute Brake

For landings on small combat-area fields, the 'chute slows down this lightning-fast three-jet Glenn L. Martin bomber. The big, rakish, swept-wing speedster was designed for Air Force support of ground troops.

natural airfield formed by evaporation of mud-laden waters from the Mojave Desert hills.

Although it's an Air Force base, the Navy, the NACA, and plane makers, too, have the use of this flat expanse of clay, of the color and hardness of concrete.

By affording plenty of take-off room and a safe place to land for the fastest of planes, the Air Force says Muroc has saved the country many lives and untold millions of dollars. Without it even the bravest of pilots would have hesitated to fly the planes that have made a sieve of the sonic wall.

Engineer + Daredevil = Good Test Pilot

On the sunny desert day when I landed at Muroc from the east, the dry lake looked like a wet one. As I stood at one end and looked across, mirage turned its shimmering surface to what I would have sworn was water.

On the rare occasions when rain falls, flying —except from the adjoining concrete runways—has to wait till the sun drinks it up. The flat, cementlike surface of the dry lake is impervious to water.

Muroc, now Edwards Air Force Base, is named for a popular pilot killed in 1948 in the crash of a YB-49 flying wing, the weird batlike bodyless bomber which the Air Force ordered in numbers, then shelved in favor of more B-36's because of shortage of funds.

Test pilots here live so intimately with danger that they know it almost as a friend, or at least as a worthy opponent.

"The Air Force doesn't pay any bonuses," said one. "You have to really like to fly."

Often a lot of the engineer is mixed with the daredevil behind these old-young faces. Maj. Jackie Ridley, for example, has a master's degree in aeronautical engineering.

Natty young Maj. Frank Everest thought he should clear up a couple of points.

"Flying through the sonic wall doesn't make your hair fall out or anything," he said, grinning. "It doesn't make you any younger, either. We've tried it."

X-1 Pilot Sits in Sea of Nitrogen

Both of these men, and several others, have flown repeatedly in the supersonic Bell X-1. "Burly" is the word for this bullet with wings. To withstand the forces, then unknown, which would be met at the wall, it was built to a strength of 18 G's—18 times gravity, its own weight. Eighteen planes like it could be stacked on its wings before they would break.

One wing of *Glamorous Glennis* was painted orange, the other white. Originally it was all orange, but white was found better for visual tracking and the white wing makes a good background for photographing tufts of yarn stuck to its surface. In flight an automatic camera takes pictures of how these tufts behave, thus giving data on air flow.

Breathing through an oxygen mask, the pilot sits in a sea of nitrogen which pressurizes the cabin. High-pressure nitrogen also drives the "lox" (liquid oxygen) and alcohol from tanks into the four rockets where the mixture explodes. Chief reason for the much greater expected speed of the Bell X-1A is a turbine pump instead of nitrogen pressure for fuel feed, increasing the time of full-power flight.

When I sat in the tiny cabin, my head bumped the top. I could see only up and straight ahead, not down (page 302).

On all X-1 flights a jet "chase plane" tags after the little bullet plane and helps it land. Though left far behind during rocket runs, it closely follows the X-1 as it comes in for a "dead stick" landing at 170 miles an hour, with all of its rockets exhausted.

"You're five feet above the ground. Hold it, hold it," says the chase pilot by radio.

Besides the high-speed research planes, most of the fast new Air Force fighters and bombers come here from the factories for their rigorous testing by the Air Materiel Command before acceptance. Later they go to Eglin Air Force Base, Florida, for tactical testing by the Proving Ground Command.

"Airborne Heavy Artillery" in Action

In the immense climatic hangar at Eglin, on the Gulf of Mexico, planes can be subjected to temperatures ranging from those of the Tropics to those of the top of the world.

"We check 'em for operational suitability—use 'em as they would be used in war," explained Col. Murray C. Woodbury, deputy commander. "We run 'em wide open and horse 'em around, then recommend changes in anything from tail pipe to gun sight."

"Jets are fine gunnery airplanes," said Lt. Col. J. T. Stewart. "In a prop-driven aircraft you have torque, the twist from the propeller. Make a dive-bombing run and you have to keep jiggling the rudder. Jets are torque-free at all speeds. It makes them wonderful gunnery platforms, particularly for rockets and strafing. They're making remarkable records for accuracy."

Fire-power demonstrations here are like the wrath of God. Fighter-bombers like the Thunderjet (page 319) are airborne heavy artillery. Each can fire 32 five-inch rockets while flying 300 to 600 miles an hour, or launch four "Tiny Tim" rockets, each with a war head that weighs 590 pounds.

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High in Air B-50 Drinks Its Fill. In This New Age, Bombers Can Circle World Nonstop

Refueling at about 200 miles an hour over Puget Sound, a B-50 Superfortress gulps gasoline from a B-29 tanker plane through Boeing's new flying boom, developed for the Air Force. Last year the B-50 *Lucky Lady II* made history's first nonstop round-the-world flight, covering 23,452 miles in 94 hours and one minute with four refuelings by an earlier hose-type device. This new telescoping boom greatly speeds the process. The V-shaped "rudelevator," like the control surfaces of a plane, enables the operator to fly the boom into the open slipway doors. Heated rubber strips on the V's leading edges prevent icing. Experimentally, even jets now are refueled in flight.

For dramatic effect, a World War II Flying Fortress first drops its dozen 500-pound bombs. Then comes today's thunderer, the B-36, dropping so many bombs that you feel the earth-shaking detonations will never stop. Then you remember that this is mild compared with the atom bomb!

Crew Calls B-36 an Air Battleship

Near Fort Worth, Texas, I saw these biggest bombers being born. They were coming off the assembly line in Consolidated Vultee's vast windowless plant, so long—three-fourths of a mile—that foremen ride motor scooters. All B-36's, old and new, now are getting four jet engines besides their six Pratt & Whitney piston engines with pusher-type propellers (pages 300-301).

From Carswell Air Force Base near by, these global bombers fly training missions that may keep them in the air a day and a half or more and cover the length and breadth of the country. One may be over your home town tonight, so high that you can't see or hear it; but even through clouds it can see your landmarks—a bend in a river, a bridge—with the re-echoing radio impulses of its sensitive radar.

"We don't think of it as an airplane," a captain told me. "We think of it as a flying battleship."

Like a battleship's is the elaborate fire-control system, with remotely controlled guns that can aim themselves eerily at unseen attackers by radar. The tail stands more than four stories high, and the fuselage has as many cubic feet of space as three five-room houses. To go aft for their share of "sack time" in one of the six bunks on long missions, men ride a scooter through a tunnel 93 feet long (page 309).

Maintaining and flying this majestic three-and-a-half-million-dollar mass of machinery is so immensely complicated that the keynote on a B-36 base is emotionless precision.

"Desert Boys" and "Flameouts"

In contrast was the Fighter School at Williams Air Force Base near Phoenix, Arizona. There the cloudless desert sky was full of young cadets in F-80 Lockheed Shooting Star jets, coming in for practice landings.

Desert dust flew up in a cloud as one lad landed just short of the concrete runway.

"There's a desert boy," said Col. Leon Gray, who watched each landing and winced or praised.

"Desert boys"—cadets who land short—must stand treat for their mates that night. Here there's plenty of room for inexpert landings, but on most fields a misjudged approach could cost the pilot's life.

Several fledglings made perfect landings, "painting it on" the runway as smoothly as if with an artist's brush. Then one came in far too fast to land.

"Take it around, take it around," the control tower told the cadet.

Far down the runway the F-80 was settling fast. Several tense seconds passed before the jet engine resumed full power and pushed the plane up out of danger for another, more successful, attempt.

"Why did the pilot wait so long?" I asked.

"A jet doesn't respond as quickly as a conventional airplane," explained the chief instructor, Maj. Charlie Cole. "If that boy had been too eager or scared and had blasted his throttle forward fast, he would have got what we call a 'flameout.' There's a rumble, and a big ball of fire comes out of the tail pipe. The engine is gone, its fire blown out.

"Sometimes it catches again, like the flame in a gas stove when you blow it. If not, the pilot's in real trouble."

Remarked one of the Acrojets, the base's crack aerobatic team, "Because of that time lag in a jet, you've got to think ahead of your plane—know what you're going to do before the time comes to do it."

Fuel Flows Like Water in Sink

Jet pilots must always know where they are. If they get lost, they may run out of fuel.

Jets burn gasoline or kerosene so fast that instead of an ordinary gauge they carry a liquidometer that constantly ticks off the number of gallons remaining. On missions pilots often must figure so closely that they reach their home base with only enough fuel for one go-around in case they misjudge the landing. Just for a second landing attempt an F-80 needs at least 22 gallons.

"When I'm flying low at full speed," an F-86 Sabre pilot told me, "I burn almost a gallon every four seconds."

Fuel sprays into the engine at the rate of water from a wide-open kitchen faucet.

Both rockets and jets push a plane along by the time-honored Isaac Newton law of physics that to every action there is an equal and opposite reaction. The motion of the plane is the opposite reaction to the blast of hot gases, like the recoil of a gun. Rockets differ from jets chiefly in the fact that they burn different fuel and carry their own oxygen.

No jet is efficient in fuel consumption at low speed and low altitude. Approaching a landing field at 200 miles an hour, it burns about as much as it would at 500 at 40,000

Even Planes Now Wear Parachutes. Thirty Feet Across, a Ribbon Chute Brakes a Boeing Stratojet Bomber to an Ice-smooth Landing

On new, fast propellerless bombers, such air anchors check landing speed, save brakes and tires, permit use of shorter runways (pages 294 and 304). A ribbon-type "deceleration chute," designed to leak some air, slows this mighty six-jet plane landing at snowy Larson Air Force Base, Moses Lake, Washington State (page 283).

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Like the Whale Swallowing Jonah, Globemaster's Clamshell Jaws Gobble a Truck Weighing 5 Tons and a Tank Weighing 19¼

Beyond, a tractor and howitzer totaling 52,420 pounds await loading in another Air Force Douglas C-124A. The pilot sits two stories high, 24 feet above ground.

U. S. Air Force, Official

In the Bowels of a B-36 Bomber an Airman Rides a Scooter

So enormous is the plane that a 93-foot-long tunnel containing this miniature railway connects the pressurized forward and aft sections (pages 300-301, 307). Hugging his parachute, the crewman lies on his back on the car, grasps the overhead cable, and pulls himself through the aluminum tube two feet in diameter.

Navy's 8-ton Skyrocket Explores the Realm of Superspeed

Brute power from jet and rockets blasts the Douglas research plane beyond the speed of sound (pages 282, 288). Loaded with fuel, the "flying swordfish" weighs 16,000 pounds. The needlelike test boom projects instruments into undisturbed air. A successor for the Air Force is designed to go much faster.

National Advisory Committee for Aeronautics

A Scientist Peers at a Ramjet; Its Thunder Is Heard Miles Away

Ready for a roaring test run, the "flying stovepipe" stands in the world's largest known faster-than-sound wind tunnel at the NACA's Lewis Flight Propulsion Laboratory, Cleveland. After a last-minute check through inch-thick windows, the research man retired to a safe distance to watch by periscope. Fuel burns fiercely in air compressed by being rammed past the nose cone into the pipe at hundreds of miles an hour. This 16-inch-diameter engine yields more than 5,000 pounds of thrust, equivalent to 20,000 horsepower at twice the speed of sound (page 321). Huge compressors drive wind through the 8-by-6-foot tunnel at speeds up to 1,500 mph.

feet. Its engine is most economical in fuel at around 90 percent of full power, compared to about 60 percent for a piston engine. Also, it gives more miles to the gallon in the rare upper air where "drag," the friction of the atmosphere, is low and where less air flows through the engine. Since the ratio of fuel to air is constant, less fuel is burned.

In addition to the turbojet engine (page 314), one new fighter will have rockets for extra boost (page 283). Many more have the afterburner, a stainless-steel tail pipe, with adjustable nozzle, in which a spray of additional fuel is burned in the already tremendously powerful blast from the turbojet engine. It more than doubles the consumption of fuel, but adds greatly to the speed.

Last April the people of Dayton, Ohio, were mystified by "explosions" like thunderclaps coming out of a clear sky. Officers of the Air Materiel Command at near-by Wright-Patterson Air Force Base were mystified too. They were making high-altitude diving tests with Sabre jet fighters, but it seemed incredible that these could be the cause.

Tests proved, however, that the planes caused the sounds. Sabres dived at high speed from 42,000 feet, pulling out abruptly at about 28,000. Each time that strange thunderclap was heard on the ground, more than five miles below. The NACA is investigating the phenomenon, apparently a result of supersonic shock waves.

Jets have given flying many new terms. "Jet jockey" struck me as especially apt because, with no engine and prop out in front of him, a pilot has splendid visibility and must feel a bit as if he were riding a race horse.

Instead of "prop wash"—the propeller's air blast—we now have "blow wash," the stream of hot gases, which can have a violent effect on a plane landing too close behind.

Some pilots call their jets "blowtorches," "firecans," or just "cans." One hears such instructions from the control tower as "turn down your wick and come on in." Airmen have been quick to spot the likeness to a big kerosene stove.

"Hot seat" is another new air term. It refers to the ejection seat, used in jet fighters, when the device is "armed"—ready to fire.*

Last word of the mechanic to the jet pilot is, "The seat's hot. Be careful!" He means that the explosive charge is in place and the safety cotter pin removed.

Jets' "Hot Seat" Saves Lives

At the high speeds usually flown by jets, a pilot would have little chance of jumping clear. Even if the fierce air stream would let him out, he might be struck and killed by the tail. The ejection seat explodes him out—60 feet high in a second (page 280).

Both Air Force and Navy have training towers where new jet pilots can ride the hot seat. At the Navy's Mustin Field, in Philadelphia, I saw this "fired from a gun" routine.

A cartridge like the shell of a small cannon was inserted beneath a seat on vertical tracks running up the steel tower. When the man in it yanked down a stiff curtain over his face, he tripped a trigger that fired the charge. One second he was sitting at the foot of the tower; the next he was 45 feet up.

"For these tests the charge is lighter than used in a plane," said the smiling human projectile when he was lowered—much more slowly. "Even the full charge isn't too bad; it's not much worse than falling down hard on your seat when ice skating."

In the first 40 inches the rider goes from zero to 40 miles an hour, straight up. For a fifth of a second he is subjected to a force of 18 to 20 times his own weight (the pressure on the seat of the pants of a 200-pound man is 3,600 to 4,000 pounds); but this is so brief it does no harm to a man in good health.

Like the British, the Navy uses the curtain chiefly to protect the face from the furious blast of the air stream at 500 or 600 miles an hour. Experiments with winds of much slower speed show that they make the flesh on the face ripple like a flag in a breeze. The Air Force uses no curtain, having decided the air blast is too brief to be harmful. Both types of seat have saved lives.

Last year Second Lt. Dick O'Leary had trouble with the elevator controls of his jet fighter while flying from March Air Force Base, California. Deciding to bail out by ejection seat, he tried to jettison his cockpit canopy, but that transparent lid stubbornly refused to budge. At last he was forced to crash-land in a wheat field.

The instant the plane hit the ground the seat fired, exploding the pilot back into the air. He fell with at least as much force as if he had fallen off a house and was badly injured. But being blown free doubtless saved his life; the plane was a total loss.

For high-altitude escape, the Navy is trying a new idea which it calls the breakaway cockpit. Not the seat but the whole enclosed cabin in which the pilot sits is blown free. Three tail fins stabilize this streamlined capsule, which looks like a small wingless plane. Still pressurized, it provides breathable air and protection from the intense cold. Parachutes bring it down slowly, and if it alights on water it floats like a boat.

"I hope we get something like that soon," said a high-flying Banshee pilot I talked with at the U. S. Naval Air Test Center, Patuxent River, Maryland.

"At present, if you bail out above 35,000 feet you might as well give up. You'd freeze before you got down."

At the Navy's Mustin Field and Patuxent, and at Wright-Patterson Air Force Base, Dayton, not only planes and materiel are tested, but also the tolerance of the human body. Today's high speeds, and the much greater ones foreseen in aviation's tomorrow, make this of major importance.

How It Feels to Black Out

Gravity forces, or G's, brought to bear on a pilot when he pulls out of a dive at 500 or 600 miles an hour are so great that he may black out—go blind temporarily—forget where he is, and become unconscious. All this can happen before you can count to ten.

The reason is that, with a gravity pull of several times a man's weight, the heart can no longer pump blood uphill to the eyes and brain. The effect is as if your neck suddenly became several times as long as it is. Blood "pools" in the lower part of the body.

Test pilot Gene May had told me how it feels:

"First you gray out—the day looks darker—and your vision narrows till you can see only straight ahead. An inexperienced man may get hysterical, black out, and faint. The same would happen to an experienced pilot if the G forces continued, but, being familiar with the symptoms, he eases the pull-out, reducing the forces, and promptly returns to normal."

* See "Our Air Age Speeds Ahead," by F. Barrows Colton, National Geographic Magazine, February, 1945.

Tensing the muscles reduces the pooling of blood in the lower body and enables a man to withstand more G's than normally. But since this would be too exhausting in combat, fighter pilots wear "G suits" with rubber bladders that help by automatically pressing against the legs and abdomen.

To study these effects, specialists in aviation medicine have contrived human centrifuges that spin a man at 25 or 30 miles an hour. To see how it feels to black out, I rode the centrifuge in the Aero Medical Laboratory at Wright-Patterson. The device is a long metal frame pivoted in the middle and whirled by a 250-horsepower electric motor.

Riding a Human Centrifuge

Though I felt like a voluntary guinea pig, I was escorted to the "human" end and harnessed to a seat in a little cab, pivoted to swing out horizontally when this super merry-go-round starts to turn.

On a panel directly in front of me gleamed two small electric lights. Near the sides of the panel were two others. One of the lights in the middle was constant. The other three lights I could turn off by switches in a grip clutched in my right hand.

"Always look at the lights straight ahead," directed the major-domo of the centrifuge, conscientious Ernest K. Martin. "You'll see the other two out of the corners of your eyes.

"Every time you see a light come on, it's up to you to turn it off. If you don't turn them off, I'll know you've blacked out and can't see them. Occasionally I'll sound this buzzer. If you don't turn it off, I'll know you're unconscious."

Carefully he explained that I must relax completely to find my true "G tolerance."

He took his seat at the center of the centrifuge, like a merry-go-round motorman.

"My eyes will be on you every second," came his voice through a loud-speaker in the cab. "Just relax now. Pretend you're sitting in an armchair at home."

He gave the word to apply power.

Suddenly I was driven down into my seat; my head swung forward, seemed to weigh 30 pounds. Lights came on. I turned them off. Those at the sides looked a bit dimmer. As the whirling ceased, I seemed to be pitching end over end, down and down.

Grinning, Mr. Martin opened the door.

"That pitching sensation," he said, "results from the fact that the cab swings back to the vertical from the horizontal when the centrifuge stops. After a few rides you don't feel it."

I told him I thought my marginal vision had grayed a bit. (I felt as if my temples had, too.)

We tried it three more times, faster, and my tolerance proved to be about average, just under four G's. Each ride lasts only 15 seconds but seems longer.

Once the operator stopped the centrifuge after only eight seconds—an emergency stop. In that brief time I had reached the point where I failed to respond to lights or buzzer and was in a confused state on the threshold of unconsciousness.

As the cab swung to a stop, I realized that the buzzer was going—had been buzzing a long time, it seemed—and I rather peevishly switched it off, as a sleepy man turns off an alarm clock. I'm glad I wasn't flying a plane in that groggy state.

Research with the centrifuge shows that a man lying down can stand about twice as many G's as one who is sitting. At Wright-Patterson I saw a bedlike device on which a pilot would lie prone. Its use may come when planes fly even faster than today.

At Muroc the Air Force has a "human decelerator" to test the forces imposed on airmen by the sudden stop of a crash landing. A rail car dubbed the "hot rod" is blasted by rockets to a speed of 200 miles an hour, then abruptly brought to a controlled stop by brakes in the rails.

One recommendation resulting from these tests is that future Air Force passenger-type aircraft have seats facing the rear. If they crash-land, occupants have a better chance if braced by the back of the seat.

Plane Tortured as if on the Rack

Aircraft companies make equally exhaustive tests to see how much their planes can stand. In the Chance Vought factory at Dallas I saw the first Navy F7U Cutlass off the assembly line undergoing structural torture. Factory men dropped it from various heights. Heavy pulls were applied to its wings and body, much as human victims in the Middle Ages were stretched on the rack.

"That one's built to be destroyed," said one. "We load it down till it breaks."

Factory manager Bert Taliaferro grimaced.

"Every time they drop it," he said, "and every time they tweak it, I suffer for fear something will break before its time. If it does, I have to go into the entrails and strengthen it."

With all these jet fighters and bombers, one expects to see at least one propellerless transport. In all the United States there is none. Plane makers say they can't afford the gamble—20 to 40 million dollars.

Marines Show How a Hovering Sikorsky "Windmill" Hoists Men to Safety from the Sea

On Navy carriers, battleships, and most cruisers, helicopters answer the "man overboard" cry, transfer men from ship to ship, deliver mail, go scouting. During carrier take-offs and landings, they hover like guardian angels. Here the water is colored a vivid green by a dye used to attract rescue planes.

Kodachrome by Dale Arnold

Flying Ribbons Dramatize the Danger of Being Sucked into a Jet's Nose

Well anchored by a safety line, a pilot tests the suction of a Republic F-84 Thunderjet's air-hungry maw. Once another make of jet fighter half swallowed a mechanic, killed him. Safe distance is 25 feet.

A Cutaway of General Electric's J-47 Engine Shows How a Turbojet Works

Air from front end is compressed by blades (center), shot into combustion chambers (red) with fuel spray. Belching rearward, gases give 5,200 pounds' thrust, turn turbine driving compressor. Plane is Sabre (p. 303).

Illustration from U. S. Air Force

Forerunner of a Possible New Type of Fighter Is This Radical Delta-winged Design

Ordinary wings and tail give way to the eternal triangle in the Air Force's high-speed jet research plane, the Consolidated Vultee XF-92A. Test flights at Muroc, California, are reported to "show a lot of promise." Wings swept back at a 60-degree angle look more like vanes on an arrow than wings. Triangular shape increases strength. With no horizontal stabilizer on the fin, "elevons" in the wings give both elevator and aileron control.

That Long, Shiny Nose Holds a Powerful Radar: Air Force's F-94 Night or Bad-weather Fighter Must "Smell Out" Enemy Planes

When Lockheed lengthened its Shooting Star (p. 293) to make a two-seat trainer, the longer plane strangely proved faster. From it evolved this fighter with afterburner.

Britain's 48-passenger de Havilland Comet, World's First Jet-propelled Airliner, Serves Notice That "the British Are Coming"

On a 2,197-mile test flight from London to Cairo, Egypt, the four-jet transport averaged 426½ miles an hour, carrying the equivalent of 34 passengers and luggage. Cruising speed averages 490 miles per hour. The United States has no propellerless airliners. The first to fly in America is the Canadian Avro Jetliner.

High Tail Makes This New All-weather Fighter Look Like an Angry Scorpion

Scorpion, in fact, is the official nickname of the twin-jet-propelled F-89, now in production for the Air Force at the Northrop plant in Hawthorne, California. The "up-swept tail-do" raises rudder and stabilizers well above jet exhausts and wake of wings.

With a length and wingspan of about 50 feet, the Scorpion is slightly smaller but heavier and incomparably faster and more deadly than Northrop's Black Widow night fighter of World War II.

Afterburners and wing-tip tanks give Scorpions now joining Air Force squadrons much more power and range than this experimental version photographed on a test flight from Muroc Dry Lake in the Mojave Desert.

Normally the crew consists of a pilot and a radar observer operating electronic equipment that penetrates darkness, fog, and storms. Speed and other details are secret, but the Scorpion is described as "enormously fast" for its weight—more than that of a DC-3 transport—and one of the fastest two-place planes in the world.

Newborn Thunderjets Fuel Up at the Republic Plant on Long Island to Join Hundreds on Duty with Air Force Squadrons

These P-84 jet fighters have a speed of more than 600 miles an hour, an 830-mile radius of action, and the ability to fly and fight above 45,000 feet. Like Republic's World War II Thunderbolt, the Thunderjet doubles as a fighter-bomber and a high-altitude fighter. "You can hang everything on it," Air Force men say, "extra fuel tanks, bombs, and rockets in all combinations." One loading consists of four "Tiny Tim" rockets, each having the hitting power of a 155-mm. gun.

Like an Insect Itself, a Bell Helicopter Rains Death on Adirondack Black Flies

Downdraft from the whirling rotors drives deadly DDT-laden fog into ground-level haunts of the busy little biters. This and the ability to hover and fly slowly make helicopters ideal for such work.

Give them an order and they will build you one, or as many as you can pay for. But U. S. airlines are not investing that kind of money in jets as yet. There are too many problems to be licked, they say, in operating pure-jet transports with the air navigation system we have today. For example, you can't "stack up" jets waiting to land. At low speed and altitude they burn up too much fuel.

Turboprop Harnesses Jet to Propeller

All admit that the pure-jet airliner will come, but meanwhile some American companies favor the gas-turbine "turboprop." This harnesses the turbojet's blast of hot gases to turn a propeller instead of using its power purely as jet thrust (pages 287 and 314). Such engines are vibrationless compared with the piston engine.

With the turboprop its advocates predict airliner speeds up to 500 miles an hour or even more. The British are building planes of this type, and in this country several companies are planning to replace piston engines with turboprop power.

Consolidated Vultee's revolutionary new turboprop flying boat made its first flights last spring, and Douglas revealed in June that it is flight-testing a powerful new Navy carrier-type attack plane, the XA2D Skyshark. Both are driven by the 5,500-horsepower twin-jet gas-turbine engine built by the Allison Division of General Motors.

Meeting the challenge of the jet, propeller makers are developing blades so thin but strong, with knifelike edges, that they work without too much loss of efficiency when their tips are traveling at supersonic speeds. Engineers of Hamilton Standard Division of United Aircraft say new blade designs in wind-tunnel tests have operated at 80 percent efficiency at airplane speeds up to 600 miles an hour at sea level.

In the battle with the jet the propeller is still on its feet and fighting; the turboprop opens a new field for it, and for most purposes the economical old piston engine retains its hold. Long range made piston-engined F-51 and F-82 fighters, as well as bombers, useful to our forces fighting in Korea.

Latest development in cargo carrying is the use of large streamlined "pods" carried under the fuselage and quickly detached when the plane lands. On Fairchild's XC-120 experimental "pack plane" for the Air Force, this big detachable cargo van makes up the whole lower two-thirds of the fuselage.

Piasecki Helicopter Corporation, maker of the twin-rotor "flying banana," foresees copters picking up such pods at airports and flying them into town. For the military it is building a pod-carrying copter, the XH-16, about as long as a four-engined airliner.

As befits the homeland of Sir Frank Whittle, pioneer of jet propulsion, Great Britain has the world's first jet airliner, the 48-passenger de Havilland Comet (page 317). How does it feel to ride in the Comet at nearly 500 miles an hour, eight miles above the earth? From England comes this eloquent answer:

"Paradoxically, there is a sensation of being poised motionless in space. Because of the great height, the scene below scarcely appears to move; because of the stability of the atmosphere, the aircraft remains rock-steady. The gas turbine's complete freedom from vibration is unexpected in a vehicle of great power; and the absence of all visible signs of engines, propellers, or other moving parts completes the illusion."

At New York last spring I saw the first jet transport in this hemisphere, the Avro Jetliner, built by A. V. Roe Canada Limited. The low-slung four-jet Canadian airliner, designed to carry as many as 60 passengers, had just flown the 365 miles from Toronto in four seconds less than an hour.

Today's propellerless planes are driven by the turbojet, which uses a turbine to compress the air in which fuel is burned (page 314). Producers in this country are Allison, General Electric, Pratt & Whitney, and Westinghouse.

Ramjets Drive Missiles and Helicopters

A real Buck Rogers device is the fabulously fast and powerful ramjet engine. Unlike the turbojet, it needs no air compressor. Essentially a fire in a flying stovepipe, the ramjet gets its name from the fact that the air is rammed through it and compressed by the sheer speed of its flight.

Ramjets do not begin to work well until they near the speed of sound. In missiles, rocket power gives them their initial boost. In airplanes of the future, engineers say, the turbojet might be teamed with the ramjet, the latter taking over at about the speed of sound. But first a way would have to be found to moderate the heat resulting from friction of air on such a man-made meteor.

Big ramjet engines pack so much power that in "hot run" tests at Daingerfield, Texas, and Cleveland (page 310) they rattle windows and dishes two to four miles away. At the Wright plant in Wood-Ridge, New Jersey, it takes a big battery of silencers, heavy springs, and 120 tons of concrete foundation to stifle the ramjet's roar so it won't break dishes,

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Past Golden Gate Bridge Flies a Navy Neptune, Long-range Guardian of the Seas

Newest version of the Lockheed P2V, the sleek piston-engine plane is specially equipped to hunt down the new snorkel submarines that "breathe" through a tube and can travel for weeks under water. Neptunes have amazingly long range—"long legs," airmen say. One, the famed *Truculent Turtle*, set a world record of 11,236 statute miles for nonstop flight without refueling.

crack buildings, and deafen the neighbors.

For helicopters the ramjet has already proved practical, because the rotor blades that lift and propel them revolve at high enough speeds. Ramjets mounted directly on the blades cause them to turn.

In St. Louis, the McDonnell Aircraft Corporation points with parental pride to its sprightly offspring, "Little Henry," which it calls the world's first successful ramjet helicopter. Its development was financed by the Air Force. Two tiny 10-pound ramjet engines on the rotor blades enable Little Henry to flit about like a bird.

Howard Hughes, in California, is developing for the Air Force a "flying crane," a jet-powered helicopter so large that, if successful, it might be used to lift trucks, bridge sections, or even an Army tank across a mountain.

Two turbojet engines are mounted in the fuselage. From there, compressed air at high pressure is channeled to the tips of the rotor blades, where it is mixed with fuel and burned, making the rotor revolve on much the same principle as a rotary lawn sprinkler. Jet thrust can be used to propel the novel craft forward.

In close secrecy, nuclear physicists and aircraft engine experts are working on the problem of atomic power for airplanes. If such a plane is designed, its range, they believe, will be virtually limitless.

No wonder airmen feel and talk like Air Force Maj. Charlie Cole, at Williams, in Arizona: "General Arnold and General Spaatz were in on the ground floor in their day and saw the development of propeller aviation all the way up. We're in on the ground floor of something even bigger. The limit is as far as you can see the stars."

Sea to Lakes on the St. Lawrence

By George W. Long

With Illustrations by National Geographic Photographers B. Anthony Stewart and John E. Fletcher

N. B. McLEAN, powerful Canadian Government icebreaker, stole from her berth at Sorel and headed up the ice-choked St. Lawrence River in the cold, gray dawn. An hour later, snug in my bunk, I was catapulted into consciousness when her reinforced bow rammed into 24 inches of snow-topped ice, end of the previous day's cut.

Probing, feinting, battering, *McLean* mounted a relentless offensive (page 362). Dusk found the sturdy ship six hard-won miles nearer her objective—Montreal Harbor, silent and white in winter's grip.

"Looks like an early opening this year," said Herb Land, Department of Transport engineer, as we watched the battle from the bridge.

"Can't tell, though," he added. "We may hit a jam tomorrow and make only 500 feet."

Over mugs of scalding tea Herb and I talked icebreaking on the St. Lawrence.

"Below Quebec the river never freezes over solid. Above the city the ice is shore-to-shore, and jams form sometimes 80 feet thick.

"Before we had breakers the jams acted like dams, and there were serious floods. Now we start in early February, clear the channel to Montreal, and keep the ice moving. We haven't had a big flood in over 20 years."

"I thought this icebreaking was done to free the port of Montreal for shipping," I said.

"It helps that way, too," Herb answered. "Since 1908, when icebreaking began here, we've added almost two weeks to the navigation season. That means a lot to a big port like Montreal."

Open Channel Forecasts Spring

First signs of spring along the St. Lawrence are these big breakers pounding at ice jams. Montreal newspapers publish daily charts of their progress; readers follow them as U. S. sports fans follow the standing of their city's ball team. Montrealers take a personal pride in this annual victory over Nature when headlines shout "Channel Open to Quebec!"

Then river ports begin to stir. Riveting and hammering sound on awakening water fronts. Channel markers are set in place; range lights begin to blink. Canada's great highway of ocean trade is opening for business.

Navigation begins about April 15. Usually, some days before, venturesome ships risk the last remnants of ice in gulf and river. Their skippers race for the gold-headed cane Montreal awards each spring to the captain of the first overseas vessel in port. In 1949 Capt. A. S. Baxter, of the *Mont Alta*, set an all-time record by docking April 7 (page 347).

The force of a continent flows in this awakened River St. Lawrence. Maps confine its name to the majestic channel coursing north and east that siphons the Great Lakes. Actually, its source is the little St. Louis River flowing into Lake Superior's western tip. The Great Lakes are but gigantic widenings in a river system that spans half of North America and drains an area almost as large as Alaska (map, pages 326-7).

Great Lakes Control River's Flow

These vast lakes mold the river's character. Immense settling basins, they spill a clear and sparkling flood almost free of silt. Huge natural reservoirs, they keep its flow more constant than any other large river's.

No "Ol' Man River" this—no seasonal rampages, no course-changing whimsy, no muddy cargo carried to a seaside delta. Vexed only by rapids in its upper reaches, the St. Lawrence flows from the heart of America to the Atlantic.

Jacques Cartier, bold Breton sea captain, discovered this wide crack in the New World more than 400 years ago. Then France sought a short cut to the fabulous Indies. Reconnoitering the gulf in 1534, Cartier thought the prize was his.

Returning the next year, he beat his way upriver 1,000 miles to the present site of Montreal. Near by, foaming rapids dashed his hopes. Cartier had found not a Northwest Passage to distant Cathay but a midwest passage leading to the interior of a vast continent.

Cartier's midwest passage gave later Frenchmen the key to a continent. Connecting by easy portages with other vast watersheds, it opened America from the upper Ohio to the Rockies and from Hudson Bay to the Gulf of Mexico.

While Maine-to-Georgia mountains dammed the tide of English colonists, the French paddled their swift canoes over a far-flung inland empire.

For 150 years New France, cradled in the St. Lawrence Valley, lived on its geographic monopoly. Lusty voyageurs, trapping the

Author George Long (Left) Interviews Officers of the *North Shore* in Quebec

St. Lawrence steamers, going where railroads and highways are lacking, serve isolated communities from Montreal to Newfoundland. To habitants and Indians they carry mail, provisions, even livestock. Possibly a dozen passengers make the voyage. In a desolate cove one of these young ladies was lowered over the side into her father's rowboat. Customs building dome, Château Frontenac tower, and Laval University steeple puncture the Quebec skyline (pages 329, 345).

western wilderness, trading with the Indians, each year sent a king's ransom in cold-bred furs into river settlements. Ships, waiting at Quebec, carried this wealth to Europe.

When French Canada became British, shrewd Scots took over the trade. When it waned, timber from virgin forests took its place. Island-sized rafts, acres big, were floated down the Ottawa and St. Lawrence Rivers to be broken up for export in Quebec.

Ocean Ships 1,000 Miles Inland

As Canada opened her prairie Provinces, timber gave way to wheat. By Great Lakes and great river the golden grain moved—still moves—eastward to world markets.

Today the midwest passage of explorer and voyageur is the open-season gateway to the world for all of Canada between the Rockies and the Maritime Provinces. Freighters, built to fit upper river canals, connect ports on the Great Lakes with Montreal (page 330).

Following the Cartier route 1,000 miles inland, salt-water ships trade world cargoes for the products of Canadian farms, forests, and factories. Despite its winter hibernation, the St. Lawrence waterway carries nearly one-third of Canada's foreign trade.

Several thousand miles traveled up and down this magnificent waterway unfolded for me a panorama of infinite variety.

Man challenged the river with his own contrasts—sleepy hamlets and bustling cities, heavy industry and handicrafts, fishing schooners bobbing beside ocean liners. French Quebec and British Ontario, oxcarts and tractors, humble churches and splendid cathedrals.

A colorful cast of characters—monks, Mounties, nuns, soldiers, Indians, priests, trappers, fishermen, farmers, lumberjacks,

Prince Knows the Trucking Business; He Enjoys Hauling Cod

As the photographers watched, the dog waited out to the dory without a word or gesture to guide him. Then he turned around and grinned. For reward he gets table scraps; canned rations are unknown to him. These lads help unload the catch, as Gaspé boys have done for three centuries. The elder is almost ready for the boats (page 344). Papa hauls a 40-pounder.

tourists, pilgrims—gave the scene life; the river gave it unity.

Hot weather found me in flannel shirt and heavy sweater on the S.S. *North Shore*, cruising the remote northern shore of the St. Lawrence near its wide, open mouth.

Off the starboard bow lay the small bay Jacques Cartier named for Saint Lawrence in 1535. For more than a century his midwest passage was called simply the "Great River" or the "River of Canada," but in time the Saint's name spread from Newfoundland to Lake Ontario.

Cartier thought this desolate north coast must be "the land God gave to Cain." Barren, lonely, it skirts a vast savagery of ancient rock.

Widely spaced fishing and logging settlements hug narrow crescent beaches, tiny riverside outposts in an unbroken wilderness that stretches to Hudson Strait and the Labrador coast. Porpoises played, whales spouted, gulls wheeled; but for hours at a time we saw no human habitation.

Gala occasions were our brief stops, each little town's event-of-the-week. Torrents of French in joyful greeting and good-natured banter mingled with deck hands' and dock workers' shouts. Protesting squeals, squawks, and barks outdid the winch's clatter as it transferred a Noah's Ark cargo.

Across the gangplank stepped priests and nuns on leave, traveling salesmen, laborers, salmon-fishing sportsmen, local people in Sunday best, and leg-stretching tourists.

A Land Rich in Iron Ore

At Seven Islands (Sept Îles), sizable by north shore standards, we heard how this bleak land has yielded one of the great iron discoveries of all time. Geologists and prospectors, probing rust-red slopes astride the

Coursing Northeast, the St. Lawrence Drains the Great Lakes' Brimming Basins

From Lake Ontario the river meanders through the scenic Thousand Islands. Quickening, it drops 225 feet to Montreal in a series of boiling rapids spread over 120 miles. Deep-sea ships steam a dredged channel between Montreal and Quebec City. Oceanward then, the river widens until, 100 miles broad, it resembles an inland sea. Tidewater reaches Trois Rivières, more than 900 miles inland; salt water comes almost to Quebec.

Drawn by Harry F. Hiller and Irvin E. Shiskin

Proposed St. Lawrence Waterway Would Turn Midwest Cities into Seaports

First suggested in 1895, the United States-Canadian plan calls for a navigation channel 27 feet or more deep between Montreal and Lake Ontario, deepening of Great Lakes' harbors and connecting rivers. Huge locks would lift and lower ships around rapids; a dam in the international section between Ontario and New York would provide 2,200,000 horsepower. Deep-sea vessels could steam 2,000 miles inland to the heart of America

Quebec-Labrador boundary, have proved 357 million tons of high-grade, easily accessible iron ore. To date they have tested only a fraction of the ore-rich Labrador trough in places where the ore thrusts naked to the surface.

As rich or richer than Minnesota's famed Mesabi Range, depleted by two wars, the new find poses tough transportation problems. It's a long haul from Ungava to the blast furnaces.

Present plans call for a 360-mile railroad south to deep-water Seven Islands. There the St. Lawrence will take over the job of getting this fat industrial pig to market.*

Farther east I had already seen one effect of this shore's newly opened treasure chest. Havre St. Pierre, remote river "metropolis," was booming like a Klondike town of 50 years ago. Pile drivers hammered foundations for a big new wharf. Earth movers strained and men labored to push a railroad inland.

Not gold but millions of tons of titanium ore had boosted the town's temperature.

Known until a few years ago chiefly as a white powder used in making paint, titanium can now be produced in once-rare metal form. As such it is 70 percent heavier but six times stronger than aluminum, 40 percent lighter and about equal to steel in strength. Remarkably resistant to corrosion, this middleweight metal promises to play a vital role in modern technology.

From Seven Islands we traced a wide-sweeping coast that curved south. As we rounded Pointe des Monts, I climbed the bridge.

"Know where the river's mouth is?" the captain asked.

"Well, the Canadian Geographical Board and a royal proclamation of 1763 say it's at the western end of Anticosti Island," I answered.

"Sounds impressive," said the skipper, "but most rivermen will say it's right here. At Anticosti it's 100 miles across; only 28 here. Some people say the mouth's at Father Point, where pilots board deep-sea ships. I even know a fellow who says it's at Quebec City! Anyway, it's a tough river to tie down."

Later I heard all these opinions and more. But I had to agree with the captain. Here, with both shores in sight, the incoming traveler gets his first feel of the river.

Baie Comeau, Paper-built City

On the shores flanking Pointe des Monts *la pulpe* is big business. At every harbor flumes float logs dockside and spit them into boats (page 349).

The chief town, Baie Comeau, held plenty of surprises—paved streets, fine hotels, cathedral, streamlined store fronts, hospital. Its 3,000 people find recreation in a big community center, gymnasium, sports arena, curling club, ski run and tow.

U. S. newspaper interests built the town in a howling wilderness little more than a dozen years ago. Its fast paper machines roll out 150,000 tons of newsprint a year for big New York and Chicago dailies.

More than half of Canada's vast newsprint production comes from the St. Lawrence Valley. Pulpwood "mountains," stored against the winter freeze-up, are a river trademark. Characteristic sight (and Christmaslike smell) is a St. Lawrence pulp boat, barked pine, spruce, and balsam logs stacked on deck.

Pulp Boats Are Family Affairs

Sunrise to dusk, these wooden tramps parade the lower St. Lawrence, their Diesels hammering the air. Linking small ports and big mills, they haul forests of pulpwood. Sharp-prowed, round of stern, their lines come down from 17th-century Breton ships. In size they approximate the vessels that Cartier sailed.

French-Canadian to the keel, they bear such names as *Gaspésienne*, *Alys*, *Mont Laurentien*. Often as not their skippers sail *en famille*. Madame cooks, does the "housework," takes her turn at the wheel. Children may romp the decks, and didies festoon the lines.

Deep-sea skippers snort at these boats.

"'Pin flats' we call 'em," one veteran captain told me, "and don't ask me why. Bloody nuisance they are, too. Their crews are as independent as their Norman ancestors; may cut right across your bow just for fun."

Slowly the great river narrows. Slate-blue Laurentians, crowding shoreward, raise a frowning coastal wall. Splitting these reluctant hills, the deep-volumned Saguenay River pours from its fjordlike chasm.

Later I took the popular Saguenay cruise. In storied Tadoussac, at this amazing tributary's mouth, I glimpsed a bit of Canada's early history. Long before Quebec was founded, Tadoussac was a rendezvous of Basque whale fishers and French fur traders.

I visited the old Indian chapel and rang its 1647 bell. I studied curious Indian artifacts in a stockaded log museum, replica of Canada's first habitation, a trading post built on this very spot in 1600.

Montagnais Indians, summering here, told Cartier whopping tales of a fabulous "kingdom of the Saguenay," where wool-clad white men lived and gold abounded.

* See "Quebec's Forests, Farms, and Frontiers," by Andrew H. Brown, National Geographic Magazine, October, 1949.

Kodachrome by B. Anthony Stewart and Jean E. Florent

High Above the St. Lawrence Perches Quebec, Once the Cornerstone of New France

A million visitors a year throng the storied city. Below turreted Château Frontenac, picturesque Lower Town lies squeezed between sheer rock and river tunneling through the narrows. Canadian Mounties sport traditional tunics.

By Canal a Plodding St. Lawrence Freighter Sidesteps the Upper River's Foaming Rapids

Head of ocean navigation on the river is Montreal. Small freighters, built to fit rapids-passing canals, link seaport and Great Lakes. Old locks, many hand-operated, limit their draught to 14 feet.

▲ Thick-walled Mills Doubled as Forts on Isolated Ile aux Coudres

Early French settlers on the exposed island, 53 miles downriver from Quebec, fled to their redoubtlike windmills whenever trouble threatened. This one dates from the 18th century. Jacques Cartier, discoverer of the St. Lawrence, named the island for its hazelnut trees in 1535.

▼ From a Yawning Outdoor Oven Comes a Half-week's Bread Supply

Large French-Canadian families can make a loaf or more disappear at every meal. Many outdoor ovens, once standard equipment on St. Lawrence Valley farms, are no longer used. This one on the Gaspé road turns out big, golden-brown loaves every three or four days.

Rapids Prince, Veteran of 40 Years, Shoots the Rock-tossed Waters of the Long Sault

Here the 1,300-ton craft hurtles through the treacherous rapids at more than 20 miles an hour. A special pilot steers her course. Long Sault, on the U. S.-Canadian border, drops the raging river 45 feet in nine miles.

Kodachrome by R. Anthony Stewart and John E. Fletcher

Sunday Picnickers on Sheek Island Get a Grandstand View of Her Spectacular Dash

Like a broken-field runner, the *Prince* picks a way through reefs and whirlpools. Before she was retired from service recently, she carried 500,000 vacationists on this 140-mile run between Prescott, Ontario, and Montreal.

Kodachrome by B. Anthony Stewart and John E. Fletcher

Ballet Students of Queen's University Practice Their Steps on the Breeze-swept Shores of Lake Ontario

Not far from this point, the St. Lawrence River, strewn with the beautiful Thousand Islands, drains the lake through a maze of scenic channels. Queen Victoria chartered the University, located in Kingston, Ontario, in 1841.

Old Fort Henry's Muzzle-loader Roars in Salute at Kingston on the U. S.-Canadian Border, Peaceful for 135 Years

Here student gobles, wearing British uniforms of the 1860's but with World War II service ribbons, fire one of the original 24-pounders. The redcoats' drill follows official manuals of 100 years ago. Fort Henry, built in the 1830's to command Lake Ontario's outlet, was restored as a museum a century later.

Kodachromes by B. Anthony Stewart and John E. Fletcher

▲ Canadian Mounties Are Heroes to Farm Boys on the Ile d'Orléans

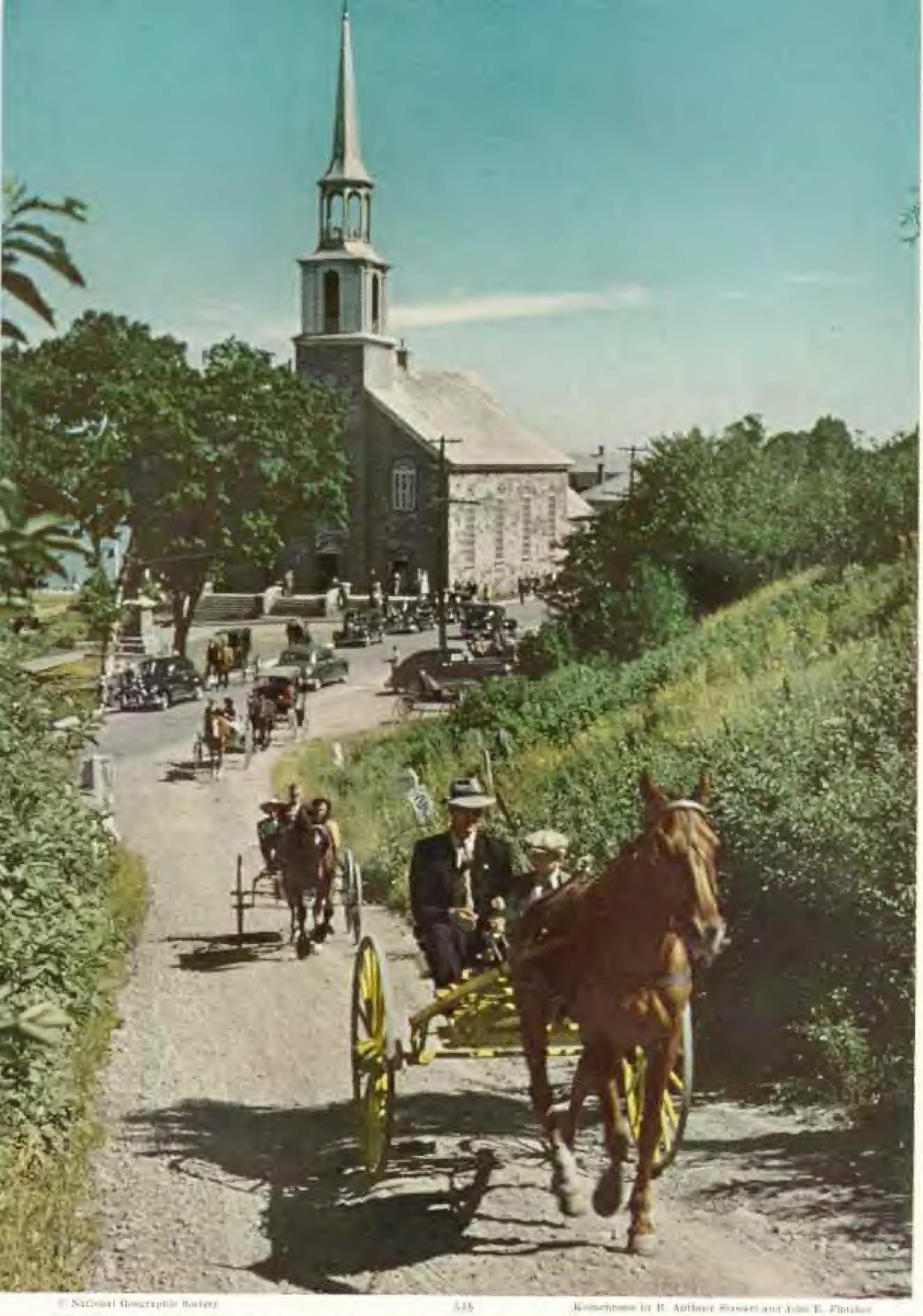
Besides enforcing Federal laws, Royal Canadian Mounted Police give talks on good citizenship in schools, teach first aid, coach hockey and baseball. Rich fruit, dairy, and truck farms cover this island, a geographical cork in the St. Lawrence bottleneck at Quebec.

▼ "Brother Henri, Take Thine Hand Away!" Fresh Berries Lead to Temptation

In the Capuchin Monastery near Carouna, on the lower river's south shore, all property is held in common. These novices, just back from collecting the fruits of their toil, were in jovial mood. Width of their hair crowns indicates length of service.

Top-hatted Cabbie and Aristocratic Bonnie Cater to Old Quebec's Carriage Trade

Shiny victorias and two-wheeled calèches line Place d'Armes, the city's hub. Machine-age visitors find them a novel way to sight-see. Horsey smells and the klop-klop of hoofs are characteristic of tourist Quebec.



Parishioners Jog Homeward to Rocky Hillside Farms after Mass in Notre Dame du Portage

Togged in Sunday Best, a Habitant Family Sets Out for Church

In rural French Canada the gasoline motor has not replaced the horse. Churchgoing is social as well as religious. Isolated parishioners linger long on church steps after services to visit and catch up with local news and the latest gossip.

Pulp and Paper Students Grind Out Their Final Examination

To graduate, pupils at the Provincial School of Paper-making in Trois-Rivières must make paper that can pass a dozen scientific tests. Here two seniors start by pulverizing pulp-wood blocks in a small-scale grinder. The school boasts a complete model paper mill.

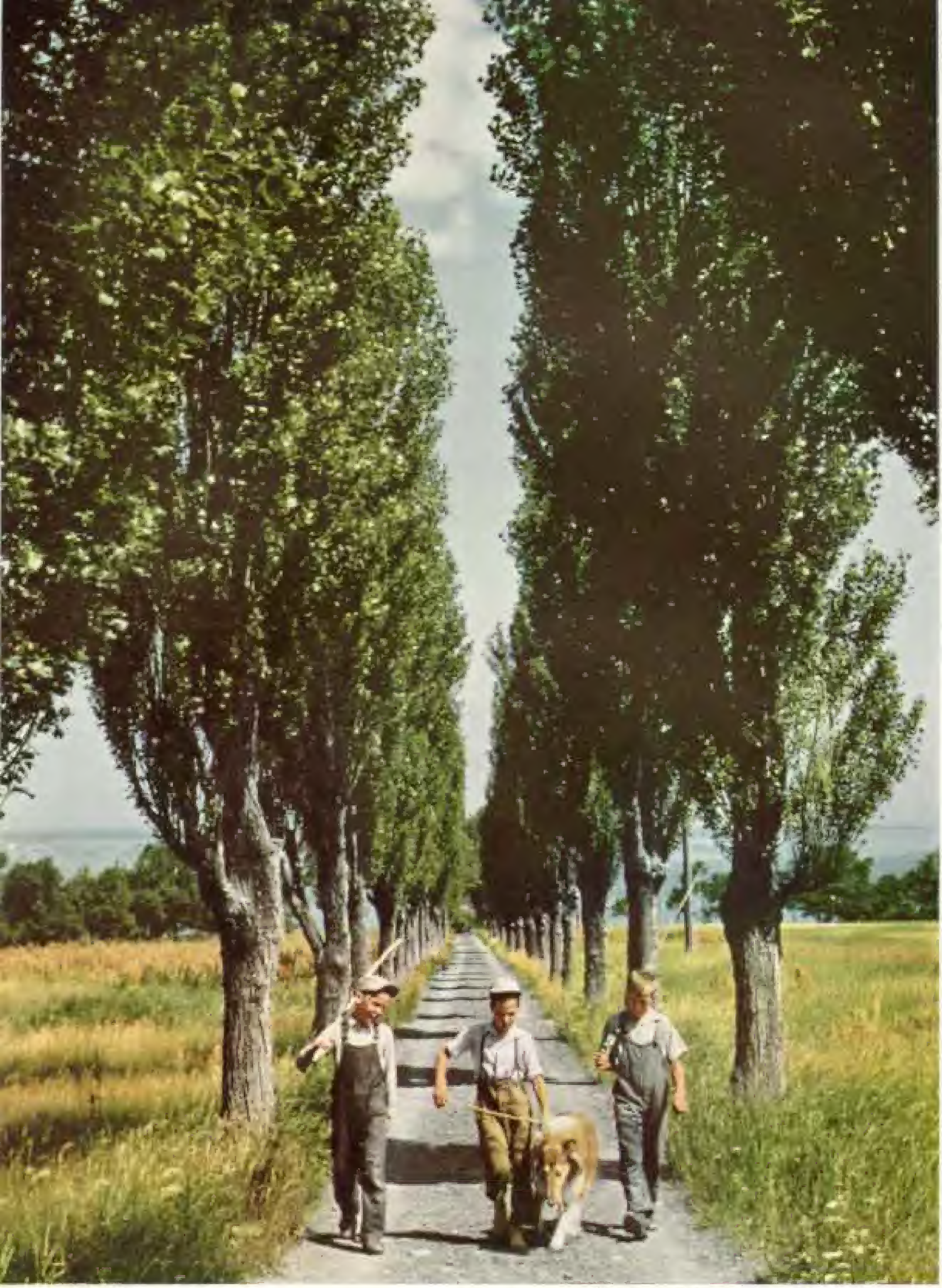
Big, Lusty, and Cosmopolitan, Montreal Is the Queen City of the St. Lawrence

To reach the 60-mile panorama atop Mount Royal, an extinct volcano in the city's center, visitors resort to horse-and-buggy days. Cars are outlawed on the mountain. Montreal is Canada's largest city.

[1] Reproduced by B. Anthony Stewart and John E. Fletcher

Dredged Ship Channel Boomed It into a World Port 1,000 Miles from the Sea

The channel links Montreal to deep water near Quebec City. Upriver canals stretch its commercial reach half across the continent. In its open season the St. Lawrence handles nearly a third of Canada's foreign trade.



Lunch Calls Novice Fishermen Home after a Carefree Morning on the St. Lawrence

The poplar-lined road, suggesting old France, leads to the site near Beaumont, Quebec, of an 18th-century riverside mill that long ground farmers' grain. After it became a museum, it burned to the ground.

↑ Every Day Looks Like Washday on the Road to Ste. Anne de Beaupré

Bright handicraft displays line the well-traveled road between Quebec City and the famous shrine. Argyle socks, sweaters, rag rugs, and bedspreads predominate. French Canadians have a knack for such work. Dog teams and miniature carriage are tourist-stoppers.

↑ Tongues Lolling, Sport and Bill Take a Well-earned Breather

Their young master is a budding businessman; for 25 cents he poses his team for visitors or takes children for short rides (above). The dogs, a matched team, belong to a French-descended family. Except for remote areas, working dogs are seldom seen in Canada today.

Kodachrome by B. Anthony Stewart and John E. Fletcher

Where Cod Is King, Fishermen Hand Down from Father to Son Their Skill in "Making Fish"

Catching cod is only the beginning; proper heading, cleaning, splitting, and salting require years of training. Gaspé boys start young to learn the trade. Many in their teens are full-fledged commercial fishermen.

Our cruise ship headed up the Saguenay into a setting sun. Sheer, glacier-gouged rock walls rose hundreds of feet. Beneath our keel black waters swirled to almost equal depths (p. 5481).

More than scenic is the Saguenay. Deep into the Quebec wilderness the river has thrust a salient of civilization.* On its incredible depths, nearly 1,000 feet, big ocean freighters push miles into the hinterland. Its narrow upper section, a torrent that drops 300 feet in 30 miles, generates more hydroelectric power than either Grand Coulee or Hoover Dam. With it, thriving Saguenay towns turn out vast quantities of newsprint and a quarter of the world's aluminum.

North Shore, however, passed the Saguenay with scarcely a sideward glance. Past towering headlands we steamed Quebecward. These dark Laurentian outposts were old-timers when the Himalayas were born. They end in frowning, 1,900-foot Cap Tourmente, which Champlain named for the tormented water swirling at its base. Here every spring and autumn migrating snow geese by the thousands make a St. Lawrence stopover.

On deck we watched entranced as these shadow-draped capes glided past in echelon. River-level towns, like Baie St. Paul, snuggled in tributary valleys; upland farms and villages sprawled high on sunny slopes. Connecting them, an adventuring road climbed and dipped.

Another day I rode that gravel roller coaster. It rose and fell so fast my ears kept popping. Changing, breath-taking scenes rewarded every climb—the broad St. Lawrence, Mediterranean-blue; emerald-green islands; toylike ships far below; the dim south shore. Brief showers alternated with bright sunlight.

Many Have Scottish Name, French Tongue

At fashionable Murray Bay, "Newport of the North," I lunched in luxurious Manoir Richelieu, saw its remarkable collection of Canadian art, and browsed in the handicraft shops of Pointe au Pic (page 354). Champlain called this harbor La Malbaie, "the bad bay," because of its tricky currents.

The town retains the name, but the bay bears that of Gen. James Murray, one of Wolfe's aides. After the conquest, disbanded regiments of Murray's Scottish Highlanders settled this shore and married French girls. Here live McTavishes, MacDonalds, Macgregors who speak no English!

Turning stern to the Laurentians, our ship headed into the deep south channel around big, pastoral Ile d'Orléans. Near the island's seaward end salt and fresh water meet in the fluid front line of a battle that daily swings to and fro, both eternal and new with every tide.

Here fresh and salty currents may flow side by side in opposite directions. Rock ledges between may have marine algae on one side, fresh-water flora on the other. Ocean fish sometimes follow saline paths deep into fresh-water precincts; drinking cattle watch porpoises play. Some towns find themselves on fresh water at low tide, on salt at high.

Storied Quebec, French Canada's Capital

Nearing Quebec, passengers crowded the rail to glimpse the historic rock-built city (page 329). After the lower river's open spaces, the channel's mile width seemed canal-like. Ahead, a bend hid the city and seemed to close this water gateway to the west. Right here Cartier's heart must have sunk.

Slowly the roofs, spires, and battlements of French Canada's capital swung into view, and the gorgelike Quebec narrows opened. Climbing the slope of Cape Diamond, once the cornerstone of New France, the storied city stood out in bold relief.† A lowering sun bathed the rock in mellow light and turned the windows of Lévis, across the river, to gold.

Few cities can boast such a spectacular site. The French, and later the British, made it the Gibraltar of America. For 150 years Quebec, high on her headland, defied her foes.

But the broad river proved an Achilles' heel. In 1759 British sea power brought besieging redcoats. Wolfe and his men climbed to glory on the Plains of Abraham; and Quebec fell. The next spring French forces defeated Murray at Ste. Foy, outside the city's gates, and bottled him up. But when the ice went out, the river brought in British reinforcements.

Capt. James Cook, later of Pacific exploration fame, made the first real chart of the river up to Quebec. He was a young officer with the naval forces supporting Wolfe.

During the French regime, and far into the British, Quebec—then the head of ocean navigation—was Canada's emporium and chief port. With vast forests to draw on and the river to float them, she built sailing ships by the hundreds, and was long British America's leading timber port.

In 1825 she built the largest ship the world had seen, the 5,880-ton *Baron Renfrew*.

The era of wooden ships marked Quebec's great days as seaport and shipbuilder. Her square-rigged barks, brigs, and brigantines

* See "Gentle Folk Settle Stern Saguenay," by Harrison Howell Walker, NATIONAL GEOGRAPHIC MAGAZINE, May, 1939.

† See, in the NATIONAL GEOGRAPHIC MAGAZINE: "Old France in Modern Canada," by V. C. Scott O'Connor, February, 1935; and "Quebec, Capital of French Canada," by William Dow Boutwell, April, 1930.

Louis Tishler

A Cold and Lifeless St. Lawrence Yields a Glittering Winter Harvest

Annually, hundreds of cakes of river ice are stored in sawdust. These men work near Quebec with power saw and tractor-drawn sledge. Smaller operators use handsaws and horses (right). Unchecked winds and 20-below-zero temperatures often coat horses' nostrils with ice. This crew, finding lunches frozen, toasted rigid sandwiches against the side of a stove.

sailed the world over. Her fast clippers clapped on sail in the race for China tea.

Steam, iron ships, and channel dredging moved deep-sea commerce 160 miles upriver to Montreal. Quebec still handles 2,000,000 tons of cargo a year, but most ocean freighters pass her by.

In old Quebec I roamed the slitlike streets of Lower Town, squeezed between sheer rock and river, where Champlain built his Habitation in 1608. I talked with third- and fourth-generation river pilots, haunted the bustling water front, watched moppets playing hopscotch at the foot of Breakneck Steps, and listened while excitable housewives matched wits with farmers in the open market place.

"Upstairs," we bounced in a two-wheeled caléche over steep, cobbled, saint-named streets on a leisurely tour of Quebec-within-the-walls. At the doors of venerable institutions we left three centuries behind. For Quebec, despite the hurly-burly of modern traffic, its humming factories, smart shops, and neon signs, keeps a timeless quality.

A hospital dispenses mercy as it has since 1637; a convent keeps its votive light burning for the 233d year; Franciscan sisters kneel in perpetual adoration; a seminary teaches its 23 7th class. Monuments, cloistered walls, old houses keep their honored places.

Island Farmers Trap Eels

With a French Canadian named MacKay I toured rustic Ile d'Orléans, island cork in the St. Lawrence bottleneck near Quebec.

Old Norman-type houses, facing the river, turned their backs to us. Wayside shrines (page 356) and simple parish churches that are gems of early French architecture bordered our route. Lush crops and bursting barns indicated a good season. I saw no ox teams; nearly every farm had a bright-red tractor.

Wooden Oxen and Settlers Clear Stumps from a Chiseled Wilderness

André Bourgault, his brothers, and 15 apprentices do a big business in little St. Jean Port Joli (page 350). Advertising their wood carvings for miles along roadsides, they attract many travelers to their shops. Big-city stores sell their wares. André roughs out with power tools, finishes his work by hand

Lew McAllister

Montreal Presents a Gold-headed Cane to the First Skipper Running the Ice Blockade

Each spring the city celebrates its delivery from winter's grip by honoring the first deep-sea captain to follow the icebreakers into port. In 1949, 33-year-old Alexander S. Baxter (with cane) docked the freighter *Mont Alba* on April 7, beating the record by two days (page 333). Born a Scot, he is now a Montreal resident.

348 Canadian Pacific Railway

Past Beetling Cliffs, Through Norwaylike Fjords, the Saguenay Leads to Giant Industries in the Quebec Wilderness

Here in its last 80 miles the Saguenay flows smoothly, but in its uppermost 10 it races like a Niagara. There its rapids, harnessed by dams, power the world's largest aluminum plant. To its smelter go South American bauxite, Greenland cryolite, and Texas petroleum carbon. Down to the St. Lawrence, ingots are shipped for world export. Trinity Cape towers 1,500 feet above a pulp boat. Ice Age glaciers gouged the channel 1,000 feet deep in places (page 345).

Truck Draws Up to Pulp Boat. Soon the Town of Kamouraska Will Throb with the Klunk-klunk-klunk of Tossed Logs

La pulpe is Canada's big business. All winter fishermen and farmers chop the spruce forests, stacking the logs. When summer unlocks the St. Lawrence, pulp boats dock at every country wharf and load the produce for paper mills. Villagers build pulp boats during their spare time. Skippers often carry wives and children on board.

True Son of the River Is the Gaspé Cod Fisherman

This French Canadian of Gros Morne counts more children than English words in his vocabulary. A fisherman's brood may number a dozen or more, and with each home-coming they meet his boat and help clean the catch. The man himself began fishing around the age of 12; before that he split cod for his father. When summer's fishing ends, he goes to the forests to cut pulpwood.

At low tide I noticed tall fences marching out to big wire-and-wood "boxes" offshore.

"Fish traps," said my guide. "Indians taught early settlers the art of weir fishing, and it's been handed down ever since. Each farm carries with it the right to build a weir. You should be here in the fall when the eels, millions of them, head downriver for their ocean spawning grounds. Traps up and down the river catch them by the ton. Quebec each year ices and ships more than half a million pounds of eels to Europe and the States."

In a field we found a father and son mending a hauled-up trap. Deft fingers wove spool wire into mesh. Wiggling his arm like an eel, the old man led us through the trap's maze. A joke in French; I didn't get it.

"He says," Mac explained, "that's why we say 'poor fish'—they can get in but they can't figure the way out."

Returning along the island's north shore, we had a wide view of the rolling Quebec plain, spilling like a glacier between the city and towering Cap Tourmente. Ste. Anne de Beaupré, famous miracle shrine, stood out against the hills (page 360). Montmorency Falls poured a sunlit cataract 100 feet higher than Niagara.

A hundred years ago Henry Thoreau, New England's poet-naturalist,* hiked this Beaupré coast. Individualist Thoreau joined a conducted tour from Boston, spent a week along the St. Lawrence. In *A Yankee in Canada* he extols the river's beauty and notes the trip cost him $12.75, "including two guide books and a map."

Next morning, with a genial French Canadian, I crossed the river and headed east for the long, glorious road that rounds the Gaspé Peninsula, outthrust lower lip of the St. Lawrence's mouth.

Through quickly changing town-and-country scenes we drove along a Mainelike coast to St. Jean Port Joli. In this wood-carving center we talked with soft-spoken André Bourgault (page 347), master craftsman, and bought a model of the trim two-masted St. Lawrence schooner of sailing days.

Beyond bustling Rivière du Loup a string of quiet summer resorts unwinds. One of

* See "Literary Landmarks of Massachusetts," by William H. Nicholas, National Geographic Magazine, March, 1950.

them, Bic, was center for the farmer-pilots of the lower river in the days of sail. Behind Ile du Bic they lay in wait; competing for jobs, they raced to incoming ships. Many a life was lost when sudden storms capsized them.

Now full-time pilots board vessels from the Government tug *Citadelle* off Father Point. Later I visited the pilot station and "walked the plank" at midnight in a misty rain between *Citadelle* and the Cunard liner *Franconia*, six days out of Liverpool.

Next morning on deck I listened to land-hungry passengers exclaim over Quebec's scenic approaches and caught the excitement of a transatlantic docking.

At Matane, 250 miles out, we reached the real Gaspé, land of sea-washed hills and cove-set fishing hamlets, of hillside churches, wayside crosses, and covered bridges.*

The St. Lawrence north shore faded; only an occasional freighter, trailing a smoky plume, disturbed the river's immensity (page 3581).

Canadian Pacific Railway

A Retired Sailor Whittles Four-masted Barks Too Big for Bottles

Accident and injury, costing his job, made the fortune of Eugene Leclerc, a former ship's pilot of St. Jean Port Joli. Forced to change trades, he chose carpentry, and, to while away long winter evenings, carved ship models. Travelers bought his first two creations, and now their orders keep Leclerc, his wife, and 11 children busy. During wartime he gave up toy ships to build real ones.

The Shickshock Mountains, part of the northern Appalachians, stump the Gaspé's rugged character. Villages nearly three centuries old remain beachheads in a vast wilderness; civilization is only coast-deep.

Cod Is King in the Gaspé

Fishermen-farmers wrest small plots from reluctant hillsides, but their main harvest is from the sea. Cod is king, its symbols are everywhere—nets airing, fish drying (though much is now iced), fleets of boats strung along the coast, whole families cleaning fish (pages 325, 344, and 359).

Life along this rocky coast is full of hard, dangerous work; returns are meager. Land and sea are stern masters. Close to both, Gaspé people have a homespun quality, live humble lives.

A Sunday-morning automobile accident showed National Geographic photographers B. Anthony Stewart and John Fletcher how Gaspé folk stand together. All parties escaped unhurt, but the photographers' car was battered. They estimated the damage at $250.

For help, the owner of the other car,

*See "Gaspé Peninsula Wonderland," by Wilfrid Bovey, NATIONAL GEOGRAPHIC, August, 1935.

acknowledging full responsibility, drove them to his village. Straight to the church he went, where Mass was just over. In a few minutes he raised the money. And on the Gaspé $250 is a tidy sum!

Next day we drove to famed Percé, spent glorious hours there before returning to Quebec.

I rejoined a freshly painted *North Shore* for the 160-mile run to Montreal (page 324). Bucking current and ebbing tide, she forced her way up the palisaded narrows. From top deck I watched historic places glide past—Wolfe's Cove; Sillery, site of the restored 1637 mission home of early Jesuits; the mouth of the Chaudière River, 1775 route of Benedict Arnold's "rabble in arms" on their way to storm Quebec; ruddy Cap Rouge, site of Cartier's ill-fated winter quarters in 1542.

Beyond Quebec Bridge, one of the world's largest cantilevers, the river widened slowly and palisades began to lower. Through Richelieu Rapids, a swirling 6-knot current, we sailed a man-made channel flanked by rocks exposed by the low tide. To navigate these "rapids," slow freighters await an inrushing tide at Quebec.

Montreal a Man-made Seaport

Sand bars and rock shoals once choked this section of the river and limited Montreal-bound ships to 200 tons. In 1851 farseeing Montrealers began dredging operations to bring ocean traffic to their water front. Soon Quebec became a port with a past; Montreal, a port with a future.

Over the years the man-made channel was deepened from 16 feet to its present 32½-foot minimum. Now dredgers seek 35 feet.

Veterans of far-flung sea lanes steam past grazing cattle and riverside farms to a world port 1,000 miles from the sea. They make Montreal's bustling water front look like a maritime United Nations. In one day I saw ships from Norway, Denmark, Great Britain, Italy, Latin America, Australia, and Turkey.

Some 135 veteran pilots conn this stream of water-borne traffic. One group shuttles between Father Point and Quebec, another between Quebec and Montreal.

At least three years at sea and a long river apprenticeship fit them for the job. Handed down from father to son, piloting is a family affair often claiming three, four, or more brothers. When two pass on the river, it calls for much waving and long whistle blasts.

I watched our pilot work. Although the channel seemed as well marked as a superhighway, his eyes kept roving the shores.

"In the old days," he volunteered, "pilots steered by church steeples, big trees, any landmark. Now we line up our course by shore markers after every turn. We still use landmarks as a check, though. Notice how those twin steeples line up one behind the other."

Around sweeping bends he guided us. More than two miles wide, the river flowed majestically. Bluffs gave way to the flat, ever-widening St. Lawrence lowland, home of a fifth of Canada's people. Both shores seemed, as they did to 18th-century travelers, one continuous village.

This reach of the St. Lawrence is forever the river of New France. Place names—Vaudreuil, Sorel, Varennes, Champlain—honor its founders. The 60,000 French Canadians of 1760 now number some 3,500,000. More than half live within the sound of hoarse freighter whistles on the great river, still the broad "Main Street" of French Canada. To them, "Canada" means the age-old valley of the St. Lawrence.

Midway between Quebec and Montreal, at the swift St. Maurice River's triple mouth, smoking factory chimneys and mountains of stored pulpwood marked industrial Trois Rivières. Its colorful past spans 316 years, from fur post to capital of Canada's huge newsprint industry.

With Canadian friends I later visited this old-new, very French city. In the world's largest newsprint mill we saw logs ground or stewed to pulp. Flowing on endless wire screens over hot rollers, the wet pulp was transformed in 50 seconds into dry paper ready for tomorrow's headlines. In the town's papermaking school we saw the process again in miniature (page 539).

Near the water front we discovered a part of town that time forgot, where convent bells tolled and narrow, Old World streets resembled Quebec's.

The St. Maurice, Valley of Power

By car, caboose, and speedboat we explored the rugged St. Maurice Valley. The river's surging power, like the Saguenay's, has built new cities in the northern wilderness and made its basin the world's largest newsprint center. High-tension wires, threading the valley, flash electric energy from five big powerhouses.

At La Tranche we saw men and machines changing the face of the land, building a giant dam to send power coursing to Sorel's new titanium-smelting plant.

North Shore steamed across big, shallow Lake St. Peter, long the St. Lawrence's first barrier to ocean vessels. Here, when even his small pinnace grounded, Cartier took to an open boat. Until the channel was dredged,

Kodachrome by H. Anthony Stewart and John E. Fletcher

French Canada's Old-fashioned Country Styles Get an Airing on Breezy Quebec Heights

Farm women along the river wore such dresses between 1870 and 1900. On occasions they were seen as late as the 1920's. These authentic copies came from the Folklore Archives of Laval University, Quebec City.

Need a Baby Sitter, Magician, Bouncer? Montrealers Call McGill Students

The University finds thousands of part-time and summer jobs for students, permanent positions for graduates. Famed McGill, chartered in 1821, was founded on the fur-trade fortune of Scotsman James McGill.

Woolen Threads of Many Hues Reproduce a Rural Scene

In Pointe au Pic's Handicraft School students learn the fine art of making tapestry rugs. They copy paintings by local artists. Minimum apprenticeship is 10 months; it takes three years to train an expert.

Toylike Visual Aids Help Cadets of Canada's West Point and Annapolis "See" Chemistry

The Royal Military College in Kingston, Ontario, trains officers for Army, Navy, and Air Force. It was founded in 1876 in "HMS Stone Frigate," a naval storehouse. Col. W. R. Sawyer explains crystal structure.

↑ Godly French-Canadian Farmers Plant Crosses with Their Crops

French pioneers set up the first wayside crosses as religious meeting places before churches were numerous. Many rural Quebec families continue the old practice. Such crosses dot the Province's roads like milestones; symbols of the Crucifixion hang on the one above.

↑ A Habitant Family Starts Chores Early on a Misty Morning

Ol' Dobbin goes out to pasture; *Madame* wears an old-fashioned wooden yoke to carry the milk pails. Divided and redivided over the centuries, riverside farms run in ribbonlike plots from shore to upland. Thus fertile bottom land, pasture, and woodland are shared.

Electric Cross atop Mount Royal Reminds Canada's Largest City of Its Pious Founding

Bustling Montreal began as a frontier mission founded by a band of mystics in 1642. The rich fur trade built a commercial town; timber, wheat, and foreign trade kept it growing.

Gaspé Lights, Sweeping a Sealike River, Warn Ships that Jagged Rocks Edge Deep Water

Enhancements by R. Anthony Stewart and John H. Fletcher

Europe-bound, *Empress of Canada* Swings into the Current at Montreal

Built to navigate the dredged Montreal-Quebec ship channel, Canadian Pacific's 29,000-ton "Empress" ships are the largest liners plying the St. Lawrence. In summer they shuttle between Liverpool and Montreal.

Work Seldom Finished, Gaspé Men Repair Nets in Off Hours

Familiar sights along the Gaspé's rugged north shore are nets airing, cod drying, fleets of open boats strung along the coast, and whole families cleaning fish when the day's catch is in.

Devout Pilgrims, Many Seeking Miracle Cures, Flock to World-famed Ste. Anne de Beaupré

The unfinished basilica, center of the shrine on the St. Lawrence, dates only from 1923. Settlers raised the first chapel to Ste. Anne here in 1658 where Breton sailors miraculously saved from shipwreck landed.

Montreal-bound cargo was lightered from the lake.

Lake St. Peter swallows the tide. From a 12½-foot rise and fall at Quebec it dwindles to less than one foot at Trois Rivières and disappears in the lake, more than 900 miles from the sea.

Flat shores and distant horizons hinted at the inland west; the wide sweep of water suggested the Great Lakes. Here, perhaps, exploring Frenchmen got their first feel of America as a vast continent.

Through big, meadowlike islands, once a favorite Indian ambush, the channel zigzagged. Port side, Sorel's spires and shipyards marked the mouth of the Richelieu River, historic gateway to Lake Champlain and the Hudson Valley. Near by, on the St. Lawrence shore, the town's new plant for smelting north-shore titanium took shape.

Several hours later we slipped past giant oil refineries and miles of docks, bucked swift St. Mary's Current under high Jacques Cartier Bridge, and tied up in Montreal.

In sailing days ox teams hauled ships up this strong current blocking the harbor. But in 1809 John Molson launched *Accommodation*, the river's first steamboat.

Soon *Hercules*, a tug with a giant's strength in a dwarf's body, lifted the current's blockade forever.

In 1642, more than a century after Cartier's visit, a band of mystics under the Sieur de Maisonneuve founded a wilderness mission on the slopes of the long-dead volcano the explorer had named Mont Réal. For years the settlement lived a precarious life under repeated Indian attacks.

River-borne Trade Built Montreal

The tiny settlement's superb location for trade—at the foot of the thundering St. Lawrence rapids and the mouth of the mighty Ottawa River—could not long be denied. The rich fur trade, paddling the Ottawa, changed the mission into commercial Montreal.

In 1803 the growing town knocked down its walls and opened its harbor to world trade. The ship channel, begun in 1851, brought the sea to Montreal. Canals, by-passing the rapids, extended its commercial reach half across the continent.

Today this island city is Canada's largest, and its financial, industrial, and commercial heart. Its St. James Street is the Wall Street of Canada. Some 5,000 industrial establishments pour out two billion dollars' worth of varied products. The port, in seven and a half months, handles 11,000,000 tons of cargo.

Big, lusty, and cosmopolitan, Montreal impresses many a U. S. visitor as just another American metropolis. Tall buildings and traffic jams confirm their view. But with a longer stay the city's personality begins to reveal itself.

Two-thirds of Montreal's population of 1,583,000 is of French descent. Bilingual signs, such as *Pont Victoria Bridge*, are everywhere. Main streets, paralleling the river, become more French as they go northeast. Iron staircases climb the sides of many houses.

French restaurants serve excellent food in the continental manner. Narrow streets of the business district, corresponding to the old walled city, have a foreign look. Small squares bordered by limestone houses with fanlight doorways recall Edinburgh. The water front resembles a Clydeside port.

Mount Royal Commands a 60-mile View

Montreal's points of interest spread from the 60-mile view atop Mount Royal down to the river (pages 340 and 341). But in a short stay the visitor can see famed McGill University (page 354) and the University of Montreal on the mountain slope; Notre Dame, one of North America's largest cathedrals; and Château de Ramezay, headquarters of Continental troops that held the city for seven months during the American Revolution.

Here Gen. Richard Montgomery planned the attack on Quebec, and a committee composed of Benjamin Franklin, Samuel Chase, and Charles Carroll tried unsuccessfully to persuade French Canadians to join the Revolution.

The visitor can linger in the city's renowned botanical gardens; mix with crowds in colorful Bonsecours Market; see the old sailors' church with its ship models carved by grateful seamen; find remnants of a 17th-century fort; enter smart shops and studios on Sherbrooke Street; and visit impressive St. Joseph's Oratory, miracle shrine second only to Ste. Anne de Beaupré.

With Maj. Guy Beaudet, assistant port manager, I covered Montreal's gray and grimy water front. Wearing dusters, we climbed towering grain elevators and followed conveyor belts carrying a golden stream from storage bin to ship's hold. On docks we watched locomotives being loaded for India, flour for Africa, horses for Trinidad's police; sugar unloaded from the West Indies, manufactured goods from Britain, and grain from canal-sized freighters.

"Montreal is the big transshipment point for western grain going abroad," the Major explained. "We ship about 67,000,000 bushels

Louis Jaques

First Sign of Spring on the River—an Icebreaker Rips a Channel to Montreal

Ice jams used to pile up in the St. Lawrence to a depth of 80 feet, causing serious overflows. Breakers, keeping the river clear, have whipped floods and lengthened Montreal's navigation season 12 days. Workers and spectators, including a priest on skis (left), follow the ship's progress. Small fire planted in the snow mark the course of a wintertime road (page 323).

a year. If necessary, we can load and unload 1,500,000 bushels a day.

"Few people realize," he continued, "that Montreal is closer to Liverpool than New York is. Last year we had 4,480 ship arrivals, 1,112 of them deep-sea vessels."

"China" Rapids Recall Old Dream

Angling into Montreal Harbor, the Lachine Canal by-passes the angry rapids that stopped Cartier. In derision the early settlement near by was named La Chine (China) when La Salle failed to find a westward passage to the Orient.

Five other Canadian canals complete a 22-lock stairway that climbs some 225 feet from Montreal to the level of Lake Ontario. The Welland Canal, connecting Lakes Ontario and Erie, and the Soo Canals, linking Huron and Superior, add 1,100 miles of Great Lakes navigation.

Ships drawing no more than 14 feet, limiting depth of the St. Lawrence canals, can sail 2,300 miles from the open sea to Duluth, Minnesota—a distance roughly equal to a voyage from Newfoundland to Portugal.

Though most ocean freighters draw nearly twice 14 feet, or more, a few follow this long inland route into America's heart. Swedish, Dutch, and Norwegian companies operate 24 specially built ships between Europe and the Lakes. They carry about 60,000 tons each way in a season.

Small canal freighters, built to fit St. Lawrence locks, haul some 7,000,000 tons a year between the Great Lakes and Montreal.

Chief cargoes are coal, wheat, gasoline, petroleum, and pulpwood.

This steady stream is almost all Canadian. Although Canada guarantees by treaty free use of the whole St. Lawrence to U. S. ships, only 41 used the canals in 1949.

To see the 182 miles of river between Montreal and Lake Ontario, I drove both shores and shot the rapids in *Rapids Prince* (p. 332).

Around sparkling Lake St. Louis, where tawny Ottawa River water and the blue St. Lawrence flow unmixed, I drove to the mouth of Soulanges Canal. Here ends a series of rapids that drop the river some 85 feet in 18 miles. Around them Royal Engineers built Canada's first canal in 1783. I watched while divers replaced a broken lock gate and impatient freighters waited in a long line.

Midway along the shore of big Lake St. Francis, French Quebec gives way to British Ontario. Many of its St. Lawrence towns were founded by Loyalists fleeing the American Revolution.

The tricolor and Quebec's fleur-de-lis flag disappeared; riverside Route 2 became the King's Highway.*

Some 25 miles later I looked across to an island farm flying the Stars and Stripes. Near industrial Cornwall, Ontario, the United States-Canadian border takes to the river and follows its channel to the Great Lakes. Here the north shore is Canada; the south, the United States. Islands a stone's throw apart may lie in different countries.

Seaway Considered Since 1895

More agitated than these troubled waters is the oft-recurring St. Lawrence Seaway and Power Project controversy. Broached periodically since 1895, this two-nation project calls for construction of the remaining links in a 27-foot navigation channel between Montreal and Lake Superior.

A proposed giant power dam would generate 2,200,000 horsepower, at Barnhart Island in the International Section.

"Operation St. Lawrence" entails the deepening of Lakes harbors and connecting rivers; the building of a control dam, the power dam, and by-passing locks in the Ontario-New York section; and improving the Soulanges and Lachine Canals in the Canadian sector.

Such a face lifting for the upper river could change Great Lakes ports into ocean ports and free big Lakes freighters to move downriver to Montreal, or to Seven Islands for Ungava iron ore.

Today generators tap the upper river for a million horsepower. But, completely harnessed, the mighty St. Lawrence could produce a staggering 5,400,000—half again as much as the combined output of Grand Coulee and Hoover Dams.

At a dozen places along the Canadian shore I watched the existing St. Lawrence waterway operate (page 330). Canal freighters squeezed into old locks with inches to spare. Lockkeepers turned hand cranks to open valves and gates. Such old-time methods pass some 4,000 ships a season.

On Sheek Island I had a water-level view of thundering Long Sault Rapids. Above Cardinal, where the locks end, the river broadened to some two miles and flowed as straight as a "canal" on Mars.

"Garden of the Great Spirit"

Crossing and recrossing the international border, I drove through miles of New England-like farm country and visited busy United States and Canadian river towns like Ogdensburg and Brockville. On both shores monuments recalled old wars on a border long undefended.

Paddling the island-strewn St. Lawrence near Lake Ontario, an early French explorer exclaimed, "Les milles îles!" And the Thousand Islands they became, though nearer 1,700 cut the river into countless winding channels and hide its broad expanse.

Indians called this land-and-water paradise Manitouna, "Garden of the Great Spirit." In its scenic maze warring British, French, and Indians played grim hide-and-seek.

Before the century's turn Americans bought islands, built summer homes, and made this a far-famed vacationland (pages 364 and 365).

By speedboat I saw the archipelago's haunting natural beauty. Mainland towns, swarming with vacationists, bore witness to its great attraction. Sight-seeing boats made their leisurely rounds; trim pleasure craft raced by. Amateur fishermen cast lines for speckled game fish. Music and laughter drifted from island lawn and swimming parties.

Recalling stark, frontierlike shores near the Gulf of St. Lawrence, I reflected how divergent are the extremes of this amazing river. Only occasional freighters tied them together.

Canada's West Point at Kingston

With brisk, 83-year-old Lt. Col. Courtlandt Strange I toured historic Kingston, Ontario, strategically set where lake and river meet.

* See, in the National Geographic Magazine: "Exploring Ottawa," by Bruce Hutchison, November 1947, and "Ontario, Next Door," by Frederick Simpich, August, 1932.

Explorers Called These the Thousand Islands. They Underestimated; There Are 1,700

This 40-mile-long archipelago straddles the international line (page 363). Americans have made their half a summer playground, with palatial villas, including a ghostly unfinished castle. Here the Canadian side remains largely a wilderness, broken by a few boathouses (center, left).

International Bridge Hops from Isle to Isle on Its 8½-mile St. Lawrence Crossing

Some of the Thousand Islands are mere pinpoints; others support villages. A glacier carved them all long ago. Excursion boats (center, right) take visitors on sunshine and searchlight tours. The bridge, opened in 1938, illustrates suspension, arch, and truss spans.

Canada Wide

Her Coat Choked with Ribbons, a Fox Farmer Holds Her Quebec Show Entry

Wild furs were virgin Canada's El Dorado; they opened the wilderness to exploration and settlement. In recent times fur farming created fresh fortunes. Lately, however, fashion's whim has ruined the fox market. Fancy pelts which used to fetch $15 to $100 now bring $5 to $30. Quebec breeders in 1943 numbered 4,000; now they count scarcely 400. This doglike white face mutation was produced from the standard silver fox. Its jaws are lightly laced to prevent snapping.

Its long past holds memories of Count Frontenac, iron-willed Governor of New France, and La Salle; of Loyalist settlers and British redcoats; the Royal Navy on Lake Ontario; the beginnings of responsible government for Upper Canada; and the first meeting of a Parliament of the Province of Canada.

Today modern establishments carry on Kingston military traditions that go back 277 years. On the site of Frontenac's 1673 fort stands the National Defense College. In 1876 the city's Royal Military College, the West Point of Canada, began here in "H.M.S. Stone Frigate," a former naval storehouse. Here, too, is the Canadian Army Staff College.

Many-sided Kingston is also a cathedral city and center of learning. Ivy-covered buildings of Queen's University, chartered by Victoria in 1841, cluster near the shores of Lake Ontario (page 334). Industrious, the city has long made boats and locomotives. Now it also manufactures aluminum products and nylon in up-to-the-minute suburban factories.

High on the ramparts of old Fort Henry I watched the slanting rays of a setting sun cancel out a summer day. A brass cannon boomed (page 335), a bugle sounded, proudly the Union Flag was lowered. Gliding from the island-studded river, a freighter headed into the sealike sweep of Lake Ontario. No wonder, I thought, that Indians told Cartier he had found "the river that has no end."

"Delmarva," Gift of the Sea

By Catherine Bell Palmer

WATER-GIRT "Delmarva," anchored to the eastern coast of the United States by a 12-mile neck, is a unique peninsula, the only one in this country containing portions of three States—Delaware, Maryland, and Virginia.

Like some gigantic crooked finger, this out-of-the-way Peninsula points southward, separating Chesapeake Bay from Delaware Bay and the Atlantic Ocean.

From Wilmington, Delaware, at its first joint, south almost all of the 180 miles to its finger tip of Cape Charles, Virginia, this low-lying level land is threaded with twisting, turning tidal rivers from the Bay and with narrow inlets from the sea (map, page 371).

The unofficial but descriptive name "Delmarva" is in everyday usage on the Peninsula. At three approaches—south from Wilmington, north from Cape Charles, and east from Matapeake, Maryland—signs announce that each is the "Gateway to the Delmarva Peninsula."

Charters of English kings and acts of legislature decreed Delmarva's division. So bound together are its half-million people, however, that State boundary lines, long in dispute, now are practically forgotten.*

One sunny spring morning I drove a National Geographic car aboard the ferry at Sandy Point, Maryland. A short distance north of the ferry slip I could see men working on the new Chesapeake Bay Bridge. "Operation Link" they call the project because, when completed, the 4-mile bridge will link Maryland's eastern and western shores.

Brisk breezes chopped Chesapeake waters, sending us spanking across the broad blue Bay, second only to New York Harbor as busiest waterway in the eastern United States.

Kent Island Rich in History

On Kent Island, Maryland, site of the Eastern Shore end of the new bridge, a native shook his head slowly and complained that the span is "going to make it too easy for 'foreigners' from Washington and Baltimore to come over here."

During three centuries away from main routes of travel, Delmarvians developed a sense of independence. This spirit still stands out in the character of the people.

Many a time I had taken this route from Matapeake across Maryland's Eastern Shore to vacation at Rehoboth Beach, Delaware seashore resort. Then, in summer, wind-whipped wheat fields were shimmering seas of gold. Mauve myrtle bushes bordered the road.

Now, as I drove along, farmers were plowing under crimson clover against green backdrops of loblolly pine. From a grove of gum trees came the bold, declarative call of the cardinal, *right here, right here, right here.*

The bucolic setting of tiny Kent Island belies its past conflicts. Few motorists taking this route realize that the land was claimed for Virginia in 1631 by William Claiborne, then Secretary of the Colony of Virginia.

Armed with a trading license, Claiborne established a post here to trade with the Indians. When Charles I granted a charter later to the Calverts, Claiborne refused to recognize their jurisdiction over Kent Island. Tenaciously he fought for possession of his beloved island for years.

Chesapeake Bay Leads in Oystering

Near Kent Island Narrows, estuary that separates the island from the mainland, rose a huge pile of oyster shells. I wondered what the men loading the shells into dingy-white boats were going to do with them. One oysterman paused long enough to tell me. "Going down the Bay to plant culch to catch spat."

Translated, that means putting oyster shells (culch) on the bottom of Chesapeake Bay to provide a good resting place for infant oysters (spat).

When summer sun warms Bay waters, oysters begin to spawn. The average female American oyster can lay 16 million eggs, discharging them into the water, but it's pure accident whether they meet males' milt. Fortunately, millions of eggs sink to the bottom unfertilized. If all were fertilized and grew to maturity, they would fill the entire Bay in a single season!

Continuous fishing on natural oyster beds of Chesapeake Bay, however, has caused a dearth of oysters. During the 1948–49 season, Virginia oystermen brought up more than 3,000,000 bushels from the Bay; Maryland, some 2,700,000 bushels. This sounds like a good catch until it is compared with the peak season of 1884-85, which for Maryland alone was 15,000,000 bushels.

In spite of the decline, however, Chesapeake Bay in 1949 gave up more oysters than any other body of water in the United States.

Virtually all of Maryland's oyster beds are owned by the State and are open to public fishing.

* See "A Maryland Pilgrimage," by Gilbert Grosvenor, National Geographic Magazine, February, 1927.

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Jay Dee, Speedy Chesapeake Bay Log Canoe, Heads for Cambridge under a Cloud of Bellying Canvas

Her 31-foot hull was hand-adzed and shaped from five big pine logs, bolted together. Fir masts, unsupported by «stays, bend alarmingly in a stiff breeze. Here *Jay Dee* beats to windward under "short" rig. When racing she carries as many as eight sails. For such graceful craft Maryland and Virginia sailors are indebted to early colonists who improved crude Indian dugouts (page 392).

Since oysters belong to the State until they are caught, the individual oysterman feels it is Maryland's duty to conserve oyster beds. This the State is doing. In 1949, 1,000,000 bushels of shells and 370,000 bushels of seed oysters were planted.

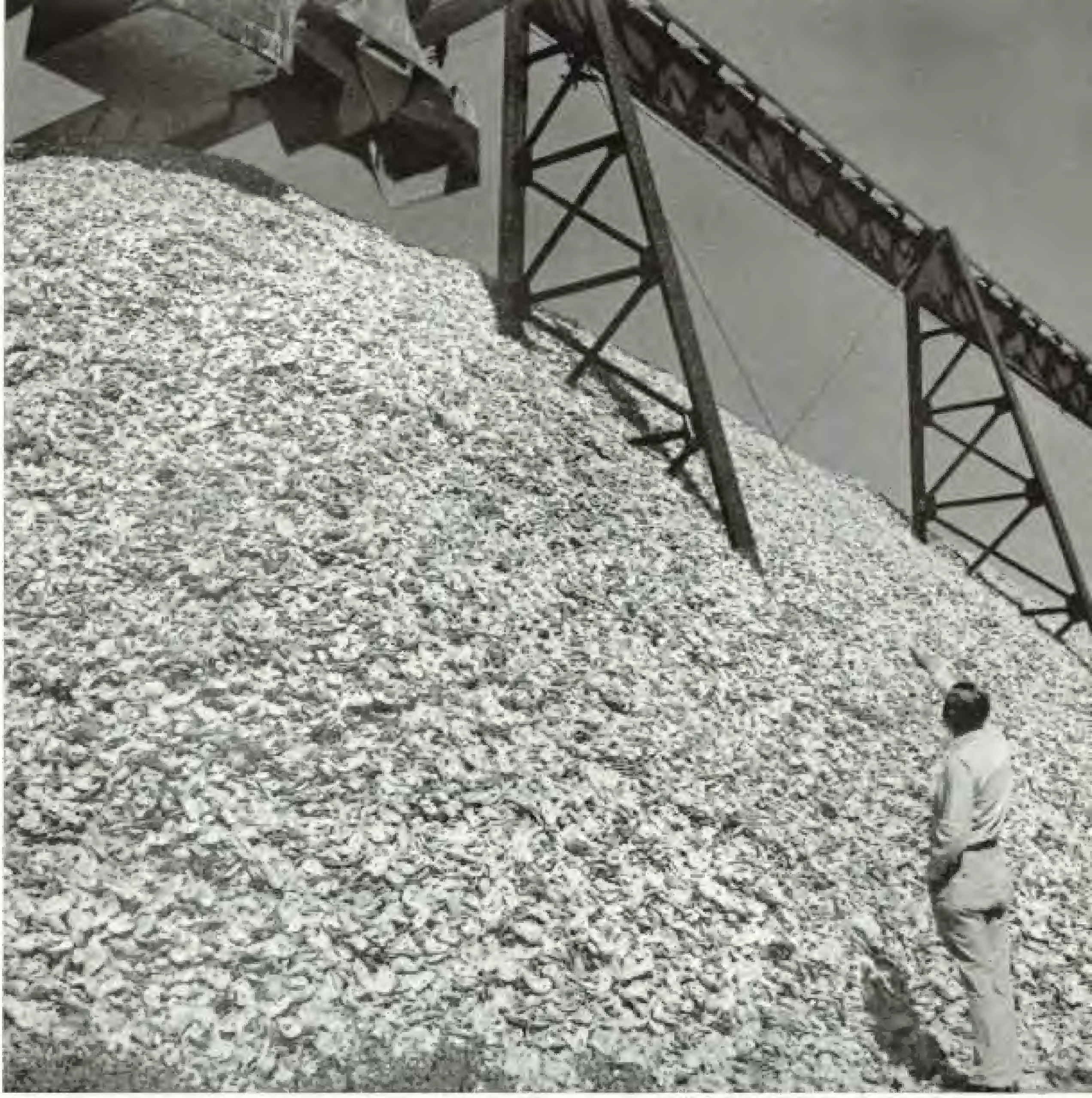
At Wye Mills, Maryland, I paused beside the famous 411-year-old white oak to study the route southeastward (page 381).

A glance at the map of the Peninsula, one of the first regions in the United States settled by men of British blood, shows that 12 of its 14 county names are English. The other two, Wicomico in Maryland and Accomack in Virginia, are of Indian origin.

Chief cities and villages, such as Cambridge, Oxford, Chestertown, Salisbury, Cape Charles, New Castle, and Dover, reflect the nationality of early colonists.

I had timed my visit to the Eastern Shore of Virginia to coincide with Garden Week, when, during the last week of every April, many of Virginia's old Eastern Shore homes and gardens are open to the public.

Unusually warm weather, with no respect for Garden Week plans, had brought flowers



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Crushed Shells from This Oyster Mountain at Crisfield Make Hens Lay More, Produce Stronger Eggshells

It takes a 30-foot-high crane riding on twin rails to handle this 300-foot-long mound. Annually, the shells of a million bushels of freshly shucked Chesapeake Bay oysters are cleaned, crushed, and screened by the Potomac Poultry Food Company to supplement the diet of broilers, pullets, and baby chicks. Ground oyster shells provide calcium that toughens eggshells. A by-product, agricultural lime, sweetens soil.

into premature bloom. Gardenias and tropical figs thrive in the mild climate. An owner of one old house told me that roses, grown in her garden, graced her table at Christmas!

Many names of scattered villages along Virginia's Eastern Shore are Indian tongue-twisters: Wachapreague, Chincoteague, Pungoteague, Machipongo, Nassawadox. Others are whimsical. When I asked the location of an 18th-century estate, Wharton, I was told it was between Temperanceville and Modest Town, on Assawaman Creek.

Adventuresome Capt. John Smith, some 300 years ago, describing the Chesapeake Bay region, said, "Heaven and earth never agreed better to frame a place for man's habitation."

Present owners of Wharton, Mr. and Mrs. Charles R. Busch of Orange, New Jersey, agree with the captain. They have restored this lovely Georgian brick mansion with painstaking care.

Mrs. Busch insisted I stay for a baked-shad dinner. Hickory-smoked flavor of piping-hot cornbread aroused my curiosity. My hosts' bacon, like their ham, was smoked with hickory wood. Smoked bacon grease, used

Pat Flanners

Gulls Hitch a Ride on the Pennsylvania Railroad's Car Float Crossing Chesapeake Bay

Freight destined for the South travels by rail from New York, Philadelphia, and Wilmington to Cape Charles, Virginia. There the cars shift to barges and make the trip to Little Creek, Virginia, in two hours and 40 minutes. During 1949 tugs hauled 130,000 freight cars across the Bay.

for shortening, gave the cornbread its hickory-wood taste.

When Mr. Busch mentioned the "provincialism" of the Eastern Shore, I asked him to explain. This was a term I had heard applied to the people here before.

"Self-sufficient, resisting change, set in their ways, I guess we'd call it," he replied. "But they are wonderful people, good friends, good neighbors."

Mrs. Busch said she heard many expressions unfamiliar to her. At a funeral a native remarked to her, "It's a bad go, isn't it?"

When a house is dusty, it is "ashy"; a barnyard is a "pound"; pine needles are "shatters"; sheets and pillowcases not properly laundered are "deadlified" looking.

The next day I met National Geographic staff photographer Robert F. Sisson at Eastville, Virginia, seat of Northampton County. We spent hours in the tiny red-brick courthouse, delving into some of the oldest continuous county court records in the United States. They date from 1632.

We were looking particularly for the Northampton Protest. This document, dated March

PENNSYLVANIA
NEW JERSEY
DELAWARE
MARYLAND
VIRGINIA
Philadelphia
Camden
Chester
Gloucester
Woodbury
Wilmington
York
Red Lion
Dallastown
Hanover
Strasburg
Quarryville
Oxford
Site of Delaware Memorial Bridge
Pitman
Williamstown
Hammonton
Glassboro
Farnhurst
New Castle
Pennsville Ferry
Delaware City
Salem
Vineland
Egg Harbor City
Mays Landing
Pleasantville
Atlantic City
Bridgeton
Millville
Middletown
Smyrna
Fort Norris
Woodbine
Ocean City
Dover
Bombay Hook National Wildlife Refuge
Wyoming
Bowers
Bay
Cape May Court House
Wildwood
Cape May
Barratts Chapel
Harrington
Milford
Denton
Milton
Lewes
Cape Henlopen
Rehoboth Beach
Bridgeville
Georgetown
SUSSEX
Seaford
Laurel
Millsboro
Bethany Beach
Delmar
Manchester
Westminster
Reisterstown
Towson
Baltimore
Ellicott City
Edgewood
Havre de Grace
Aberdeen
Elkton
North East
CECIL
NEW CASTLE
KENT
QUEEN ANNES
TALBOT
CAROLINE
DORCHESTER
WICOMICO
WORCESTER
SOMERSET
Chesapeake Bay
Delaware River
Susquehanna River
Chesterton
Hinchingham
Glen Burnie
Gibson Island
Site of Chesapeake Bay Bridge
Sandy Point
Kent Island Narrows
Wye Mills
Wye River
Kent Fort Manor
Kent Island
Wye House
Easton
St. Michaels
Cedar Point Farm
Tilghman I.
Chester R.
Corsica R.
Centerville
Queenstown
Laurel
Silver Spring
Annapolis
Ferry
Matapeake
Bethesda
Washington
Alexandria
Mount Vernon
Chesapeake Beach
Waldorf
La Plata
Prince Frederick
Cambridge
Federalsburg
Oxford
Choptank River
Sharptown
Fairmount
Princess Anne
Snow Hill
Pocomoke City
Crisfield
Salisbury
Berlin
Ocean City
Fenwick Island
Tyaskin
Upper Ferry
Bivalve
Nanticoke
Wicomico R.
Pocomoke R.
Milton
Bridgeville
Georgetown
Lewes
Rehoboth Beach
Seaford
Laurel
Millsboro
Bethany Beach
Delmar
Dahlgren
Leonardtown
Colonial Beach
Lexington Park
Solomons Island
Bloodsworth Island
Point Lookout
Smith Island
Montross
Warsaw
Callao
Tappahannock
Sharps
Reedville
Tangier
Parksley
Modest Town
Onancock
Accomac
ACCOMACK
Kilmarnock
Irvington
Rappahannock River
Piankatank R.
Pungoteague
Wachapreague
Deltaville
West Point
Nassawadox
Exmore
Gloucester
Mathews
Old Town Neck
Machipongo
Oak Grove Plantation
NORTHAMPTON
Eastville
Cherrystone Inlet
Cape Charles
Ferry
Old Plantation Creek
Kiptopeke Beach
Cape Charles
Ferry
Chesapeake
Site of Arlington
Toano
Williamsburg
Yorktown
Ferry
Jamestown
Surry
James River
Waverly
Smithfield
Wakefield
Newport News
Hampton Roads
Ferry
Ocean View
Ferry
Cape Henry
Little Creek
Virginia Beach
Windsor
Portsmouth
Norfolk
Chincoteague
Wallops Island
Wharton
Accomac Creek
Temperanceville
Parksley
Modest Town
Onancock
Accomac
Machipongo
Oak Grove Plantation
Eastville
NORTHAMPTON
Cape Charles
Ferry
Old Plantation Creek
Kiptopeke Beach
Cape Charles
Ferry
Chincoteague
Wallops Island
Wharton
Accomac Creek
Ocean City
Assateague Bay
Chincoteague Bay

Atlantic Surf and Two Broad Bays Wash Delmarva's Shores

Soon the Peninsula's moated isolation will be ended. A 4-mile Chesapeake Bay bridge will speed traffic to Baltimore, Washington and beyond. Also under construction is a Delaware River span.

0 10 20 30 40 50
STATUTE MILES

Drawn by H. E. Eastwood and Irvin E. Alleman

Delaware's Governor Knuckles Down to a Marble Game While Schoolboys Watch

Elbert N. Carvel, the Diamond State's 40-year-old Chief Executive, visits his son's public school in Laurel. Delaware provides over 90 percent of the running expenses of public education throughout the State. Now under way is a $20,000,000 school building program, with higher salaries for teachers.

30, 1652, is the oldest recorded organized protest against taxation without representation in America. Irate citizens objected to a tax on tobacco without representation in the Assembly at Jamestown, Virginia.

About three miles from Eastville, on Old Town Neck, is Oak Grove Plantation, present home of Mr. and Mrs. Ralph C. Gifford, formerly of Louisville, Kentucky.

Mr. Gifford asked us if we had ever fished over "racks." Suspecting some trick, Bob and I raised questioning eyebrows. Gifford said, "That's how I felt when some Eastern Shoremen invited me on such a fishing expedition.

"After a two-hour run through choppy Atlantic waters," Gifford continued, "the captain cut the motor. Pointing to a spot on his chart, he told us we'd fish over this 'rack.'

"I peeked over the captain's shoulder. It was a United States Coast and Geodetic Survey chart showing positions of *wrecks*!"

The next morning I drove south to Cape Charles on U. S. 13.

For 17 years the Virginia Ferry Corporation has operated ferries from Cape Charles to Little Creek, Virginia. During 1949 they transported more than a million and a quarter passengers and nearly half a million vehicles across Chesapeake Bay. Recently they started operating from a new terminal at Kiptopeke Beach.

Settlement Predates Plymouth

Several years before the Pilgrims set foot on Plymouth Rock, 17 men went from Jamestown to the Eastern Shore to establish a saltworks. They settled along Old Plantation Creek, south of the town of Cape Charles.

Beside this same creek, John Custis built his estate, Arlington. The house is no longer there, but the tomb of his grandson, Col. John Custis IV, still stands, protected by an iron fence and guarded by gnarled trees.

National Geographic Photographer E. Anthony Stewart

Oxford, Maryland, Once a Thriving Port, Dozes Quietly Beside the Tred Avon River

Almost three centuries ago, before Baltimore was founded, the Eastern Shore village's harbor was jammed with ships bringing African slaves and Old World goods to be exchanged for tobacco. Today the chief activity is building and repairing workboats and yachts. Here two shipyard men pole a Chesapeake Bay bugeye onto a marine railway for overhaul.

Traditional tales about the colonel and his marital troubles tell of times when no word was spoken between him and his wife. But this eccentric father-in-law of Martha Dandridge (later, Mrs. George Washington) had the last word. The inscription on his tombstone reads: "Aged 71 years and Yet Liv'd but Seven Years which was the space of time He Kept a Batchelers house at Arlington on the Eastern Shoar of Virginia."

I was amused by an additional statement—"This inscription put on this Tomb was by his own Positive Order."

In 1608, when Capt. John Smith and his band of 14 men explored Chesapeake Bay in an open barge of "two tunnes burthen," they reported they had never seen "better fish, more plenty or variety, in any place." They tried catching them with a frying pan, but "found it a bad instrument to catch fish with." *

By rod and reel, however, a world's record 102-pound cobia (sergeant fish) was caught off Cape Charles, Virginia, in 1938; record rod-and-reel channel bass catch, 83 pounds, was made off this same port, September, 1949.

Clams Make Cherrystone Famous

Eastern Shore folk speak of the eastern and western parts of their Peninsula as "seaside" and "bayside." On seaside, from narrow waters of Chincoteague Bay, come famed Chincoteague oysters.

Familiar to sea-food gourmets are Cherrystone clams on the half shell. A tiny inlet on bayside, Cherrystone, north of Cape Charles, is supposed to have given the clam its name. I heard this story on the Eastern Shore, but the U. S. Fish and Wildlife Service says Cherrystone is a trade name denoting size of the clam.

* See "Chesapeake Odyssey," by John Maloney, National Geographic Magazine, September, 1939.

National Geographic Photographer John B. Fletcher

From Cambridge, Maryland, a Highway Bridge Leaps Two Miles Across the Choptank River to Link Dorchester and Talbot Counties

To Cambridge Harbor (upper right) Chesapeake Bay bugeyes and skipjacks bring loads of oysters and crabs. Cambridge Yacht Club, on a corner of the yacht basin (right center), annually holds eastern seaboard championship races for Hampton-class sloops (page 187). The Dorchester County seat is the second largest town on Maryland's Eastern Shore. A leading industry is canning vegetables, meat products, soups, and sea food.

A Lifeguard "Rescues" a Shark in Distress

At Ocean City, Maryland, William Kekeris (holding jaws) swam out to what he thought was a drowning swimmer. Instead, he found this 6-foot sand shark. Apparently struck by a boat, the fish was thrashing around in circles. Kekeris grabbed it by the tail and dragged it to shore.

National Geographic Photographer Robert F. Sisson

Gay Plastic Handles Add "Eye Appeal" to Crisfield's Cleavers

At Chas. D. Briddell, Inc., operators clamp multicolored grips to steel blades. Bonded with a special type of adhesive, the tools remain under pressure half an hour. The company manufactures many types of cutlery, from ice picks and oyster knives to steak sets.

Most of Delmarva Peninsula is a part of the Atlantic Coastal Plain of the United States, the emerged portion of the continental shelf.

Geologically speaking, the land is new—a mere 55 million years young. During these years the land rose from the sea and fell again at least half a dozen times. At the time of the last submergence, the ocean advanced across the continental shelf to a point far west of the present shore line, and the Susquehanna River found its way seaward through the Virginia capes.*

When the region finally sank to its present position, the restless sea took possession of the lower Susquehanna River Valley and transformed it into Chesapeake Bay.

During these geologic ducklings, layers of sand, silt, clay, and gravel were deposited. So new is the land, however, that the material has not yet had time to turn to solid rock.

"Been plowing for 20 years and haven't struck a rock yet," one Worcester County, Maryland, farmer told me.

Proximity to the ocean promotes a long growing season, ranging from 185 days in the northern section to 220 in the south. An early spring and porous soil, permitting easy underground drainage, hasten maturity of vegetables and fruits (pages 379, 398, 399).

They warn a newcomer to the Peninsula when he sets out seed not to leave his fingers too long in the ground or they'll sprout!

The day I visited the John H. Dulany frozen food plant at Exmore, Virginia, spinach was being prepared for freezing.

Huge machines shook it free from dirt and from sour grass and other weeds. The greens were washed five times to remove grit.

In gigantic pressure cookers called "blanchers," the spinach was precooked two minutes at 212° F. A conveyor belt moved the leafy vegetables along to the sorting table, where girls removed stems and cut out blemishes.

A Medley of Early Architecture

In the spring many of Maryland's pre-Revolutionary homes are open to the public. The twelfth annual pilgrimage was in full swing when I reached the Eastern Shore. Sponsored by the Federated Garden Clubs of Maryland, the tour included some 50 homes.

Rivers of the Eastern Shore were its highways in early days; so colonists, English planters, built homes near the water. Cutting into the level land, rivers have created a fantastic number of narrow necks. On almost every neck there is a house.

Architectural designs vary. Kent Fort Manor, in Queen Annes County, represents the small 17th-century one-and-a-half-story house. The "telescopic" type, each unit smaller than the other, is Kent County's Hinchingham. Characteristic of the five-part house, described locally as "big house, little house, colonnades, and kitchen," is Georgian colonial Wye House, on Wye River.

Salisbury's location near the center of the Peninsula makes it the metropolis of the Eastern Shore. The city is the converging point of two main Peninsula highways, east-west U. S. 50 and north-south U. S. 13.

Those who have business within an approximate 50-mile radius of Salisbury make its 150-room modern hotel their headquarters. It is also a popular stopover for motorists using the New York-Miami Ocean Highway.

I was startled at first when the desk clerk told me that the hotel had a "share-the-bath" custom. To provide everyone with a private bath for at least part of his visit, each guest may have a room with bath for two consecutive nights only. Practically every day is moving day. One week I was shifted three times!

Chickens Plucked by Rubber Fingers

Within the past 25 years, the raising of broilers on Delmarva has jumped from a mere 1,000 birds in 1924 to 135 million in 1949, one-fourth the total of the United States.

Salisbury's large poultry-dressing plant can house 52,000 chickens. I think they were all there the day I was. Trucks loaded with crates of chickens were backed up to the receiving-room platform. Amid squawking and flapping of their wings, I shouted, "How many chickens can you handle in a day?"

"About 50,000," the plant superintendent shouted back. "It takes about a half-hour to unload 3,000."

Chickens are kept from one to four days before being dressed, to calm their frayed nerves and to fatten them with a special mash.

I followed the whole dressing process, from throat slitting to the beheaded, denuded, eviscerated broiler. Attached by the feet to overhead conveyors, the birds were dipped automatically in a tank of scalding water, then drawn through mechanical feather removers. Thin rubber fingers of machines revolving at high speed beat off feathers.

After a dip in hot wax, chickens were immersed in a tub of cold water. When the hardened wax coat was removed, feathers which machines missed were embedded in it.

Recently the Wicomico County Free Library, in Salisbury, acquired a bookmobile. Traveling 3,000 miles the first five-and-a-half

* See "Down the Susquehanna by Canoe," by Ralph Gray, National Geographic Magazine, July, 1950.

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Under "Del-Mar-Va's" Finger, Dover Second-graders Read About Their Three-State Peninsula

"Del" stands for the Delaware section, in red; "Mar" for Maryland, in yellow, and "Va" for Virginia, in green. Delaware's three counties, nine of Maryland's, and two of Virginia's share the flat, fertile neck of land separating Chesapeake Bay from Delaware Bay and the Atlantic Ocean. Half a million people live on the 180-mile-long Peninsula. Delmarva's truck and poultry farms and its fisheries supply much of the eastern seaboard.

Kodachrome by Robert F. Sisson

Maryland Trappers Plod Home with a Good Day's Bag of Muskrats, Soon to Become "Hudson Seal" and "Mink-dyed" Coats for Milady

Glossy brown fur of the "marsh rabbit" resembles that of the true Alaska seal. At season's end, trappers compete in a skinning contest at Cambridge. Some can strip five "rats" in under two minutes! Muskrat flesh is served fried, roasted, or stewed. Cooked with sherry, it may supplement costly diamondback terrapin.

They Wend Their Way Through 15 Acres of Pumpkins . . . She Picks Peppers for Pickling, Near Dover

Facing bay, river, and ocean, Delaware enjoys a temperate climate assuring a 180-day growing season. Its fertile soil fosters a wide range of crops, from hays and grain to fruits and vegetables. Dairy and grain farms flourish in upper New Castle County; poultry, fruit, and truck farms, in lower Kent and Sussex Counties.

Kodachromes by John E. Fletcher

Young Dover Artists Sketch the Capitol of Delaware, the First State to Join the Union

Delaware calls its State building the Legislative Hall. Completed in 1933, the Georgian colonial structure is built of handmade brick to conform to the outgrown State House, formerly occupied by the legislature. Atop the pole (right) flies the flag of Delaware, hoisted only when Governor Elbert N. Carvel is present.

Flags of three nations, the Netherlands, Sweden, and Great Britain, flew over Delaware before Old Glory was unfurled.

First among the States to ratify the Federal Constitution, Delaware was named for Lord De La Warr, Governor of Virginia, 1609 to 1618. In area it is the second smallest State in the Union.

In his order of 1683, William Penn directed that a county seat named Dover be laid out along the King's Highway. But not until 1717 did the Delaware Assembly found a town on that site in Kent County.

Wye Oak, Big Enough to Shade a Hundred Picnickers, Was a Sapling When Henry VIII Ruled England and Red Men Owned America

Largest living white oak in the United States, this monarch at Wye Mills was purchased by Maryland in 1939, the first tree bought by a State solely for preservation. Narrow waters of the Wye River region wind through country settled in the 17th century, present a lovely panorama of mellowed houses set on sloping lawns.

Kodachromes by John E. Fletcher

Far to Windward a Crewman Gets Best Speed from Log Canoe *Jay Dee*, Swift Offspring of Indian Dugouts—Racing on the Choptank

Flashing Signal of Traffic Lightgun Guides 620 Planes to Safe Landing at Rehoboth Beach Airport . . . Red Means "Stop Approach"

Aircraft Owners and Pilots Association staged the largest flight of its kind in United States aviation history September 17-18, 1949, when from 16 States and the District of Columbia a host of private planes winged their way to this Delaware resort. More than 150 ships of many makes appear on the airstrip.

Kodachromes by John E. Fletcher

Kodachrome by John E. Fletcher

Stately Read House, Ivy Covering Its Bricks, Preserves Colonial Traditions in New Castle

Built by the son of George Read, a signer of the Declaration of Independence, the house is open to the public the third Saturday in May, "A Day in Old New Castle." Townspeople, in colonial costume, guide visitors.

months, it distributed some 7,000 books among rural schools and stations.

The library on wheels is popular with rural folk. "Book truck" they call it. A farmer's wife remarked, "Now we can see what we are paying taxes for."

I journeyed with the bookmobile to Tyaskin, Bivalve, and Nanticoke, fishing villages. Business was slow that spring morning. Farmers were plowing. Others, ordinarily on hand to greet the bookmobile, were shucking oysters.

I wandered over to a dock at Tyaskin, on the Nanticoke River. Beside his dog sat a shoreman mending a wooden basketlike affair, about the shape of a cucumber but larger. He explained it was an eel trap, with a plug at one end and a narrow opening at the other.

His was a typical shoreman's face, weathered by years of wind and sun. His deep-blue eyes crinkled at the corners when he squinted at me under the bright sunlight.

Chesapeake Bay Retriever, Native American Dog

"Isn't your dog a Chesapeake Bay retriever?" I asked.

"Yup," he nodded. "And her is a good one, too. Her is a better retriever than either of the two males I had afore her. If'en you can tarry a mite, I'll tell you a story. Set on yonder keg."

He had just bought the dog and was bringing her home in his boat across Nanticoke River one cold November day. Suddenly, out she jumped and started swimming away. He whistled and called, but on she went, paddling through icy waters. After a half-hour, when he was ready to give up, back she came with a duck between her jaws!

"Danged if'en I weren't proud of her," he mused. "Her was nothing but a puppy, and her had never see no duck afore!"

The Chesapeake Bay retriever is America's only native sporting dog.* No authentic record of its origin exists. Generally accepted legend is that the breed originated from two puppies, Canton and Sailor, aboard an English brig bound from Newfoundland and wrecked off the Maryland coast in 1807.

I struck up conversations with scores of shoremen and found, invariably, that if business at hand didn't require full attention, they'd spin yarns as long as I'd listen.

Some 30 miles east of Salisbury is Maryland's only ocean port and largest seashore resort, Ocean City. Built on a barely quarter-mile-wide sandy strip, Ocean City is separated from the rest of Maryland by a narrow arm at the tip of Sinepuxent Bay.

I'd always been curious about the changing width of the beach at Ocean City. My mother visited there when she was a girl and told me about its wide beach. But when we spent a week at the resort in 1926, there was hardly any beach at all. Now here it was back again, as wide as she had described it.

An official of the Army Engineers' Beach Erosion Board explained that wave action, washing beach material away, probably accounted for the narrow beach of 1926. The hurricane of 1933 cut an inlet south of the boardwalk. Jetties were built to protect this inlet, which now gives entry from the ocean to commercial fishing trawlers. The jetties interrupt wave movement, giving the wide beach back to the resort.

Tales of Berlin, Maryland, and of the Eastern Shore are old ones to me. In this town, birthplace of Stephen Decatur, American naval hero, my maternal grandfather was born. Although Grandfather left Berlin when he was young, an elderly doctor spoke of him as if he'd seen him yesterday.

I talked with distant relatives of mine, who used a vernacular familiar to me since childhood. A poorly done piece of sewing looks as if it had been "sewed with a hot needle and a burning thread."

From Berlin I drove southwest to Crisfield. The road through the State forest to Pocomoke City is one of the most deserted on the Eastern Shore. Monotonous "thumpety-thumping" of tires over tar strips, glaring sun in eyes, a balmy breeze, and no sign of life forced me to sing to keep awake.

Salty Savor of Crisfield

At Crisfield, tracks of the Pennsylvania Railroad run down the middle of South Main Street to the water's edge. The water front, with scores of oyster-shucking and crab-picking houses, oyster dredgers, skipjacks and bugeyes at anchor, crab floats, and mounds of oyster shells, gives Crisfield its salty savor.

As I walked down to one of the crab-picking houses, it was difficult to realize that the firm ground beneath me was man-made—man-made, that is, with the aid of millions of bushels of oyster shells.

I watched white-capped and white-aproned Negro women, seated at stainless-steel tables, pick crabmeat from bright-red hard-shelled crabs. They were softly humming a spiritual to the rhythmic "tap-scrape" of knives (page 395).

Over at the crab pound, "peeler" crabs lay jostling one another, shedding their shells in

* See "Field Dogs in Action," by Freeman Lloyd, National Geographic Magazine, January, 1947.

National Geographic Photographer J. Baylor Roberts

An Early Colonial Country Seat—Cedar Point Farm, near Easton, Maryland

The site of this Eastern Shore home, owned by Mr. and Mrs. W. Alton Jones, was acquired from Lord Baltimore through patent in 1658 by one Robert Jones. The house's rare hanging stairway survived a fire a century ago. The left wing was originally the kitchen and is reputed to be 250 years old.

wooden floats staked in the water. At crab shanties shoremen packed limp and exhausted soft-shells in wet seaweed for shipment.*

At Crisfield I met Lem Ward and his brother Steve, two old-timers who hand-carve and hand-paint wooden duck decoys.

Directions for finding their shop were complicated. No matter which way I went, I always ended in front of the same grocery store.

Hollywood could have used the setting for a typical country store. Shelves bulged with canned vegetables. Counters were piled high with goods, from candy and chewing tobacco to bobby pins and bubble gum. Around a wood-burning stove sat tobacco-chewing shoremen, their target the brass spittoon. A cat slept among the cabbages.

I asked the owner where I could find Lem Ward.

"Calculate he'd be a hard one to run into now. He's out asparagrassin'. Want to see him personal?"

I explained I was interested in duck decoys.

"His brother could help you. Hey, Steve," he yelled to the group. "Lady to see you."

I drove Steve over to his shop. Navy surplus life rafts were stacked in the yard. He explained that they carved their ducks from the rafts' light, buoyant balsa.

In the small shop, duck decoys were everywhere, piled high on shelves, scattered over

* See, in the National Geographic Magazine "Maryland Presents—," by W. Robert Moore, April, 1941, and "Crabs and Crablike Curiosities of the Sea," by William Crowder, July, 1938.

National Geographic Photographer Robert F. Sisson

"Let's Duck the Champ" Is a Welcome Cry to the Winning Skipper

At the Cambridge Yacht Club willing hands toss Marvin Foxwell off the dock—traditional penalty for skippering the fastest Hampton-class sloop. Hamptons are 18-foot centerboarders, developed in Virginia and seldom seen except in Chesapeake Bay and its tributaries.

the floor. Some were without heads, some half-painted, others unsanded (page 389).

"We've got hundreds of orders to fill, but seems like we just don't get time to work on the ducks," said Steve. "This morning, for instance, I had to go fishin'."

He told me that a Philadelphia millionaire sportsman had offered to set them up in business there at no cost to them and guaranteed that in a few years they would make a fortune. They turned him down.

"You know, money isn't everything," Steve explained. "I'd rather set in my boat, fishin' a little and awatchin' the sun sink down behind Bay waters, than make a million dollars. The shore's my home. I wouldn't be happy anywhere else. That's peace and contentment hyar city folk never git to know.

"So long as I have enough to eat, enough clothes to cover me, and a place to sleep hyar, that's all I want. But reckon I *will* have to git to work on them ducks one of these days."

On my way back to Salisbury I drove through Princess Anne. No one ever seems to be in a hurry in Eastern Shore towns. Princess Anne typifies this slow tempo.

I stopped at the Washington Hotel, host to weary travelers since Revolutionary days, to see its old partitioned double stairway, with one side for ladies and one for gentlemen. Legend says that in Revolutionary times, when ladies going up and down the stairs had to raise voluminous skirts, the partition kept gentlemen from seeing a well-turned ankle!

National Geographic Photographer Robert F. Sisson

Gulping Juicy Mash, 11,000 Broilers Fatten in This Bridgeville, Delaware, Shed

Their life is pampered but short. After 11 weeks of gorging on vitamin-rich foods, these hybrid chicks from Barred Plymouth Rock roosters and New Hampshire Red hens will be ready for market as 3-pound broilers or fryers. Vaccines and sulfa drugs protect them against disease (pages 376, 390).

The next day, pushing on to the neat little town of Easton, I crossed the Choptank River on the two-mile bridge outside Cambridge (page 374).

Broad shaded streets and mellow old houses set Easton apart. It reminded me of many New England villages.

Town fathers, with an eye to retaining Easton's charm, carefully screened its few industries before admitting them. Tucked away on a side street stands the small modern plant of Chesapeake Frozen Foods, Inc. Here cattle are slaughtered, poultry dressed, vegetables, fruits, and sea food quick-frozen. In one room stands row upon row of rented lockers.

When George D. Olds 3d got out of the service after World War II, he was dissatisfied with his former job. Now he believes that owning his frozen-food business and running a farm make the ideal setup.

"When I have time, I fish. Last summer I caught enough fish in one day to last me and my family a year," he told me. "I reserve enough space in the lockers for our own food. Besides fruit and vegetables, I store ducks, chickens, fish, and sometimes even deer."

Southwest of Easton, on Tilghman Island, is the Tilghman Packing Company, which specializes in the "bobbed" crab. Cooked, cleaned, and highly seasoned with vinegar, cayenne pepper, and salt, it comes wrapped in parchment paper, ready to serve.

The following day I left the Eastern Shore of Maryland for Delaware. In the small vil-

Delaware Preserves Its Colonial Charter in a Fireproof Vault at Dover

State Archivist Leon de Valinger, Jr., shows a visitor the letters patent by which King Charles II granted the three Delaware counties to his brother James. Later, the Duke of York conveyed the lands to William Penn. Mrs. Sarah Wistar Miller of Media, Pennsylvania, presented the charter to Delaware in 1909, turning down an offer of $50,000 from a British museum (page 391).

National Geographic Photographer Robert F. Sisson

Lifelike Decoys Watch Steve Ward Fondle a "Newborn" Duck

Lem and Steve, brothers, of Crisfield, Maryland, won first and second prizes at the 1948 National Sportsmen's Show in New York with their handmade wooden birds. Dowels and glue hold cedar heads atop bodies of light, buoyant balsa. Most tedious job is painting fine lines to indicate feathers (page 386).

E. I. du Pont de Nemours & Company

Like a Giant Spider, Du Pont Spins Nylon by the Mile

Yarn shoots out of chimneys (upper right) to be wound on bobbins in a factory at Seaford, Delaware. Chemistry's miracles create strong, durable nylon from coal, air, and water.

lage of Seaford, Delaware, E. I. du Pont de Nemours & Company established in 1939 the world's first commercial nylon plant.

Nylon Transforms a Town

Within the past decade Du Pont has transformed this country town. Former farmlands are now studded with bungalows of plant workers; super markets, beauty shops, and a large movie house have sprung up along the main street; bank receipts have trebled.

Even after my two-hour tour of the plant, watching each step in the manufacture of nylon, it seems sheer wizardry to me that coal, air, and water, plus chemistry, can produce a gossamer thread more than three times finer than human hair, yet twice as strong as aluminum wire the same size!

A year after Henry Hudson explored Delaware Bay,* English Capt. Samuel Argall, blown off his course, sailed into its waters. He named it for his superior, Thomas West, Lord De La Warr, Governor of Virginia from 1609 to 1618.†

The Dutch made the first settlement in Delaware in 1631 on the present site of Lewes (pronounced Lewis). They called it Zwaanendael, "Valley of Swans."

As I walked along Pilot Town Road to Ship Carpenter Street, salty sea breezes stung my face. Fishing-party boats, cabin cruisers, and sleek sailing craft rocked at anchor in roughed-up waters of the harbor. "Easterly weather" a Delaware Bay pilot called it.

Pushing farther north in Sussex County, I came to the heart of the broiler country. In 1949 Delaware led all States in the production of broilers. Of the 71,881,000 "hothouse" chickens raised in the State, 90 percent came from Sussex County. Begun only 20 years ago, commercial broiler production is today the State's most important source of agricultural income (page 388).

Delaware claims 29 of Delmarva's 47 hatcheries. From them some 119,000,000 baby chicks were shipped in 1949 (page 397).

At the John H. Mulholland plant in Milford, wooden ice-cream spoons are cut out of veneer from gum logs.

One day a Mulholland official noticed a little boy with dirt-grimed fingers pull a

* See "Henry Hudson, Magnificent Failure," by Frederick G. Vosburgh, National Geographic Magazine, April, 1930.

† See "Diamond Delaware, Colonial Still," by Leo A. Borah, National Geographic Magazine, September, 1935.

wooden spoon from its wrapper by the larger, or eating, end. Why not, he thought, make a spoon with both ends the same size? Now, no matter which end of Mulholland's dumbbell-shaped spoons is pulled from its cover, there's always a clean eating end.

On U. S. 113, some 10 miles south of Dover, stands Barratt's Chapel, called the "Cradle of Methodism in America." Here, on November 14, 1784, the Communion was administered for the first time in America by a Methodist minister.

Venerable Dover, Delaware's Capital

Driving into Dover, I noticed first the quiet charm of the green, shaded by tall 100-year-old elms and bordered by houses which were old when Delaware ratified the Constitution, to become the first State. Venerable is the adjective for Dover.

On the green, Delaware regiments, "Blue Hen's Chickens," were mustered to join Washington's army. Here, also, townspeople of Dover assembled to listen to the reading of the Declaration of Independence and to burn King George in effigy.

East of the green, facing a broad mall, the Georgian colonial brick capitol is flanked by smaller buildings of similar design (page 380). In one, the Hall of Records, I saw the beautifully preserved royal charter given by Charles II to James, Duke of York, for the Delaware counties. Dated 1682, this document is one of the country's seven surviving royal charters of the Thirteen Colonies (page 389).

Annually Dover opens its historic homes and buildings to the public on the first Saturday of May. Visitors to the Ridgely House, begun in 1728 and lived in continuously since 1767 by members of the Ridgely family, are shown the Lowestoft tea set presented by Gen. Anthony Wayne to Mary Vining.

In the churchyard of Christ Church, built in 1734, stands a monument to Cæsar Rodney, who made an 80-mile dash to Philadelphia on July 2, 1776, to cast Delaware's deciding vote for the Declaration.

Traveling westward from Dover I crossed Delaware into Maryland. As I drove over the bridge that spans the broad Chester River into Chestertown, golden rays of the sinking sun touched 18th-century mansions along its shore, mirroring them in darker waters.

Close by the central square stands Emman-

National Geographic Photographer Robert F. Sisson

Virginia Game Wardens "Shoot the Breeze" While Reading Mail

Tiny Oyster, on the Eastern Shore's seaside, ships salty bivalves to distant markets. In surrounding creeks, ponds, and marshes, sportsmen hunt Canada geese, widgeon, and black ducks. Game wardens' duties include checking hunters' bags. Limit is four ducks first day; following days, eight.

ued Protestant Episcopal Church. A tablet commemorates the adoption here in 1780 of the title, "Protestant Episcopal Church" of the United States, as distinguished from the Church of England.

North of town I passed the rolling campus of Washington College, first in Maryland to receive a charter and only one to bear George Washington's name with his personal consent.

From Chestertown I headed east across the Peninsula, leaving narrower transverse roads for the broad Du Pont dual highway. So wide is this famous boulevard that exceeding the speed limit is not only a temptation but a fact. Here was the only time I ever saw anyone in a hurry on Delmarva.

When I asked a Delawarean why east-west roads in his State weren't as wide as the Du Pont Boulevard, he grinned and replied, "Because no one wants to get out of Delaware!"

I found it difficult to drive anywhere on the Peninsula, particularly on back roads, without almost hitting many kinds of birds. Delmarva is in the Atlantic flyway, land bird and waterfowl migration route. Bombay Hook National Wildlife Refuge, some 14,000 acres of marshland along Delaware Bay, offers bed and board to migratory geese and ducks.

By placing fresh-water pools within the marshlands, the refuge has attracted shovellers and gadwalls, species of duck, to nest near Atlantic tidewater. Particularly unusual is this nesting record for the gadwall, which normally makes its home in the north-central States and central Canada.

Nearly half of Delaware's 297,000 people live in Wilmington, at the head of the Peninsula. Although referred to as the northern gateway to the Peninsula, somehow this cosmopolitan industrial city seems far removed from agricultural Delmarva.

Between Wilmington and New Castle, near Farnhurst, a sign marks the proposed approach to the new Delaware Memorial Bridge, to link Delaware and New Jersey shores.

New Castle Preserves Its Heritage

To the average motorist driving north on U. S. 13, New Castle, Delaware, means only the place to catch the ferry to Pennsville, New Jersey. Because the highway by-passes the quaint old town, motorists miss seeing a gem of surviving colonial architecture.

Unlike restored Williamsburg, Virginia,* many of New Castle's houses, preserving some 150 years of architectural Americana, are owned and lived in by town merchants, lawyers, and doctors. The "lived in" look of these colonial homes, with none of the stiffness of so many exhibit houses, gives old New Castle its individual charm.

The third Saturday in May each year, New Castle turns back pages of history, dresses in colonial costumes, and opens its lovely old homes and buildings to visitors (page 384).

When I arrived, "William Penn" and town criers, in knee breeches, white stockings, and silver-buckled shoes, were strolling past the old Court House, seat of New Castle County courts for two centuries. Long lines of visitors were waiting to lunch in the courtroom, where representatives of Lord Baltimore and William Penn struggled for Delaware territory.

On an autumn day in 1682, Penn first set foot on American soil here. From the Duke of York's agents he received the town and land within a 12-mile circle.

With 1,500 other people I watched folk dances on the green laid out by Peter Stuyvesant when New Castle was Dutch.

As I looked down Packet Alley to the river, it took little imagination for me to visualize stagecoaches rumbling down this lane, carrying famous men of their day—Daniel Webster, Henry Clay, Sam Houston, and others—to board packet boats for Philadelphia.

Proud of its heritage, New Castle plans further preservation where necessary. A recent survey, made by Williamsburg and Wilmington architects, revealed that, so carefully has New Castle preserved its buildings, some 70 percent need little alteration.

They Love Their Land

Traveling up and down this historic Peninsula, rambling back and forth from bayside to seaside, I was struck, as others have been, by the intensity with which its people love their land. To Delawareans, Marylanders, and Virginians alike on Delmarva, there just isn't any other place that can compare.

As I headed toward Washington, I shared a little of their feeling. I was sorry to leave this wind-swept land with its quiet villages, peaceful rivers, and easygoing way of life. The Eastern Shore, which had lured so many "foreigners" to buy or to build their homes on its shores, had once more cast its spell.

Leaving Delmarva by Matapeake Ferry, I asked the pilot what he would do when the Bay bridge was built. He smiled.

"It won't make no difference to me, ma'am, 'cause I'm retirin' soon to the best spot in this whole wide world to live—the Eastern Shore. Got a place where I'm goin' to settle down to a little fishin' and a little farmin' and let the rest of the world go by!"

* See "Restoration of Colonial Williamsburg," by W. A. R. Goodwin, National Geographic Magazine, April, 1937.

Maryland's Governor, William Preston Lane, Jr., and His Family Relax at Government House

Governor and Mrs. Lane and their daughter, Dorothy, are seated beneath a painting of Maryland's namesake, Queen Henrietta Maria, wife of unlucky Charles I of England. Florence Mackubin made this copy of Van Dyck's portrait for the Executive Mansion in Annapolis.

Skipjacks on the Choptank—To Conserve Its Famous Oysters, Maryland Permits Only Sailing Craft to Dredge Chesapeake Bay Beds

With Flying Fingers They Pluck Meat from Steamed Maryland Crabs

Bluish green when alive, "hard-shells" turn bright red in the pot. At the R. C. Bradshaw plant, Crisfield, 40 workers pick and pack 1,250 pounds of crabmeat a day. In 1949 this cannery shipped 110,000 pounds of fresh crabmeat, packed in ice, as far west as Utah, north to Minnesota, and south to Florida and Texas.

The Chesapeake's sudden squalls may upset even the best of sailors. This 18-foot Hampton sloop capsized while racing for the Cambridge Yacht Club championship. Maryland's Eastern Shore, with its many tidal rivers, is a paradise for yachtsmen. Many towns, including St. Michaels, Oxford, Chestertown, and Cambridge, hold annual regattas.

Home Folk Ride Free, "Foreigners" Must Pay to Cross the Wicomico at Upper Ferry, Maryland

When the author arrived here in a National Geographic car with District of Columbia tags, she paid 50 cents to cross on this scow near Salisbury.

The tiny ferry can carry two cars, one in front of the other. In the past, the ferryman pulled it by a grooved pole which fitted over the wire cable. Now an outboard motor, shown at the right, pushes the craft across; "sticks," riding on the cable, guide and brake its speed. When not in use, the loose cables lie on the bottom.

County records show that a ferry operated here as early as 1727. An important link in peninsular travel during stage-coach and carriage days, the ferry now is a curiosity. Out-of-State motorists, wishing to cross by it, must leave a modern highway and travel dusty back roads. Ten cars a week is considered a good haul.

Some six miles northeast of the landing is Salisbury, the largest town on Maryland's Eastern Shore. From there, in colonial days, ships loaded with tobacco sailed down the Wicomico River's 23 miles into Chesapeake Bay bound for London.

4-H Club Boys Candle Eggs, Looking for Telltale Shadows; Pullman Carries Peeping Baby Chicks to Delmarva Poultry Raisers

At the 1949 Chicken Festival, Salisbury, Maryland (left), teams from Delaware and Maryland competed in an egg-judging contest. Light shining through the eggs shows up any defects, such as overlarge air cell, blood spots, meat specks, or germ development. Pullman (right) loads 27,000 chicks from Charles C. Marker's hatcheries near Dover, Delaware. His six incubators, with a capacity of 400,000 eggs, hatched some 5,000,000 baby chicks last year.

Hovering Only Four Feet Up, a Helicopter Sprays Chemical Dust, Death to Hornworm and Blight, over an Eastville Pepper Patch

Fed from hoppers, calcium arsenate and copper dust is blown over the plants by the down-wash of air from the rotor blades. An "eggbeater" can dust as many as 50 acres per hour. Approximately 200 Eastern Shore of Virginia farms were dusted last year, some fields, particularly potatoes, as many as five times.

Virginia's Eastern Shore Canneries Squeeze, Cook, and Mix Tons of Tomatoes into Carloads of Juice, Soup, and Catsup

Once considered poisonous, tomatoes are this Nation's second leading vegetable crop. In 1949 the United States produced three million tons. This plant in Cheriton, Virginia, ships 20 carloads of tomato products a day. Pioneer Harrison Crosby, first American to can tomatoes, stuffed "love apples" into only 1,000 cans in 1848. One hundred years later, the industry produced 583 million tins.

Kodachromes by Robert F. Sisson

They're "Mapping the Universe," to Uncover Secrets Hidden for Eons in the Sky

Launching the National Geographic Society-Palomar Observatory Sky Survey, astronomers prepare to load a photographic plate and red filter into the Schmidt 48-inch telescope. Pictures taken with this new wide-angled "eye" will provide a vast chart of three-fourths of the entire heavens. The chart will reveal millions of new heavenly bodies and will guide Palomar's 200-inch telescope in explorations out into remote depths of space.

Mapping the Unknown Universe

By F. Barrows Colton

NIGHT was fast blotting out the landscape on the lonely summit of 6,000-foot Palomar Mountain, today's most famous outpost for exploring the Universe.

Only a ghostly wraith of light still hung in the western sky.

Standing beside me in the silent darkness, astronomer Albert G. Wilson was scanning the starry heavens with a practiced eye.

"What's your first target for tonight?" I asked.

"That patch of sky just east of the bowl of the Big Dipper," he said, pointing almost straight overhead. "As soon as the twilight's gone, we can get to work. The wind has died, and there's no haze. Tonight should give us good hunting!"

Mapping the Universe

We soon would be embarking on a night of exploring into the Unknown, deep into outer space, on one of the greatest projects of discovery in the history of astronomy.

This project is the making of the most stupendous map ever put together—a map of the Universe. Not all the Universe will be included, of course, for man may never be able to explore it all, but the map will show many times more of it than ever has been known before.

Made with telescopic photographs, the map will show for the first time almost all the heavenly bodies that exist in three-fourths of the sky, out to an average distance of 2,000 billion billion miles from the Earth. It will pick up objects so faint that their light takes 300 million years or more to reach us. And it will point the way for astronomers to explore still farther out into the even more remote regions beyond.

Survey Probes Unexplored Areas

Ancient and baffling riddles of astronomy will come nearer solution through new things the map will show. How big is the Universe? Does it have a boundary somewhere, or is it infinite in size? Is it expanding like an exploding bomb, or contracting, or just standing still? How and when did it come into existence? Is the whole Universe constructed like the small isolated samples that astronomers have explored so far?

The making of this map, known as the National Geographic Society-Palomar Observatory Sky Survey, is a joint undertaking of your Society and the California Institute of Technology.

Until now, telescopes could photograph no more than a tiny patch of sky at a time, so that only small scattered samples of Creation have been explored out to great distances. These samples have covered but one percent of the total area of the sky. But the Sky Survey will reach far out all over the heavens, covering vast areas previously unexplored.

Formerly, it was like trying to visualize the entire bottom of the ocean from a few widely spaced deep-sea soundings. The Sky Survey is equivalent to finding a way to see down through the water everywhere and chart accurately the whole ocean floor.

That night on Palomar we could see dimly on a near-by ridge the silvery dome of the famous new 200-inch Hale telescope, which can pick up objects so far away their light takes a billion years to reach us (pp. 408-9).

"Big Schmidt" New Kind of Telescope

But we ourselves would be working with the "Big Eye's" less-publicized but powerful partner, the "Big Schmidt," an amazing new kind of telescope destined to equal if not surpass the fame of the 200-inch (page 404).

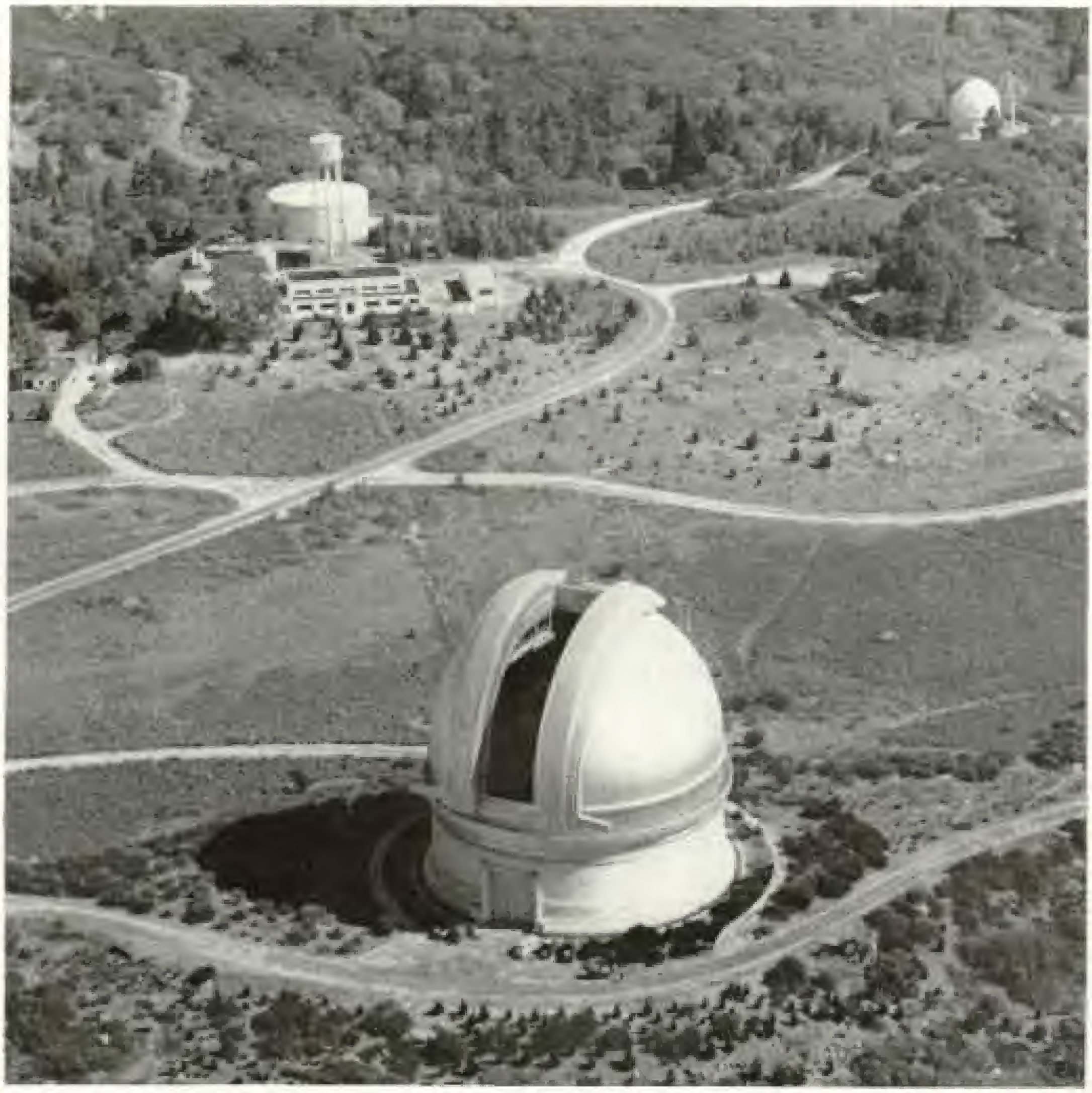
This is the telescope that is mapping the Universe. It is named for its inventor, Bernhard Schmidt, an eccentric German genius who devised a new system of optics of great benefit not only to astronomy but to television and X-ray work (page 417).

Actually the Big Schmidt telescope is a wide-angle camera. It is doing something that has been impossible until now—taking photographs of very large areas of the sky which are clear and sharp all over. Where the Big Eye of the 200-inch "sees far," the Big Schmidt "sees wide." Although it can penetrate out into space only about one-third as far as the 200-inch, it can cover on a single photograph 500 times as great an area of the heavens.

In only four years the Big Schmidt will photograph all the sky visible from Palomar, three-quarters of all the heavens. For the 200-inch telescope to do this job would take 5,000 years!

The night sky is being photographed systematically in 935 sections on 14- by 14-inch plates. All the pictures will be published in a great Sky Atlas of 20 volumes, which President Lee A. DuBridge of Cal Tech says will be "an astronomical Bible for 100 years."

As we stood there in the darkness, the familiar Earth seemed unreal and far away. Above us the blazing stars, set like diamonds



Edwin G. Pope

Two Giant "Eyes" Gaze from Palomar's Top into the Uncharted Depths of Space

Immense dome in the foreground, 135 feet high, houses the 200-inch Hale telescope, which can photographs objects a billion light-years distant, four million times fainter than the faintest star the human eye can see. Its partner, the Big Schmidt, which is making the Sky Survey, is in the smaller dome at the far right (page 404). Power plant, shops, and water tanks of the Observatory are at the left.

in the black dome of the sky, seemed to bring very close the Universe that stretched away all around us, out through the cold, awful depths of space.*

The Vast, Lonely Universe

Palomar's 200-inch telescope can reach out to explore a spherical section of this Universe so colossal that light, traveling 186,000 miles a second, takes two billion years to cross it. Astronomers measure it with a giant yardstick, the light-year, the distance light travels in a year, which is nearly six million million miles.

Scattered far and wide through this void, like lonely islands in a limitless ocean, there are estimated to be more than 100 million tremendous formations of stars, dust, and gas, called nebulae, or galaxies. Many of them are flat and round like a watch or coin, with arms spiraling out as from a Fourth-of-July pinwheel. Some are globular or oval (p. 410).

One of these systems is what we call the Milky Way Galaxy—our home in space. Like countless other galaxies, it is round and flat, with outward-spiraling pinwheel arms. In it are perhaps 5,000 million stars, including all

* See "News of the Universe," by F. Barrows Colton, National Geographic Magazine, July, 1939.

National Geographic Photographer J. Baylor Roberts

Explorers of the Universe Study New Heavenly Bodies Revealed by the Sky Survey

Some of the pictures taken with the Big Schmidt telescope in the first year of its mapping of the sky are examined by four of the astronomers taking part in the project. Left to right: Milton L. Humason, Edwin P. Hubble, Walter Baade, and Rudolph Minkowski. All are on the staff of both Palomar and Mount Wilson Observatories. Portrait is of the late Dr. George E. Hale, prime mover in the building of Palomar's 200-inch telescope, which bears his name.

those we can see in the sky, and great clouds of dust and gas (page 406).

About two-thirds of the way from the center to the rim of this great disk of stars is a yellowish star which is the Sun. Our tiny Earth circles round this star, and at the same time moves on through space with the galaxy as a whole, which is slowly turning like a wheel.

The bright pathway across the sky that we call the Milky Way is really the concentrated light of all the stars between the Earth and the outer rim of this great wheel.

That night on Palomar the astronomers were about to go searching out from this little obscure Earth deep inside the Milky Way, out through and beyond our neighboring stars, far across the reaches of space.

Today's Telescopes Are Cameras

All astronomers do their exploring today not by looking through their telescopes but by using them as cameras. Long time-exposure photographs register the images of celestial objects too faint and far away for the human eye ever to see.

Ready for Action, the Big Schmidt Telescope Points at a Target in Outer Space

Dr. Edwin P. Hubble watches the guide star in the eyepiece. He keeps the instrument aimed true by pressing buttons in the "guiding head" which he holds (page 411). Photographs are taken with all lights out.

Already new heavenly bodies of all kinds, in vast profusion, are being discovered on the Sky Survey photographs.

On some single pictures taken with the Big Schmidt appear as many as 15,000 to 20,000 huge galaxies of stars out in space beyond the Milky Way. Each one of these galaxies is an isolated island in the Universe, containing hundreds of millions of stars (page 410).

Clusters of galaxies, rarely seen until now, are showing up on almost all the pictures; one plate alone shows 17 clusters, almost as many as all previous telescopes had found.

Dwarf galaxies, too, containing only a few million instead of hundreds of millions of stars, are being found in far larger numbers than ever had been observed before.

New "Neighbors" of Milky Way

Two new "neighbors" of the Milky Way Galaxy, small elliptical-shaped galaxies, have been found on the Schmidt plates. One is the smallest galaxy ever found, only 1,500 light-years in diameter. These galaxies, some 650,000 light-years from us, are near enough so that more than 200 of the brightest stars in each of them can be distinguished.

In our own Milky Way Galaxy the Sky Survey pictures are expected to reveal more of the mysterious novae, or exploding stars, which suddenly flare up to hundreds of millions of times their former brightness in a few hours or days.

They are called novae (Latin for "new") because old-time astronomers, seeing them suddenly appear where no star had been noticed before, thought they were new stars. Supernovae are as much as 10,000 times brighter than ordinary novae.

In the Milky Way, too, the Survey is revealing huge glowing clouds of gas, and is recording for the first time, all on one picture, the over-all extent of gigantic dark clouds of dust and gas that are so big they formerly could be photographed only piecemeal.

New members of the solar system, the little asteroids, or subplanets, that circle around the Sun, are being picked up by the score.

Astronomers used to think these asteroids might be fragments of an old planet that once followed an orbit between Mars and Jupiter, and later broke up, because most of them circled the Sun between these two planets. But now, with asteroids showing up all over the solar system, this idea may have to be changed. Instead, perhaps, these little bodies may be debris left over from some ancient cataclysm in which the planets were created, or old comets that have lost their tails.

Two new comets have been found by the Survey, one of which speeds in near the Sun and out again into space on a circuit that takes only two-and-a-third years. The other is now moving toward the Sun, and will come closest to it in January, 1951.

Trail Blazer for the 200-inch

Already, too, the Big Schmidt is performing its intended task as trail blazer for the 200-inch telescope, pointing the way for the Big Eye to explore still farther out.

Until now, the 200-inch and other big telescopes could only grope more or less blindly out into space, hoping to pick up distant galaxies here and there. But the Schmidt's wide-angle pictures are showing the Big Eye where to look (pages 414, 415).

Though the most distant galaxies that the Big Schmidt can pick up barely show as pinpricks on the photographs, their exact positions in the sky can be determined. Then the big telescope can be trained on them without delay, to photograph them on a larger scale.

Already the 200-inch telescope is photographing such newly found galaxies as a step toward solving one great puzzle of the Universe—whether it is expanding at breakneck speed like a gigantic soap bubble. Distant galaxies found in the past all show the famous "red shift," a reddening of their light which indicates they are rushing away from the Earth and from each other at almost unbelievable velocity, thousands of miles per second, like the fragments of a bursting bomb.

Is this happening everywhere in the Universe? Are all the galaxies speeding outward, or are some standing still, or even rushing back toward us? Now the astronomers expect to find the answer, for on the Survey pictures they can select distant galaxies distributed uniformly all over the sky and see if all of them show the telltale red shift.

Exploring in Space and Time

Where to search still farther out in space, for galaxies too faint to be registered by the Schmidt telescope, will be indicated indirectly by the Survey pictures. Where the photographs show galaxies to be concentrated out as far as the Schmidt can penetrate, the chances are good that the bigger telescopes will find even fainter ones beyond. And the clearest "windows" in the sky also will be revealed, areas where no clouds of dust or gas obscure the view.

Watching the Big Schmidt and the Big Eye in action through the long night hours, you sense the drama and quiet excitement and marvel at the precision that goes into the exploration of the sky.

First of 1,870 Photographs for the Monumental Sky Atlas Shows the North America Nebula

Named for its resemblance to our continent, this cloud of gas in the Milky Way shines by light reflected from the supergiant red star Xi Cygni at left. It was photographed July 19, 1949, at the start of the National Geographic Society-Palomar Observatory Sky Survey. Two hot blue stars at the upper right appear especially brilliant because the picture was taken on a plate sensitive to blue light (page 411).

National Geographic Photographer Ellsin L. Wisbard

What Startling New Discoveries in the Sky Will This Survey Plate Reveal?

Heavenly bodies so far away they appear as barely visible pinpoints are examined with a hand glass by Dr. Albert G. Wilson, in charge of the Survey's photographic work. Plates 14 by 14 inches in size, taken with the Big Schmidt telescope, are illuminated from behind in this viewing box for detailed study. Astronomer Walter Baade shows eager interest.

How bold seem these little beings on a tiny, lonely planet to be probing out through distances inconceivable to the human mind.

And they are exploring not only far out into space but far back into time. Images of the more distant heavenly bodies are formed on their photographic plates by light that has traveled hundreds of millions of years to reach the Earth; hence the photographs show these bodies not as they are now, but as they were when this light first started on its journey in the ancient past.

Excitement in Dr. Wilson's voice was only half-suppressed that night as he scanned a new Survey picture and noted the new objects on it—objects that his eyes were the first to see in all the millions of years since the Universe came into existence. "Here's a dwarf nebula at X-41, Y-11," he said, naming its coordinates of position. "Here's a cluster . . . a cloud of nebulae . . . a faint small cluster."

Astronomers have their headaches, too. One is the unpredictable behavior of the air that lies above their telescopes. It's sometimes harder to penetrate these few miles of air than all the trillions of miles of space beyond.

Turbulent Air Spoils Pictures

When the air overhead is quiet, pictures of heavenly bodies are clear and sharp. Astronomers call that "good seeing." But when the air starts to boil and tremble, photographs become fuzzy and blurred.

So important is good seeing that Palomar has probably the world's only fire department whose main job is to help keep the air quiet.

"Barren burned-over areas absorb the sun's heat in the daytime, then give it off again at night," Byron Hill, Palomar's superintendent, told me. "The rising heat waves cause a shimmer in the air that can ruin the seeing on an

California Institute of Technology

Largest Ever Built, Palomar's 200-inch Telescope Dwarfs 300 Astronomers Meeting Beneath It

The big mirror is poised directly over their heads in the lower end of the openwork tube. The glass focuses light of heavenly bodies into the cell in the upper end where the observer rides and makes photographs (page 412). The big cylinder, foreground, is part of the telescope's supports.

California Institute of Technology

Millions of Stars Make Up This Spiral Galaxy, Typical of Countless Others

Thousands of such huge bodies, unknown before and scattered throughout the Universe, are being discovered by the Sky Survey. This one is 75 million light-years from the Earth. Our own home in space, the Milky Way Galaxy, would appear much the same if seen from outside, but Earth would not be visible. Bright patch in center is formed by myriads of stars too close together to show individually.

otherwise good night; so we have a fire engine and water mains and hydrants ready to keep brush and forest fires from spreading."

Inside the Big Schmidt's open dome the bulky gray tube of the telescope loomed eerily in the dim light. There was a penetrating chill up here at 5,600 feet, and I was glad to be wearing "long-handled" underwear, thick wool socks and cap, and all the heavy clothes I had. On very cold nights the astronomers wear electrically heated suits which can be plugged into outlets conveniently placed around the telescope.

Big Schmidt in Action

Joseph Stehlik, night assistant, was pushing buttons and turning dials at his big control board, feeding into a mechanical brain the data on the position of the first patch of sky to be photographed, much as one dials a telephone number.

As soon as the first photographic plate was placed in the telescope, Stehlik pushed his "execute" button, electric motors whined, and the Big Schmidt swung up into position. Then it began turning slowly from east to west, at the same speed the Earth was turning from west to east. This kept it pointed steadily on its target in the sky, just as the guns of a moving battleship swing to follow the target at which they are firing.

"Take a look here at the guide star," said astronomer Robert G. Harrington, pointing to the eyepiece of a small telescope mounted on the Big Schmidt's side (page 404). Peering into it, I saw a single bright star shining at the intersection of two fine cross hairs.

"That star is in the center of the area we're going to photograph," he explained. "We watch it all during the exposure. As long as it stays on the cross hairs, we know the telescope is pointed true. It's like sighting a rifle: the

California Institute of Technology

Rosette Nebula Is a Huge Shining Cloud of Dust and Gas in the Milky Way

Part of its light comes from atoms in the cloud which glow from the heat of near-by stars. It also reflects light from stars in its vicinity. Some astronomers think such clouds may be the raw material from which stars are formed, or the remains of stars that have disintegrated. This object is 2,500 light-years from the Earth and 30 light-years in diameter. It is located in the constellation of Monoceros, the Unicorn.

guide star is the bull's-eye. The driving gears that keep the telescope pointed at its target aren't perfect, so now and then it drifts off a little; when it does, the guide star drifts off the cross hairs. We correct our aim by pressing one of these electric buttons. That realigns the telescope, which brings the guide star back into position."

"Don't you get a crick in your neck watching the guide star all the time?" I asked.

"Yes," he laughed, "practically every night!

"Joe, this exposure is 45 minutes," he sang out.

Dome Turns Automatically

Joe flipped off all the lights and replied, "Say when!" Harrington glued his eye to the guiding eyepiece, clicked his correcting buttons once or twice, and called "When!" Instantly Joe snapped open the shutter of the telescope-camera, and the plate began soaking up light from the distant bodies out there in space.

The only sounds were the humming of the telescope's driving motors and the click of Harrington's correcting buttons. An occasional rumble overhead told us the big dome was turning automatically to keep its open slit in line with the moving telescope. Stehlik tuned in some radio music.

Suddenly an alarm bell startled me. "One minute to go," said Joe. Exactly on the second he closed the camera shutter.

Each section of the sky is photographed on two plates, one sensitive to red light, the other to blue. Red stars stand out on the red-sensitive plates, and blue stars are more prominent on the blue (page 406).

Red stars are comparatively cool; blue stars are hot, some of them a score of times as hot as the Sun. Comparing the brightness of stars shown on both plates reveals their color.

P. Barrett Collins

Dawn Is Bedtime for Astronomers

Robert Harrington sleepily pulls down the blackout shade in his room at the "monastery" on Palomar Mountain after a night's work taking photographs for the Sky Survey (page 414). His workshop, the Big Schmidt telescope dome, appears in the distance. Astronomers take photographs throughout clear nights except when the Moon is shining, since its light fogs their plates.

which gives an indication of their temperature, and this in turn is an important clue to their life history.

Red light also penetrates better through the dark clouds of dust and gas that hide or dim the light of many stars in the Milky Way, helping to reveal what lies concealed behind these gigantic curtains.

Big Eye Takes a Long Look

Next night I watched the 200-inch Big Eye turn its more powerful gaze on some far-off galaxies that the Big Schmidt had discovered only a few nights before. Dr. Milton L. Humason, veteran explorer of the Universe, showed me a cluster of pin-point dots on a photograph taken by the Big Schmidt (page 407). Under a magnifying glass their outlines were slightly fuzzy, which showed they were galaxies far off in space and not stars near by, which have hard, sharp images.

Humason was to rephotograph these galaxies on a larger scale, then later would photograph the spectrum of their light. If this showed the red shift (page 405), it would indicate the galaxies were rushing away into space at terrific speed.

These galaxies were so far away that their light, arriving at Palomar that night, had started on its journey through space 300 million years before. It had been speeding toward Earth since the Paleozoic Age, long before the human race or even the higher animals existed, since the time when the first fishes were evolving in ancient seas.

The pictures Humason would take would show those galaxies as they were in that long-distant past. What they are like today no one can know. Perhaps by now they have sped billions of miles more off into space; perhaps they are speeding back toward us again; possibly they have changed their forms entirely, or even no longer exist at all.

Observer Rides in Telescope

In the small open elevator we rode up the inside of the curving dome to its very top, 12 stories above the ground. So huge is the telescope that the astronomer rides in a little steel cell hung in its upper end, dwarfed by his vast instrument like a mouse in the mouth of a 12-inch gun. Here he sits hour after hour in a cramped seat, watching the

National Geographic Photographer J. Baylor Roberts

Giant Mirror of Palomar's 200-inch Telescope Is Carefully Checked for Flaws

Dr. Ira S. Bowen, Observatory director, hunts for possible blisters in the newly applied aluminum coating, a few millionths of an inch thick, which serves as the reflecting surface. Byron Hill, Palomar superintendent, holds a light. The mirror, weighing 14½ tons, was cast from Pyrex glass by the Corning, New York, Glass Works. Shaping it to an almost perfect parabolic curve took nearly seven years.

guide star in his eyepiece (pages 408-9).

Down in the lower end, the giant mirror, 16⅔ feet across, gathers in the light from distant heavenly bodies and reflects it back up into this little cell, where it is focused on the photographic plate. Humason pushed a button, the mirror's protective covers slowly opened like the petals of an enormous flower, and the Big Eye shone forth, ready for another long look out into the depths.

Below, at the control board, I watched Ben Traxler, the night assistant, start the telescope swinging into position. He turned out the lights, and Humason's voice sounded almost unearthly as it came down over the "intercom" system from his invisible perch up in the blackness.

"All set, Ben?"

"Ready here."

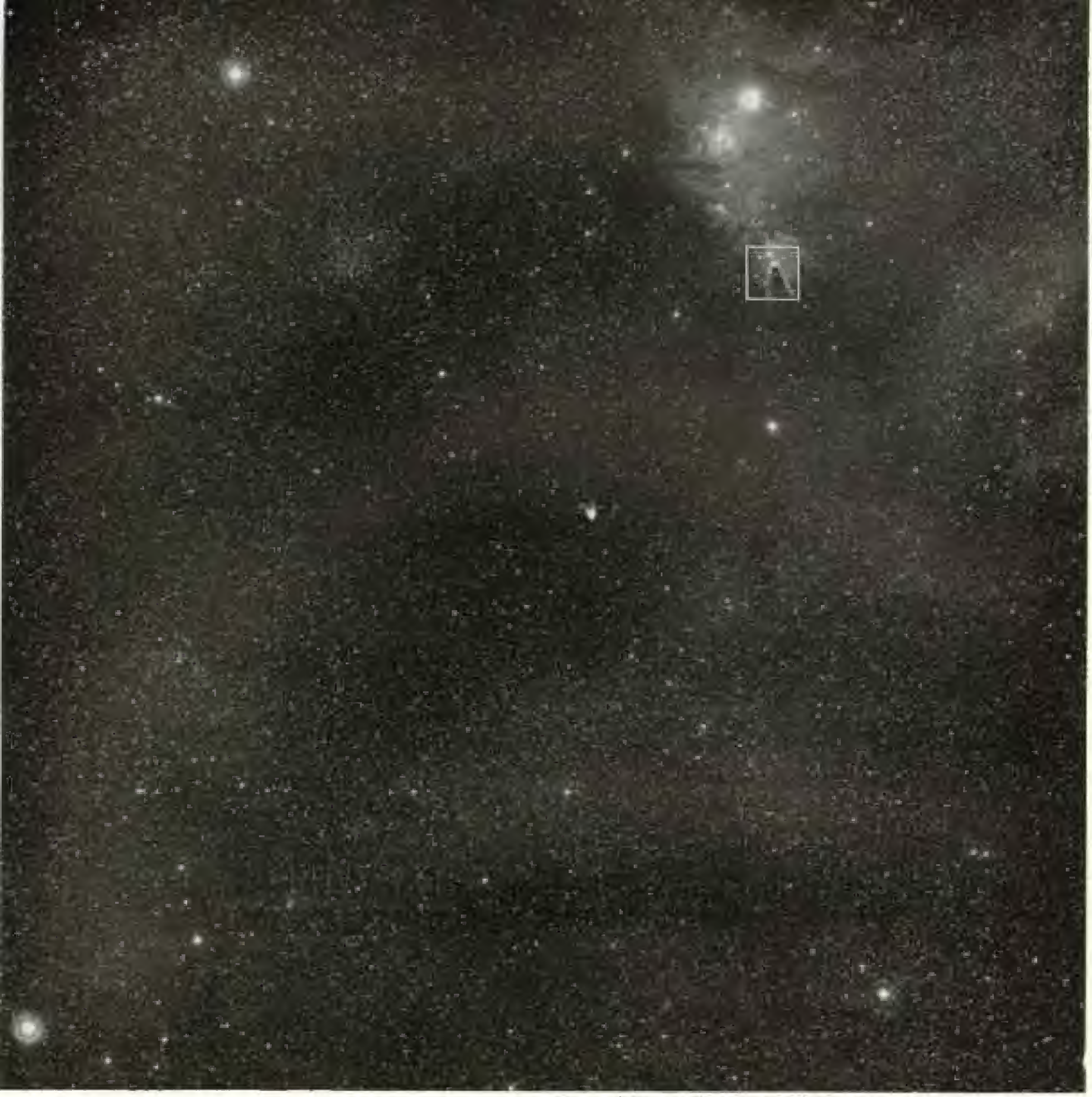
"Give me the count then," said the eerie voice. Watching his clock dial, Traxler started counting seconds, "Ten, nine, eight . . . three, two, one, go!" That signaled Humason to open his camera shutter up there in the top of the telescope. His photographic plate began slowly registering the feeble light coming from that distant cluster of galaxies.

Investigating Mars' "Canals"

At midnight Humason stopped work for an hour, rode down to us in the elevator, and we boiled eggs and made toast and coffee in the well-equipped kitchen.

"Do you ever turn the 200-inch telescope on near-by things like Mars or the Moon?" I asked.

"Well, a man who said he held a patent on exploring the Moon once warned us not to turn our telescope on it!" he laughed. "Actually, the 200-inch is intended for use on very faint, distant objects. Smaller telescopes serve just as well for near-by bodies.



434 © National Geographic Society, Palomar Observatory Sky Survey

This Picture and Opposite One Show How Sky Survey Finds Targets for the "Big Eye"

The oddly shaped Cone Nebula is barely visible within the square at the upper right, but when rephotographed with the 200-inch telescope its details are revealed. This photograph represents about one-fourth of a plate taken with the 48-inch Schmidt telescope. Such pictures guide the 200-inch in studying bodies of special interest. Bright disks are nearby stars. Dots are distant stars and galaxies.

"At some time in the next five or ten years, when Mars is unusually close to the Earth, we might train the 200-inch telescope on it to try to obtain the first photographs of the so-called 'canals.' But one of the smaller telescopes on Mount Wilson more likely will be used for this purpose."

"How about new planets?" I asked. "Is the Sky Survey likely to find any more of them?"

"Probably not," he said, "because any new planet in the solar system would show only as a point of light, like a star, on the Schmidt pictures. However, if we photograph the sky again a few days later, and find an object has changed its position noticeably in the interim, we'll know it is a planet. The stars are all so much farther away that their motion cannot be detected except over a period of a few years."

Up on Palomar the astronomers lead a topsy-turvy but busy life, working most of the night and sleeping days in the comfortably furnished "monastery," so named for its isolation and the fact that no women but the housekeeper-cook live there.

Planners located the monastery in a quiet, secluded grove of ancient oaks, with special blackout shades at the bedroom windows, so

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Seen with the "Big Eye," Cone Nebula Resembles a Comet Leaving Wake of Black Dust

This photograph, covering the area outlined by the small square on the facing page, was made with Palomar's 200-inch telescope. The bright star at the top illuminates a cloud of dust or gas at the apex. The cone-shaped formation may be partly a shadow cast by this cloud, or the whole object may be a cloud of unusual shape with its edges lighted by stars behind

that the astronomers could sleep undisturbed in the daytime. But they reckoned without Palomar's woodpeckers.

No Holidays for Astronomers

These birds decided that a good place to store acorns was in holes in the fine new copper roof, and that morning was the ideal time to drill the holes. For weeks the weary astronomers tried futilely to sleep under the steady tattoo overhead, until finally they replaced the copper with composition shingles, and the noise ceased.

Sleeping until noon, the astronomers get up for lunch, then spend the afternoon developing plates exposed the night before, making notes, and doing chores. After an early dinner they pick up their lunchboxes and are back at the telescopes again by dark. Nights off for them come not on Sundays or holidays, but only when the seeing is poor.

Astronomers spend only a few days at a time on the mountain, then return to a normal schedule of work in offices and laboratories down in Pasadena, studying the results of their last observations and planning for the next.

In the monastery's lounge and dining room, when they aren't working, they chiefly talk

National Geographic Photographer J. Baylor Roberts

When the Lesson Is Astronomy, Palomar Pupils Should Know All the Answers!

Appropriately, the "Science Corner" is prominent in the mountain's classroom, almost in the shadow of the Schmidt and 200-inch telescopes. Children of the Observatory's resident staff, ranchers, and farmers attend school here, since they live far from any town. Edward Griggs, son of a State park ranger, recites for Mrs. Marion Bechler, who teaches first, second, third, and eighth grades in one room.

about—astronomy! But in spare time they read science-fiction magazines, detective stories, and the NATIONAL GEOGRAPHIC.

Palomar Mountain, 6,138 feet high, is an island of green pastures and pleasant woods above the arid lands below. California earthquakes scarcely budge its solid granite bulk, extending 25 miles down into the Earth, one reason why it was chosen for an observatory. Its name, meaning "dovecote" or "pigeon roost," was given by Spanish settlers, who found it teeming with band-tailed pigeons.

Visitors Flock to Palomar

Today pretty little cottages nestle among the telescopes, with all modern conveniences including television. Here live the permanent staff of astronomers' assistants, technicians, and other workers. In winter they have been isolated as long as a week by 5-foot snows, so a supply of food is always kept on hand.

Over San Diego County's well-paved and graded "Highway to the Stars," tourists by the thousands swarm up to Palomar on week ends.

Now and then people display weird ideas of what the big telescopes are all about.

"I overheard one man telling his friends that the 200-inch dome was painted silver color so it could be seen from Mars," Byron Hill told me. "People ask whether we've seen men on Mars, flying saucers, life on the Moon, or the gates of Heaven. A preacher down in Los Angeles told his congregation we had spotted a big square object heading straight for the Earth, but were afraid to announce it because we didn't know what it was!"

One visitor the astronomers regret they cannot have is shy old Bernhard Schmidt. They would like to show him the good use they are making of the idea that came to him only a few years before he died in 1935 (page 418).

The story of the Big Schmidt telescope, even of the Sky Survey itself, one might say, began with a small boy rubbing the bottom of a broken bottle in a saucer of fine sand in an obscure Estonian island village in the Baltic Sea, some 60 years ago.

With these ingredients young Bernhard Schmidt was grinding a lens for a camera made from a cigar box, and getting interested in the science of optics. The son of a German father and a Swedish mother, the boy had first been interested in explosives, but a crude homemade bomb blew off one of his arms. This accident was fortunate for science, for it turned young Schmidt's attention to the less dangerous business of experimenting with cameras, lenses, and mirrors.

Solving an Ancient Problem

Schmidt settled in Germany, grinding mirrors for astronomical telescopes. An eccentric, solitary figure, he always worked in formal costume of cutaway coat and striped trousers, chain-smoking big cigars. He disliked regular hours, but finally consented to take a job with the Hamburg Observatory at Bergedorf because the director would permit him to work pretty much as he pleased.

For years he struggled to solve a problem that had plagued astronomers ever since they started photographing the heavens. In their pictures only the center was clear and sharp: images of stars outward toward the edge were distorted because of unavoidable defects in the way light is reflected from the mirror onto the photographic plate.

In 1929, while Schmidt was on the way to the Philippines to observe an eclipse of the Sun, the solution dawned upon him. Later he built a small telescope on the new model, trained it upon a distant cemetery, and invited his friend, Dr. Walter Baade, now on Palomar's staff, to take a look.

"Can you read the names on the tombstones?" Schmidt asked.

"Yes," was Baade's elated reply, "but I can see only one thing—the optics are absolutely marvelous!"

Schmidt's system provides a thin glass correcting lens in the upper end of the telescope, through which the light of celestial bodies passes before it falls upon the mirror at the lower end (page 419). This lens has a rise in the center, dips down into a concave hollow all around, then rises again at the edge. Light rays passing through the lens are bent in such a way that when they fall upon the mirror they are reflected onto the photographic plate in perfect focus all over its surface.

The mirror is ground into a spherical curve, rather than the parabolic curve used in most telescopes, and the photographic plate is bent into the same spherical curve as that of the mirror. This helps produce photographs that cover a wide area and are clear and sharp all the way out to the edge.

U. S. astronomers saw at once that Schmidt had solved a long-vexing problem. The first Schmidt telescope put into professional use was an 18-inch constructed for Palomar in the Cal Tech shop at Pasadena. The phenomenal success of this instrument inspired the construction of a still larger one, the 48-inch, which would act as an auxiliary for the 200-inch Hale.

Today's Big Schmidt, with a 48-inch lens placed in front of a 72-inch mirror, not only "sees wide" but can gather enough light to pick up very distant bodies as well, an ideal combination for mapping the heavens. Its speed of F2.5 makes it extremely fast.

Schmidt's system is also used today in projection-type television sets to make all possible use of the available light in forming a clear image on large screens.

Some of the X-ray machines used in mass tuberculosis surveys employ the Schmidt system to produce clear photographs on small film, replacing expensive large glass plates. Though other scientists came close to developing the optical system designed by Schmidt, none carried it quite as near perfection as he.

Plates Kept in Special Vault

More precious even than the Big Schmidt itself will be the 1,870 glass plates on which it is recording the map of the Universe.

In a vault three stories below ground, beneath a building that is proof against fire and earthquake, on the campus of California Institute of Technology, the priceless plates will be carefully guarded. As an extra precaution, a set of duplicate positives will be made, also on glass.

Positives on film will be made as well, and from these in turn will be made negative prints, showing the heavenly bodies as dark images against a light-gray background. Astronomers prefer such prints for study, because the size and brightness of objects can be measured more accurately when they are dark on a light field.

Negative prints like these will be used for the actual pages of the Sky Atlas containing all the pictures taken in the Sky Survey. If engravings were used to reproduce the Survey pictures, much of their fine detail would be lost.

Most of the actual discoveries in the Sky Survey are made not on Palomar itself but

Ewing Galloway

Bernhard Schmidt Found a New Way to Map the Universe

His invention of a wide-angle telescope made it possible for the first time to make photographs of large areas of the sky without distortion of star images in any part of the picture (page 417). Here the German optical genius, who died in 1935, tries out an instrument at the Hamburg Observatory. The combination of lens and mirror which he devised is used in television and X-ray photography as well as astronomy.

in the laboratories in Pasadena, where the astronomers study the photographs of the sky with high-precision instruments (page 407). Delicate photometers measure the brightness of images, a clue to their distances and temperatures. Sizes of images are measured in hundred-thousandths of an inch.

Our Galaxy Has Spiral Arms

All this will provide a far better understanding both of how our own Milky Way Galaxy is put together and of the structure of the great Universe of outer galaxies beyond.

"If we could travel out into space and see the Milky Way Galaxy from a distance, overall, it would be easy to understand its structure," Dr. Rudolph Minkowski told me, "but we have to look at it from the inside, like an ant trapped within a big cheese sandwich trying to figure out how the sandwich is put together (pages 405, 410).

"Our Galaxy is actually a great flat disk containing billions of stars mixed up with great clouds of dust and gas. A large part of these stars are located in spiraling pinwheel arms.

"The Earth and solar system are located, we think, in one of these spiral arms, which is made up of big clouds of gas and myriads of bright, hot, blue stars. Our nearest neighbor spiral-type galaxy, the Andromeda nebula, is built this way. We can look out and see this galaxy overall, and its arms contain just such clouds of gas and hot blue stars.

"Our Survey plates will show which stars are the hot blue types, and also the location of the big gas clouds. From that we can get a more accurate picture of where the spiral arms are located and whether we really are in or near one of them."

The Milky Way Galaxy revolves like a wheel around a great hub of stars, so concentrated that they would show as a big bright patch in the sky if they were not hidden from our view by a heavy curtain of dark dust and gas clouds. But the Sky Survey may reveal rifts in this curtain through which parts of the "hub" can be photographed and studied.

Why and how often do stars explode, to become novae or supernovae (page 405), suddenly flaring up into a vastly greater bright-

National Geographic Photographer Edwin L. Wisherd

Looking down the Big Schmidt's Throat Shows Arrangement of Its Lens and Mirror

Don Hendrix, Palomar optician, is reflected in the 48-inch transparent correcting lens, foreground, and upside down in the 72-inch mirror at the rear, both of which he ground (page 417). The telescope's plate-holder is the square object between the lens and the mirror. The image of the camera that made the picture is reflected at its right.

ness? Do stars explode more often in some types of galaxies than others? What is the condition of a star before it explodes? The Sky Survey will help answer these questions.

Clues to Star Explosions

About two dozen exploding stars show up every year in our nearest neighbor spiral galaxy, the Andromeda nebula. What sets off a nova's flare-up may be a true explosion of the star, or perhaps a nuclear chain reaction like that in the atomic bomb.

Hereafter, when astronomers spot a nova, they can refer back to the Survey photographs and see what the star was like before it blew up. The pictures will reveal its original color, temperature, and brightness, which may furnish clues to the cause of the cataclysm.

Nearly 23 million galaxies, or nebulae, are scattered through outer space within range of the Big Schmidt's eye, it is estimated by Dr. Edwin P. Hubble, who has studied them for 25 years (page 404).

He thinks the galaxies may go through a process of evolution, from a globular mass of gas to an oval formation, then into the flat spiral shape, with stars appearing in them, at last becoming an irregular mass of stars and gas.

Enough samples of all kinds of galaxies should show up on the Survey plates to indicate whether this theory is correct, or whether

the galaxies begin and end their lives in some other way.

"We'll see in the Survey pictures a far more complete and accurate sample of the Universe than ever has been available before," Dr. Hubble told me. "It will give us a far sounder basis on which to judge what the rest of the Universe is like. But, of course, if the Universe is infinite in size, even this sample will be insignificant."

Galaxies May Decrease Far Out

There's some indication, Dr. Hubble says, that the number of galaxies begins to drop off at a distance of about 500 million light-years from the Earth, judging from pictures previously taken with the 100-inch telescope at Palomar's sister observatory Mount Wilson, near Pasadena.

That may mean the Universe is finite, or limited in size; or merely that the number of galaxies decreases at one point, then increases again farther out. The 200-inch telescope, penetrating twice as far as the 100-inch, should give the answer.

Some scientists believe all the matter in the Universe once was concentrated in a huge primordial "atom," which exploded into fragments consisting of the millions of galaxies that we see today still flying off into space.

Another theory is that the explosion filled all space with gas and dust, which gradually condensed to form the galaxies, and that the stars were formed in turn by further condensation of the gas within each galaxy, a process still going on.*

The only real evidence that the Universe is expanding is the red shift of light from the outer galaxies. According to the laws of physics, this means the galaxies are rushing away; yet it's possible, says Dr. Hubble, that the red shift in this case is caused by some law of Nature unknown to us and means something else entirely.

"Why is all this important? Why study astronomy, why map the Universe, when most of it is so infinitely far removed from human affairs?" I asked Dr. Ira S. Bowen, director of both Palomar and Mount Wilson Observatories (page 413).

"Well," he said, "I might ask you, why study geography? Astronomy is really an extension of geography. Exploring the Earth, people were never satisfied until they found what lay over the next hill. Now that man has charted most of the surface of his own planet, he wants to know what lies beyond, out in space. Curiosity will never let him rest until he solves the riddles of the Universe.

"How old is the Universe and how did it begin? People used to think our own Earth had existed only a few thousand years. Now we know that it and the rest of Creation date back two or three billion years. How it all began is still a mystery, but maybe sometime we'll get at least part of the answer, and mapping the sky will help.

Man's Place in the Universe

"Man's place in the Universe is another riddle. The ancients believed that the Earth was the center of everything, with the Sun and stars revolving around it. Then it was found that the Earth and other planets revolved around the Sun. Next we discovered that the stars were much farther away than anyone had realized, and our horizons expanded again.

"Until only about 25 years ago, most astronomers thought that the outer galaxies were comparatively small objects inside the Milky Way. But with the big new telescopes we found that these galaxies were of enormous size, as big as the Milky Way itself, and were scattered out through space at distances no one had ever imagined.

"Each step seemingly has further reduced man's relative importance in the universal scheme of things, but still his mind can reach out and at least partially explore and understand the immensity around him."

Not all astronomers are religious men; yet when the Palomar Observatory was dedicated, the program bore on its final page those well-known words from the Eighth Psalm:

> When I consider thy heavens, the work of thy fingers, the moon and the stars, which thou hast ordained;
>
> What is man, that thou art mindful of him? . . .

* For additional articles on astronomy, see "National Geographic Magazine Cumulative Index, 1899–1949," especially "Heavens Above," by Donald H. Menzel, July, 1943.

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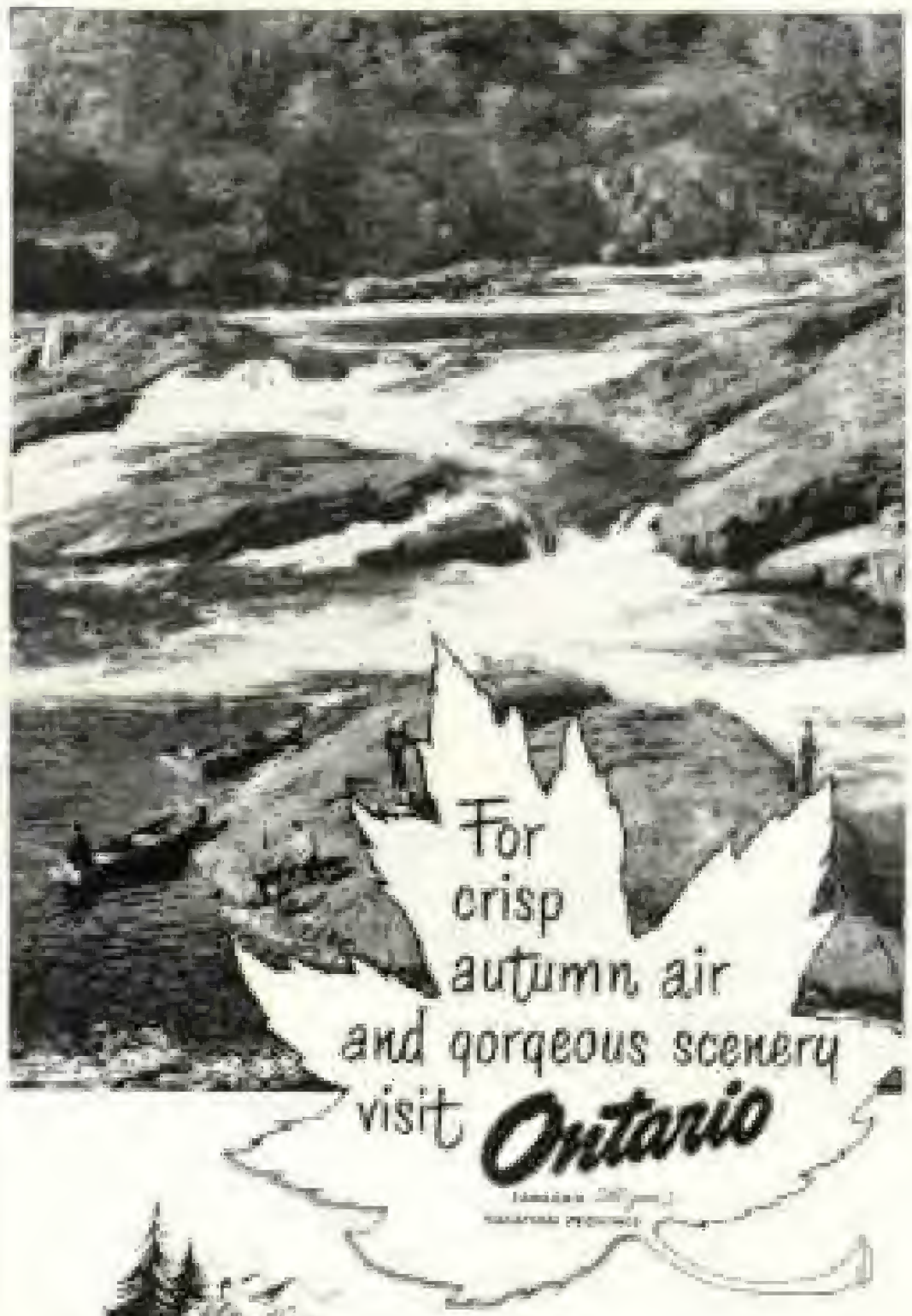

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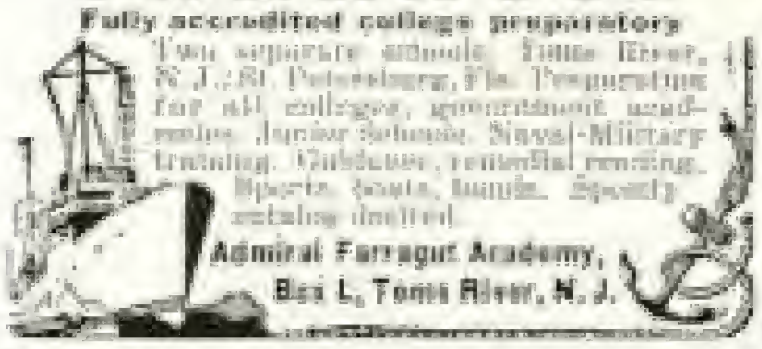

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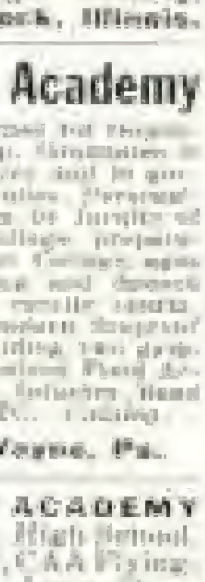

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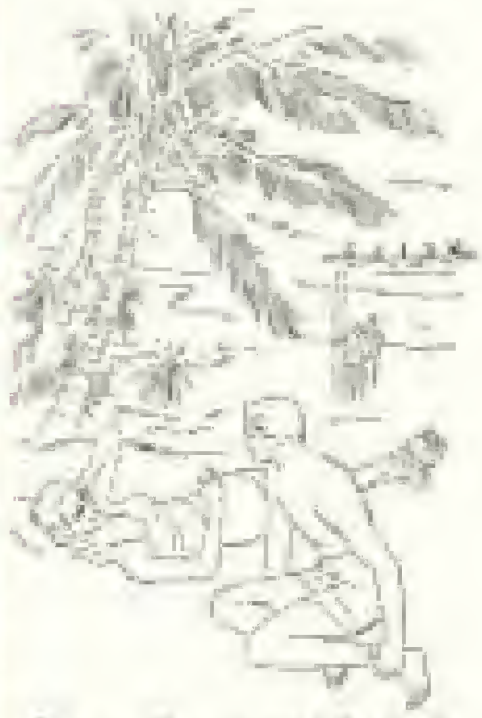

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