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THE NATIONAL GEOGRAPHIC MAGAZINE

Aviation Looks Ahead on Its 50th Birthday

Now a Billion-dollar Business, Airlines Plan Jet Transports, Fast Freighters, and Downtown Helicopter Ports

BY VICE ADMIRAL EMORY S. LAND, USN (RET.)

President, Air Transport Association of America, and
Life Trustee of the National Geographic Society

ON the morning of December 17, 1903, an obscure bicycle mechanic clambered aboard a strange-looking craft, nodded to his brother and a small group of onlookers, and began one of history's greatest voyages of discovery.

His journey lasted just 12 seconds.

In those few fleeting moments a frail, kite-like machine bore Orville Wright aloft and carried him safely a distance of 120 feet across the desolate, wind-whipped sands at Kitty Hawk, North Carolina (page 740).

Humanity's age-old dream had been realized. Man had flown successfully for the first time in a powered, heavier-than-air machine.

Celebrating a Year of Jubilee

In the United States, and in many foreign lands on freedom's side of the Iron Curtain, that epoch-making achievement will be commemorated with special ceremonies on December 17, 1953, the fiftieth anniversary of powered flight.

Here in our own land all of 1953 has been declared a Golden Jubilee celebration of the airplane's birth. There have been scores of commemorative events, among them air meets, State and regional air tours by the Civil Air Patrol, special radio and television programs, airport dedications, special newspaper editions, and the issuance of an anniversary air-mail stamp.

Perhaps you, like myself, belong to that older generation whose lifetime spans the entire history of successful flight. If so, I am sure you feel, as I do, a sense of wonder at the tremendous scope of the achievements we have witnessed in aviation.

Fifty years is a mere moment in time compared to the millenniums that have passed since man's invention of the wheel. Yet in that relatively brief interval we have seen the airplane grow from a fragile thing of wood, cloth, and wire into the fastest means of travel ever devised.

We, and our children, have seen the warplane play a major role in shaping the fate of nations. We have seen the airliners of peaceful commerce change the habits and living standards of ourselves and our neighbors.

With no exaggeration, mankind's first half century of powered flight has been called "the fifty years that changed the world."

The Wright brothers made a total of four flights that memorable winter's morning, averaging an air speed of 31 miles per hour. The longest flight, with co-inventor Wilbur at the controls, went 852 feet in 59 seconds.

Speeds and Loads Vastly Increased

How unimpressive these figures inevitably seem in an age when fleets of huge airliners wing along our busy skyroads! I doubt if even the Wright brothers could have dreamed in 1903 how greatly their distances and speeds would be exceeded.

Including fuel and Orville, the Wright aircraft weighed 750 pounds. Today any one of a number of planes in the United States scheduled air fleet can carry 50 times that weight and fly 12 to 15 hours nonstop.

Recently a United States research plane

MILITARY AIR TRANSPORT SERVICE

streaked more than four miles in the 12 seconds Orville required to travel 40 yards.

Even the fuselages of some modern military aircraft are longer than that first flight!

In our Air Age the farthest spot on earth is only hours away. Leaving New York, an airlines passenger can reach Paris in 13 hours, Chicago in 3¼, Los Angeles in 10¾, Rome in 19¼, Tokyo in 39.

By the time this article appears, one airline plans to be operating the first nonstop coast-to-coast service. New DC-7's will make the flights in less than eight hours.

Air Travel Sets Records

The Wright brothers, though gifted dreamers, could not have visualized in those struggling pioneer days the hordes of people who would one day travel by air.

In 1952 United States domestic and international scheduled airlines—i.e., those certificated for route operations by the Civil Aeronautics Board—carried a record 27,386,504 passengers, the equivalent of nearly one-sixth of the Nation's population. In 1953 we shall undoubtedly better that total; figures for the first six months show a 20 percent increase over the corresponding period of 1952.

To handle the growing tide of traffic, our scheduled airlines are constantly modernizing and adding to a fleet of some 1,400 planes. Our airlines fly 236,000 route miles and offer more lift capacity than the rest of the world's air carriers combined.

While achieving that growth, the airlines constantly improved their records for safety.

On February 11, 1953, the domestic scheduled carriers completed 12 months of operations without a single fatality. During that period they averaged a landing or take-off every seven seconds, or approximately 13,000 per day.

Wilbur Wright died of typhoid fever in 1912. Orville, the younger brother, lived until 1948 and saw aircraft put to a multiplicity of uses which would have strained the imagination of a Jules Verne: rain making, crop dusting and spraying, power-line patrol, mineral prospecting, game surveys, forest-fire fighting—even the herding of livestock (page 737).

Today, exclusive of the military and the airlines, there are approximately 88,000 airplanes in service in the United States, most of them operated by private flyers.

A half century ago there were only two power-plane pilots in the entire world. In 1952 there were 267,759 active civilian pilots in the United States alone.

More than 16,000 of these flyers are members of the Civil Air Patrol, civilian auxiliary of the United States Air Force. Organized into 52 wings, one to each State and Territory, CAP flies air search and rescue missions, airlifts supplies in time of disaster, supports the Nation's aerial defense observation system, and currently instructs more than 48,000 cadet members in aviation subjects.

Airlines Plan a New Era

Of aviation's many facets, the one affecting our lives most directly, and perhaps of greatest interest, is public transportation.*

As president of the Air Transport Association of America, a nonprofit service organization representing 42 scheduled airlines, I am intimately concerned each day with the sharp growing pains of a still-youthful industry. In 1952, for the first time, the airlines entered the billion-dollar industry class in annual gross revenue. We have grown big, but we are destined to grow much, much bigger.

That growth will see many changes. What will they hold in greater speed, comfort, and convenience for airlines customers?

I'll answer that question, but first let me disclaim the role of prophet. Few industries are so dynamic and changeable as the air transport business. (I once told my board of directors they were "a grand bunch of prima donnas.") Competition is keen, the problems large, the imponderables many. No one can foresee all the changes that lie ahead, and none can claim special clairvoyance.

Nevertheless, a number of developments can be predicted with reasonable certainty *if the world remains at peace*. In most instances my thinking on these future developments typifies the viewpoint of many colleagues.

Our Nation is about to enter a new era in commercial air travel—the age of the gas turbine aircraft, already introduced elsewhere in the world by the enterprising British with their jet-powered Comet airliners.

* See "Our Air Age Speeds Ahead," by F. Barrows Colton, NATIONAL GEOGRAPHIC MAGAZINE, February, 1948.

Military and Civil Air Transport Chiefs Confer on U. S. Defense

Commercial airlines form an integral part of the Nation's defense system. Mobilization plans earmark nearly 300 four-engined planes for transfer to the Military Air Transport Service on 48 hours' notice. Of this number, more than 85 percent will be leased from scheduled airlines, the remainder from nonscheduled carriers.

Here the author, Emory S. Land, president of the Air Transport Association of America, represents the scheduled airlines at a meeting with Lt. Gen. Joseph Smith, commander of MATS, at Andrews Air Force Base, Maryland. The polar map shows MATS' globe-girdling routes; the swept-wing model aircraft represents a proposed jet transport.

Kodachrome by Volkmar Wentzel and Bates Littlehales

↑ 23 Firms Helped Build This Copy of the First Wright Plane

In honor of the airplane's 50th birthday, Los Angeles members of the Institute of the Aeronautical Sciences decided to duplicate the original Kitty Hawk *Flyer*. They assigned the making of components to volunteer companies and gave Northrop Aeronautical Institute, Hawthorne, California, the job of wing-panel construction and final assembly. All work and materials were donated.

The finished reproduction, shown at Hawthorne, is a twin of the original in every detail but one: its engine is a wood and metal mockup (p. 728). After dedicatory ceremonies last July 15, IAS members put the plane on display in their W. F. Durand Aeronautical Museum, Los Angeles.

England's Kensington Science Museum has the only other full-scale copy. The museum contributed blueprints to the IAS project, as did the National Air Museum of the Smithsonian Institution, Washington, D. C., custodian of the original Wright plane.

George M. Russel, grandnephew of the Wright brothers and an aeronautical engineer, lies prone on the wing, demonstrating the pilot's position to jet ace Robert J. Love, now a test pilot for Northrop Aircraft, Inc.

Upper left: Stunt pilot Joseph Boone, entertaining at an air show in Richmond, Virginia, last May 16, flies a 1910 Curtiss pusher. Its "butter paddle" propeller, powered by a 1918 Curtiss motor, drives the venerable relic a scorching 45 miles an hour. Paul Mantz, owner of this and other old planes, contracts for their use in air shows and movies.

← All 88 Seats Were Taken on This Flight

In 1948 airlines introduced an attractive bargain on domestic runs: air coach or tourist service at approximately 30 percent less than first-class fares. In 1952 carriers inaugurated the service on transatlantic runs, making possible vacations abroad for thousands of Americans who lacked time to go by ship. Today about 23 percent of all air travel in the United States is by coach.

Seating arrangements are less spacious on coach flights and luxury services are curtailed, but planes are the same types used for first-class travel.

These coach passengers prepare for take-off from Washington on a TWA run to the Pacific coast.

Kodachromes by Luis Marden, John E. Fletcher, Donald McBain, and Guy Starling, National Geographic Staff

Basically, there are two types of gas turbine power plants: the propellerless turbojet, usually referred to simply as the jet, or pure jet, obtaining thrust from a blast of hot gas; and the lesser-known turboprop, which gears its whirling turbine to a propeller (page 770).

Today practically all developmental work on large piston aircraft engines has been abandoned in the United States in favor of these two new types. Our latest airliners, the DC-7 and the Super Constellation, probably will be the last big new-model transports with reciprocating engines (pages 730, 732).

Jet Debut Expected Soon

I believe 1956 will see a jet transport introduced in domestic operation and another placed in service by a United States transatlantic carrier. Our first jet may be an improved type of the British Comet, or a new Boeing 707 transport, now in prototype construction phase. Other possibilities are on the drawing boards.

Many of our present airliners could be converted to turboprop power, and we may see such aircraft in service by 1956, or perhaps even sooner. New planes specifically designed for turboprop operation are contemplated, but American manufacturers have indicated they will introduce their speedy jet transports first.

In 10 to 15 years jetliners of American manufacture may replace most piston-driven aircraft on transcontinental and a number of other long-haul routes.

You may be an inveterate air traveler, but I predict your first flight in one of these jets will be the smoothest, most pleasant journey you have ever undertaken.

Your plane will be luxuriously fitted, with seats for about 80 passengers, plus a lounge. You will fly at 35,000 to 40,000 feet, far above the weather. Outside, the air will be rarefied and below zero, but inside the cabin, with its double windows for safer pressurization, you will still be warm and comfortable.

Since the jet has no propellers, your plane will be virtually without vibration; therefore, fatigue will be reduced. The roar of the engines will be muted to a murmur by sound insulation in the fuselage. You will cruise at about 550 miles an hour, compared to 365 for our fastest piston liner.

Despite one stop en route, our first jet transports will cross the continent in less than seven hours, clipping an hour from the nonstop DC-7 schedules (page 723).

But in 25 years, perhaps sooner, an airlines passenger will leave New York at noon and arrive in Los Angeles at noon! The time zone differential will erase the three hours required by his supersonic jet to streak across the country.

The jet's optimum performances will be on long flights at high altitudes. The turboprop, more economical to operate, promises to be most effective on intermediate runs and on extreme long-haul routes.

The turboprop has a glittering future, both as a transport plane and as a cargo carrier. Although not so fast as the jet, it will cruise at 450 miles an hour. When fully engineered, it will reduce cargo costs per ton mile, enabling the airlines to capture an increased share of the freight and express now being carried by surface transportation.

Last year domestic and foreign airlines carried more people to and from the United States than did ships. Domestically, our airlines accounted for nearly 57 percent of the first-class travel market, as compared to about one percent in 1932. Jets and turboprops will increase the trend to air travel.

I am confident that in 10 years' time the scheduled airlines will carry 60,000,000 passengers a year compared to our present 27,000,000. Instead of 2,000,000 miles per day, our planes will log 5,000,000, equal to 10 round trips to the moon every 24 hours!

Airlines are planning the large-scale introduction of helicopters, an innovation that seems likely to arouse more general interest than perhaps any other "new look" in aviation (page 738).

I predict that in 10 to 15 years big multi-engined 50-passenger helicopters will replace fixed-wing aircraft on many routes of less than 300 miles through large population areas. They will be economical, safe, and reasonably fast. Their ability to hover and descend vertically will enable passengers to disembark at downtown heliports instead of outlying airports, saving valuable time—and saving time is commercial aviation's prime asset.

Automatic Flight a Possibility

Today new electronic aids permit airlines to maintain dependable all-weather schedules. So promising is the outlook in electronics that completely automatic flight is a distinct probability during aviation's second half century.

Amazingly versatile electronic brains will take airliners off, fly them to their destinations, and land them safely and smoothly. Pilots will ride in the cockpits, but only to monitor the automatic equipment.

This technique is, of course, not a reality today, and it may be 25 years before we see it in use by the airlines.

I intend to discuss each of these future developments—jet, turboprop, helicopter, and automatic flight—in more detail, answering a number of questions that must be in the reader's mind.

But first, for a better understanding of the

Kodachrome by National Geographic Photographer David S. Boyer

Tower Operators Direct Washington, D. C., Air Traffic from a Radio Console

On a busy day the National Airport records more than 700 landings and take-offs. Farthest man and girl beside him control airborne traffic. Others direct ground movements and transmit flight data.

Boeing Airplane Company

728

Pilot and Crew Work in Office-size Quarters Aboard a Boeing Stratocruiser

Extra roominess and comfort make the Stratocruiser a favorite with crew and passengers. This nose compartment of the 72-ton airliner houses pilot and copilot, flight engineer (center), and navigator (left).

airlines and their problems, let's take a look at the half century now ending. Let's see how the airlines grew.

A beloved war hero, Lt. Gen. James H. Doolittle, heads the National Committee to Observe the 50th Anniversary of Powered Flight. While working with Jimmy's executive committee, I have been amazed to find how little the general public knows about the birth of the airplane.

As a case in point, here is a favorite yarn of mine:

Those "Lucky" Wright Brothers

Early in 1953 several organizations decided to build full-size reproductions of the original Wright plane. One is a museum piece (page 725).

Two other groups planned powered copies which would actually be flown by test pilots. Later these projects were abandoned.

A private pilot of my acquaintance asked an industrial executive who headed one of the projects why his program had suddenly been grounded.

"Well, we just didn't think the confounded plane would fly."

"Not really!" my friend exclaimed. "Who was going to build it?"

"Oh, we had 10 aeronautical engineers lined up for the job."

"And they couldn't make it fly? Why, two bicycle mechanics were able to do it!"

"Yes," growled the executive, "but they had a lot of horseshoes with them!"

His reply typifies a myth that is all too prevalent—the myth of the Wright brothers' "lucky" achievement.

Actually, luck played a very small role in their work. The brothers, faltering though their first flights were, unlocked the secrets of the air. An excellent account of their early experiments and struggle for recognition accompanies the historic photographs beginning on page 740.

One of the few sage, respected voices to

declare faith in the possibility of flight prior to Kitty Hawk was that of Dr. Alexander Graham Bell, inventor of the telephone and president of your Society from 1898 to 1903.

In the June, 1903, NATIONAL GEOGRAPHIC MAGAZINE, featuring an account of his experimental kites, Dr. Bell wrote:

"We are all of us interested in aerial locomotion; and I am sure that no one who has observed with attention the flight of birds can doubt for one moment the possibility of aerial flight by bodies specifically heavier than the air. In the words of an old writer, 'We cannot consider as impossible that which has already been accomplished.'"

Later, during aviation's pioneer years, the distinguished scientist predicted that aircraft would attain high speeds and forecast 13-hour transatlantic crossings by air.

In the airplane's infancy most people believed it lacked commercial possibilities. A statement by Octave Chanute, friend of the Wrights and a prominent engineer and glider pioneer, typifies the thinking of the day.

Writing in the Smithsonian Institution's annual report for 1903, Chanute forecast a limited military use for the airplane and said it might even carry mail "in special cases." Then he declared:

"But the useful loads carried will be very small. The machines will eventually be fast, they will be used in sport, but they are not to be thought of as commercial carriers. To say nothing of the danger, the sizes must remain small and the passengers few."

However, by 1914 flying boats were shuttling passengers back and forth between Tampa and St. Petersburg, Florida. This service has been called the first scheduled air passenger line in the United States. It was an unprofitable, short-lived venture, as were several similar undertakings that followed, but they served as yardsticks for future operations.

World War I Boosted Aviation

World War I gave tremendous impetus to the development of the airplane. Having participated mightily in that development, our Government naturally desired to capitalize on it in time of peace.

Speedier delivery of mail proved to be the airplane's first peacetime use.

In May, 1918, the War Department inaugurated regular air mail between New York and Washington, D. C. Later that year the Post Office Department took over the service.

New York-to-Chicago air mail was established by 1919; San Francisco was added to the route the next year. Night air mail, Chicago to the west coast, started in 1924 and was extended to New York in 1925.

This was the brief, brave era of the pilot veterans of World War I and the happy-go-lucky barnstormers of the postwar aerial circus days. They were the men hired to fly the pioneering planes, the men who put new meaning into the Post Office slogan, "The mail must go through."

So rudimentary were navigational aids that the odds were 25 to 1 against an air-mail pilot's survival over an 18-month period. In those days, when flying blind, men often had to judge their angle of flight by "the feel of the seat of the pants." Mechanical failure was relatively commonplace.

I was doing some flying in the 1920's, first as a Navy aerial observer, and later as a pilot. Any forced landing you could walk away from was a good one, and I was lucky enough to walk away from five!

There was no Civil Aeronautics Administration then to impose safety regulations and strict discipline. Pilots were a venturesome fraternity. They pulled some stunts that probably would cost them their licenses today.

In one such episode I was the butt of an amusing but hair-raising practical joke.

Plane "Buzzes" Speeding Train

My friend Al Williams, later renowned as a speed king, was flying me across the Maryland countryside in a two-seated open-cockpit de Havilland biplane. Suddenly the irrepressible Williams swooped down upon a speeding passenger train.

Overtaking the engine, he jockeyed the plane into a position above the smokestack and reduced our speed until it matched that of the train. So nicely did he judge the maneuver that only the rear cockpit, in which I sat, caught the smoke from the stack.

Engulfed in cinders and noxious fumes, I coughed, spluttered, and choked. Beating on the rim of the cockpit, I voiced my opinion of Williams in profane shouts. Finally Al tired of the game and hedgehopped away across the fields. When we landed I looked like the end man in a minstrel show.

Today such questionable larks have all but vanished from the aviation scene.

In 1926 the Federal Government turned over flying the mail to private contractors. Under private enterprise the nucleus of the airlines we know today took form.

The big challenge was to deliver the mail in the shortest time. The letter that today takes 10 hours to get from coast to coast, at a cost of 6 cents an ounce, took 32 hours in 1926 and averaged 24 cents an ounce.

Air mail was so profitable that few contractors bothered to install seats in their planes. But some pioneer travelers consented to ride in open cockpits or sit on mail sacks. Later they crowded into boxlike cabins.

Kodachrome by Luis Marden, National Geographic Staff

Drills Screech, Rivet Guns Chatter as Workers Assemble the Fuselage of a DC-7

Douglas Aircraft's DC-7 is America's newest airliner (page 732). This rear quarter takes shape at Santa Monica, California, largely through the efforts of women. Anti-corrosive zinc chromate colors the metal.

The first regularly scheduled passenger service by an air-mail carrier was inaugurated May 23, 1926, by Western Air Express, today's Western Air Lines. Each plane carried about 1,000 pounds of mail and two passengers over the 660-mile route from Los Angeles to Salt Lake City.

On July 6, 1926, the first air transport company primarily engaged in passenger business established service between Washington, D. C., and Philadelphia. By the end of 1927 many pioneer transport services were operating, including one to Latin America.

With expanding routes came larger and faster planes, trimotored, each carrying up to 14 passengers. The year 1935 saw the introduction of an all-metal, low-wing, twin-engined transport, the Douglas DC-3, which became the work horse of the fleet.

Law Stimulates Civil Aviation

To regulate and promote the scheduled airlines in the public interest, Congress passed the Civil Aeronautics Act in 1938. It was a remarkably fine piece of legislation. Scheduled airlines moved forward under this new directive. Passengers increased and cargo carrying by air developed.

On the day Pearl Harbor was attacked, the military turned to the scheduled carriers for help. Approximately half their fleet of 359 transports and 27 flying boats and half their personnel, 7,300 employees, went to work for Uncle Sam within six months.

After World War II new 5-mile-a-minute, 50-passenger aircraft made their debut. As these planes settled into routine service, a new degree of efficiency was achieved.

Then, once again, there were war rumblings, and the airlines answered another call to the colors. Three days after the Korean War's outbreak they made available 40 of their largest planes to the United Nations effort.

During the height of fighting, commercial aircraft were carrying 67 percent of passengers, 56 percent of cargo, and 70 percent of all mail flown to the war theater. Thanks to the airlines, the Military Air Transport Service (MATS) was able to meet its other obligations in the free world (page 722).

At present the scheduled airlines are bringing direct passenger, mail, and cargo service to 687 cities in the United States at rates far cheaper than in the old days. For instance, in 1926 the average passenger fare was 12 cents per mile; today it is 5½ cents.

Earlier I outlined the air transport picture as we believe it will look during aviation's second half century. Now let's sketch in the details and consider some of the problems.

Those problems are enormous, particularly in the matter of jet transports.

For many years American manufacturers have dominated the international market with their highly refined, piston-driven machines. At present about 80 percent of the world's transport planes are American-built. But recently we have seen the very capable British enter the competitive scene—jet-propelled.

For more than a year the government-owned British Overseas Airways Corporation has been operating jet-powered de Havilland Comet I's (page 736).

Three improved versions of the Comet, the Series II, III, and IV, are planned.

Meanwhile, other British aircraft manufacturers have not been idle. Vickers, Avro, and Handley Page say they will introduce giant high-speed jet transports. Moreover, both Vickers and Bristol have built medium-range turboprop airliners. Other, larger British turboprops are in the planning stage.

In contrast, American manufacturers have yet to produce a jet transport.

Douglas, Lockheed, and Boeing plan jet airliners, and Boeing will be ready to test-fly a prototype in the summer of 1954.

Consolidated Vultee has converted several of its familiar Convair-Liners to turboprop operation and has sold two such aircraft to the United States Air Force. Similarly, Lockheed is experimenting with turboprop installations in its Super Constellation.

But that's the extent of our activity to date. Obviously, British manufacturers and airlines are ahead of us in the race for commercial supremacy in the Jet Age. Their lead, I believe, is confined to jet plane airframes, not power plants.

Nevertheless, how did it come about?

Long-range Planning Helped British

The explanation lies in the basic difference between British and American civil aviation and in the nature of the jet engine itself.

Britain's new airliners, though designed and built by private firms, found their inception after World War II in government-sponsored, long-range planning for civil aviation development. Actual production was assured by orders from the Ministry of Supply and the government-owned airlines.

In short, government help gave the British a head start in jet commercial development. This statement is in no sense a reflection upon our overseas cousins. They approached the jet problem with characteristic energy, initiative, and imagination.

However, the situation of our own highly competitive aircraft industry was quite different. Airlines supported a legislative proposal in 1948 that the Government sponsor a jet-liner prototype, but nothing came of the suggestion. Lacking government help, and an

↑ A Super Constellation Cruises Past Lower Manhattan's Towers

Lockheed introduced the first of its famed Constellations in 1943. Improved versions followed, each retaining the original's graceful dolphin shape. The Super Constellation, latest in the line, is the largest transport in commercial use. Its over-all length, 113 feet, exceeds the previous model by 18 feet.

Standard engines drive this TWA liner, but the newest Super Connies boast ingenious compound engines, a wedding of piston and turbine power. Motor exhaust, instead of dissipating, swirls through turbines geared to the propeller drive shafts. A 20-percent gain in horsepower results. The new engines drive the Super Constellation 376 miles an hour at top speed and 335 at cruising speed.

→Douglas's DC-7, five feet shorter than the Super Constellation, is the world's fastest piston-driven transport. Compound engines power the liner at a top speed of 410 miles an hour. It cruises at 365. This model test-hops across the California countryside. White paint deflects sunrays, reducing cabin temperature by as much as 15 degrees.

Kodachrome and Ektachrome by Trans World Airlines and Douglas Aircraft Company

assured backlog of orders, manufacturers were not in a position to gamble upon an early venture into the jet field.

Several makers were smarting under sharp losses incurred in the development of conventional transports. The cost of building a jet prototype, estimated at $30,000,000, was reason for pause.

Moreover, manufacturers and airlines alike were concerned over the high cost of jet operation. Our 4-engined DC-6B consumes 8.9 pounds of fuel per mile. A jet transport of the same size would gulp 20.4 pounds.

At low altitudes jets may burn 4 to 10 times as much fuel as they do at their most efficient cruising height, 35,000 to 40,000 feet.

Obviously, the necessity for carrying huge fuel reserves keeps pay loads down. This was, and still is, a matter of concern to the business-managed, private-enterprise airlines. Our present big airliners begin to make money when about 62 percent filled with passengers. If the airlines are to remain healthy and continue to improve their service, the load factor for jets must be comparable.

These contrasting economic considerations made possible Great Britain's "lead time" in jet transport development.

Refinements in jet engine design here in the United States have brought somewhat better fuel economy; more progress is expected in a few years. This outlook, more than any other factor, now

has prompted American manufacturers to risk the enormous sums needed for jet transport development.

Early in the planning phase the Air Transport Association laid down certain requirements for these new aircraft. They would have to be safe and dependable; have sufficient range for transcontinental and transoceanic travel; be able to land and take off at existing airports; and be as profitable to operate as existing 4-engined transports.

Some manufacturers say they can meet these requirements. On one point, operating profit, many airline officials are dubious. But there is no doubt that jet transports will be part of the American scene.

One United States airline, Pan American, has ordered three Comets (Series III models) for delivery in 1956 and has an option to buy seven more. So far, other carriers are waiting to see what our own manufacturers produce. Boeing's jetliner may be in production by 1956. Douglas and Lockheed jets probably will be somewhat later.

Since World War II the scheduled airlines have bought and paid for 1,193 piston-type airplanes, some costing as much as $1,900,000 each. Orders for an additional 226 have been placed for 1953-55 delivery.

Now comes the jet, bearing a probable price tag of about $4,000,000 each for early production models. The airlines expect to acquire approximately 100 of these planes during the period 1955 to 1960. Over the next 10 years we may have to raise more than $1,000,000,000 for all types of new aircraft: turbojet and turboprop transports, air freighters, local service aircraft, and helicopters.

We are prepared to do this, but readers should not expect conventional aircraft to disappear for a good many years. New planes, for both financial and operational reasons, must be introduced gradually.

Turboprop Planes in Design Stage

To date the United States has devoted far more research to the jet than to the turboprop, largely because of military considerations. But the gap between the two narrows.

The turboprop shows much promise as a transport plane and its development is now being pushed. Several manufacturers have commercial designs in the planning stage. Company spokesmen predict that this type of plane eventually will be more economical than any large transport aircraft now flying.

Like piston-driven aircraft, the turboprop upon landing will be able to retard speed by reversing the pitch of the propeller blades. This advantage is denied the jet, which will require longer runways.

However, there is no truth to the oft-repeated rumor that jetliners cannot use existing airports. They will take off and land with complete safety from our larger terminals. Early models will have improved braking developed for the military. Doubtless the future will see the perfection of reverse jet thrust, the ultimate in braking efficiency.

Although no jet planes have been delivered to airlines in this country, jetliners have maintained regular coast-to-coast schedules for more than a year. No passengers ride them, and not a single eye sees the propellerless giants streak overhead.

They are United Air Lines' "Paper Jets," make-believe aircraft dispatched daily on hypothetical sprints between New York and San Francisco. Meteorologists and dispatchers plan and schedule these flights just as they do regular operations.

The Paper Jets are United's own design, planned to carry 70 to 80 passengers, a crew of five, and 8,000 pounds of cargo, to cruise at 550 miles per hour at 40,000 feet, and to land on present runways at New York, Chicago, San Francisco, and alternate airports.

Conditions Good for Jet Flights

By preparing flight plans with jet capabilities and requirements in mind, United has gained valuable information on problems the airlines will encounter in actual jet operation, particularly with respect to high-altitude weather conditions and airport traffic.

United says its studies indicate conditions in this country generally are favorable for commercial jet flights.

Five years ago the introduction of jets on a large scale would have been extremely difficult because of airport traffic conditions. Navigation and traffic-control facilities simply had not kept pace with the development of the aviation industry. Foul weather canceled many flights. Planes often had to circle above an airport in "holding patterns" for many minutes because of bad weather and antiquated ground-control equipment.

This is the problem known as "stackup." It would be acute in jet operation because of the engines' ravenous appetite for fuel at low altitudes. Fast new transports will have adequate fuel reserves for any eventuality, but they would hardly be economical if long landing delays were encountered frequently.

Fortunately, stackup is being eliminated as a major problem, thanks to pioneering work in electronics by many organizations.

Until recent years pilots flying the Federal airways navigated primarily by means of low-frequency radio signals from ground stations. Chief among a number of disadvantages were these: the signals could not be broadcast in all directions, and frequently they were

Kodachrome by Luis Marden, National Geographic Staff

Passengers Arriving in New York Await Shuttle Service by Helicopter

New York Airways is pioneering the use of helicopters for short hauls (page 738). En route overseas, these Eastern Air Lines patrons use the regular helicopter airlift between La Guardia Field and International Airport.

Britain's Jet Comet Cruises Above Cotton-puff Clouds

On May 2, 1952, a de Havilland Comet took off from London on an epoch-making 6,724-mile flight. Less than 24 hours later the plane landed at Johannesburg, South Africa, completing the world's first regularly scheduled jetliner passage.

Since that day British Overseas Airways Corporation has pioneered three additional jet routes from London: to Ceylon, Singapore, and Tokyo. The planes carry 36 passengers and cruise at 490 miles an hour.

Recently two French airlines, Union Aeromaritime de Transport and Air France, began Comet operations to North Africa. Air France also flies the jets to Rome, Istanbul, and Beirut.

BOAC is planning to use improved, larger Comets. Series II, due in 1954, will seat 44. Series III, carrying 58 to 78, will enter service to the U. S. in 1956 or 1957.

Comets have revolutionized international air travel (page 731). They clip 15 hours off Singapore schedules.

The author predicts the first U. S. jetliner service, both transatlantic and domestic, beginning in 1956 (page 726).

BOAC

737 Bell Aircraft Corporation

Roundup Time in Texas, Helicopter Style

Half-million-acre W. T. Waggoner Ranch, which takes in parts of six counties in north Texas, has solved its cowboy shortage with a Bell Model 47-D-1 helicopter. Hovering close to the ground, the pilot flushes cattle from thickets. His flying bronco, darting in any direction, rounds up strays and drives them toward ranch hands. Secretary of the Navy R. B. Anderson, on leave of absence from his post as ranch general manager, says the copter does the work of 15 cowpokes.

Above: Pilot Sherman Kennedy (cap) and foreman Tony Hazlewood reconnoiter.

➤The helicopter's landing skid points direction of drive.

obliterated by the buzz and crackle of static.

Today the Civil Aeronautics Administration is rapidly replacing this equipment with two new radio aids. One, known as distance-measuring equipment, operating in the ultra-high frequency band, automatically determines a plane's distance from a known geographical point. The other, called omnirange, in the very high frequency band, sends out course signals over a full 360-degree circle. Together they determine the plane's position. Both are virtually static-free because of the frequency bands in which they operate.

At airports the CAA is installing many new aids, among them high-intensity lighting, improved radio instrument landing systems, surveillance radar, and precision approach radar.

A number of years will be required to complete the installations on a nationwide basis. But marked improvement at major airports already is evident, paving the way for jets.

These new devices are considered only transitional in air-traffic control. Already planned are machines, operating on the radioteletype principle, which will eliminate voice control in ground-to-air communications. Pilots will receive instructions on tape from electronic devices in the crew's compartment. Built-in safeguards will prevent the devices from transmitting a confusing or dangerous order.

Flying by Robot Control

The next logical step leads to the ultimate in airplane control, fully automatic flight. It is, of course, many years away, but CAA spokesmen and a number of other aviation leaders see it in the future picture.

Here, in general terms, is how it will work.

Ground crews, after preparing a step-by-step sequence of events for your flight, will put the information in code on a punched card. The pilot will feed the card into an electronic programing device, then sit back and watch as the ingenious robot goes to work.

It will take your plane off along an airport radio beam, switch to various omnirange stations while navigating you to your destination, then land your plane according to terminal approach and glide radio beams. Throughout your flight the robot will control the throttles and the plane's automatic pilot.

In recent years civil aircraft equipped as flying laboratories have made partially automatic flights, but much work lies ahead before the system is entirely safe and feasible.

You can be sure the robot will not replace your trusted, efficient human pilot. Mechanical brains, though they minimize the possibility of human error, cannot cope with emergencies or changes in flight plans. Man must monitor the equipment and be ready to assume manual control of the aircraft when necessary.

Today there are some 50 applications pending before the Civil Aeronautics Board for certificates to inaugurate helicopter routes.

Three companies actually are in scheduled operation. New York Airways carries mail, cargo, and passengers between three New York City airports: International, La Guardia, and Newark (page 735). It also flies regular runs between communities in New Jersey, New York, and Connecticut. Los Angeles Airways has a similar operation, and Helicopter Air Service transports mail in the Chicago area.

As yet these operations are small, but they promise to burgeon. Growth awaits big multi-engined helicopters. Such machines, developed for the military, will be rolling off commercial production lines in 1955-56, and fleets will be available by 1959 or 1960.

So promising is the outlook that operations departments of scheduled airlines contemplate a test program in which multi-engined helicopters will be used in round-the-clock operations. Details are being worked out.

Heliports: Where to Put Them?

One problem in particular looms large in the operation of rotor aircraft—heliports. Where will they be located in downtown areas? What will they look like?

Proposals are many and varied. Helicopters may operate from ground-level lots surrounded by terminal facilities. Others may fly from platforms atop reinforced roofs of office buildings. Many undoubtedly will use low-level facilities built above water.

To me this latter method seems the most promising. It has already been adopted by the Port of New York Authority. Engineers have bridged two piers along Manhattan's East River and now are constructing a heliport atop the platform. A water approach guarantees unobstructed flight paths.

Flight obstruction will be a serious problem in rooftop heliports. For instance, suppose you were operating helicopters from the roof of a 4-story building, the highest in the neighborhood. Then one day the owner of the building next door decided to tear it down to make way for a 20-story structure. If the new building obstructed your flight path, you might be put out of business in that locality.

Here is a problem not only for airlines people but for real-estate specialists. Ironclad covenants and municipal legislation involving building heights will have to be worked out in many communities before rooftop heliports can be used extensively.

Basically, however, the idea is good. Helicopters can land on roofs just as easily and safely as on vacant lots. Passengers would buy tickets in the building lobby and then

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Philadelphia Inquirer

World's Largest Transport Helicopter, Built for the Air Force, Dwarfs Older Models

Piasecki's YH-16 Transporter carries 40 soldiers, 32 litter patients, or three jeeps. A version planned for airline use will seat 48 to 72. Piasecki also builds the H-21 (hovering) and the HUP-2 (foreground).

be whisked by elevator to their aircraft.

Obviously noise would be a problem close to a heliport. But downtown locations can be found which will not be objectionable to citizens. Also, much can be done in noise abatement by routing flight paths away from certain locales. Muffling of high-powered aircraft engines is not yet practicable for economic reasons, but experts are working on the problem.

Helicopter Ideal for Short Hauls

Frankly, today's fixed-wing aircraft are not designed to compete effectively with surface transportation on trip lengths of 60 to 140 miles. Airlines generally lose money carrying people such short distances. Moreover, on abbreviated hops the airplane may not offer passengers a saving in time because terminal facilities usually lie outside cities.

These circumstances have weighed heavily on the short-haul local airlines, the operators whose routes tie into the main-line airways, and upon the growing number of air-taxi operators serving small communities.

Unlike most of the big scheduled carriers, local lines depend upon air-mail payments to make ends meet. That picture is likely to change for some local lines, particularly those serving large metropolitan centers, as the helicopter captures an increasing share of the short-haul transportation market.

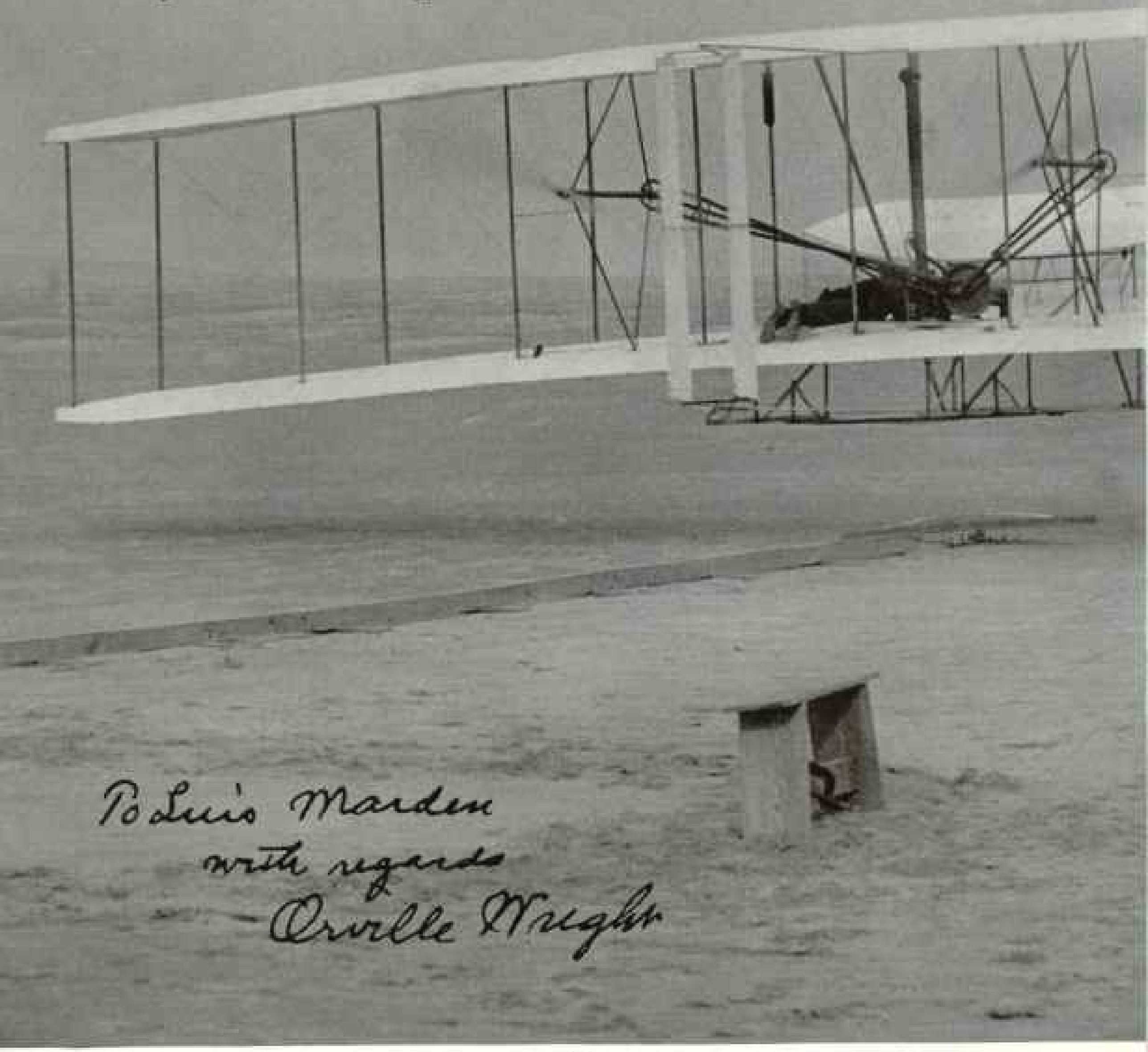
In 1932 a grateful Congress erected a 60-foot monument to the fathers of powered flight on the windy crest of Kill Devil Hill. Around the monument's base are these words:

> In Commemoration of the Conquest of the Air by the Brothers Wilbur and Orville Wright, Conceived by Genius, Achieved by Dauntless Resolution and Unconquerable Faith.

Today the aviation industry is blessed with many young men who possess the elements of genius, who are resolute, who are spurred on by faith. They are the spiritual heirs of the brothers Wright.

These men, given an era of peace, will continue the transformation of our world with the magic carpet born at Kitty Hawk.*

* The National Geographic Magazine published its first article on aeronautics, "Tetrahedral Principle in Kite Structure," by Alexander Graham Bell, in June, 1903. Since then The Magazine has printed more than 120 features on aviation subjects. Among the authors have been such distinguished authorities as Rear Admiral Richard E. Byrd, Col. Charles A. Lindbergh, Brig. Gen. William Mitchell, General of the Army H. H. Arnold, and Gen. Curtis E. LeMay. For a complete list of aviation articles, see the two-volume National Geographic Magazine Cumulative Index, 1899-1952.



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Kitty Hawk, North Carolina, December 17, 1903: Man's Dream of Flight Comes True

Ice coated the rain pools and a bitter wind whipped the sand dune of Kill Devil Hill. Two brothers—bicycle makers from Dayton, Ohio—tinkered with a frail contraption of wood, muslin, and wire. Presently they placed their device, a double-winged aircraft with a gasoline engine, on an iron-shod rail. Orville Wright lay down in the machine, grasping a lever.

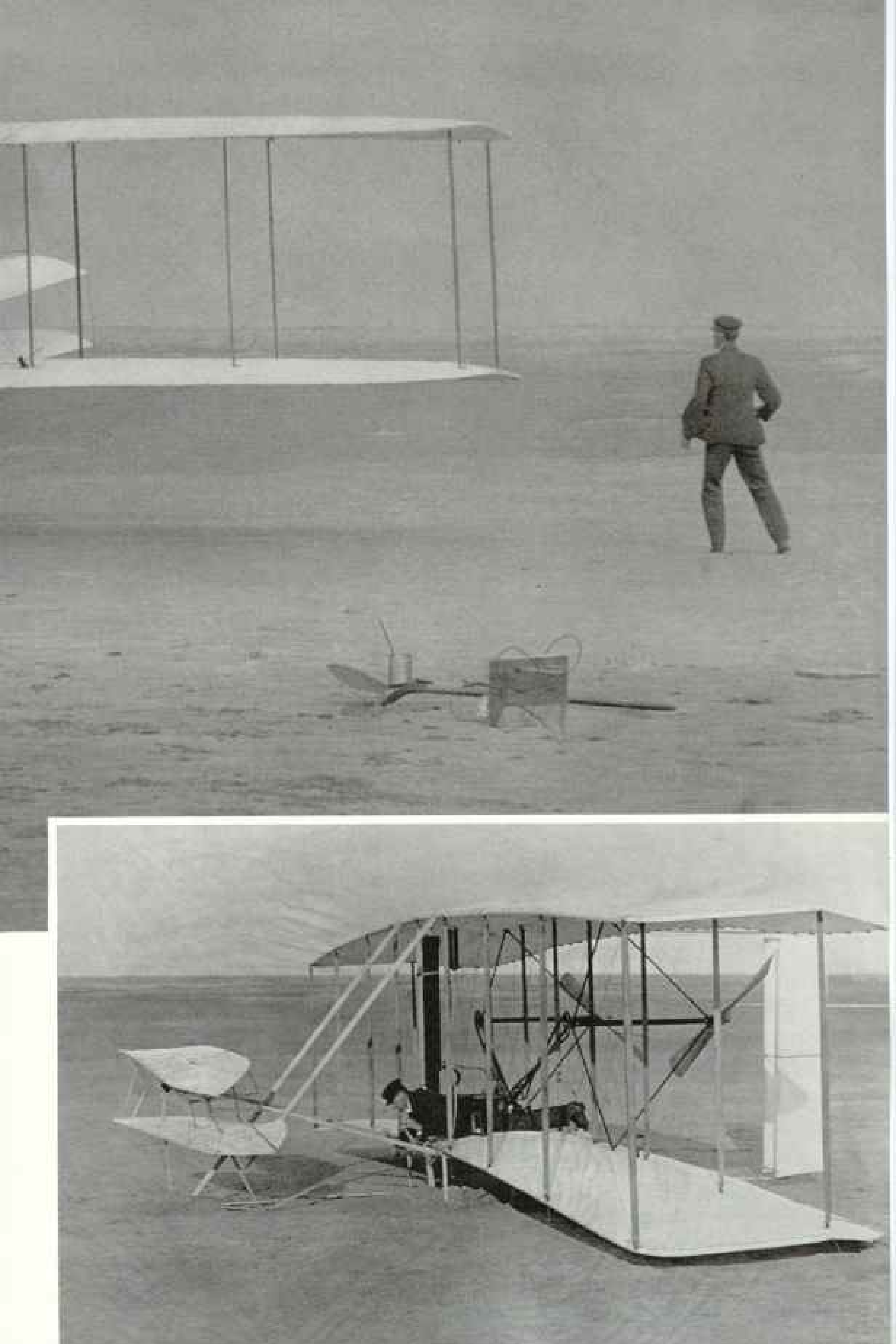
The motor coughed, then roared; two propellers turned. The *Flyer* moved slowly into the wind. Wilbur Wright ran alongside, steadying one wing until the craft rose into the air.

For 12 momentous seconds the machine stayed aloft. It was man's first successful powered flight in a craft heavier than air. Before noon on that fateful December day 50 years ago, the contraption flew three times again, once carrying its pilot for 59 seconds and 852 feet. The Wright brothers, after four years of painstaking experiment, had solved the riddle of flight, learning a secret man had coveted since he first watched the birds.

Seldom has such an auspicious event gone so unheralded. The Wrights seemed unmoved by their epochal achievement. Having flown gliders hundreds of times, they were completely confident of success. Five bystanders hardly understood the drama of the occasion. Most newspapers refused to carry the story; later they picked up an exaggerated and inaccurate account. It was years before the American public realized that a new dimension had been added to travel and gave to the Wrights the credit due them (page 742).

Some years before he died, Orville Wright presented this photograph of his history-making flight to Luis Marden of the National Geographic staff. Wilbur runs beside the lifting airplane.

➤ Wilbur, having won a coin toss, attempted a flight December 14, three days before Orville's triumph. He missed his chance to become the first flyer when the plane stalled and nosed into the sand. Ripples on this photograph were caused by the Dayton flood of 1913, which damaged many of the Wright negatives.



Photographs by Carl H. Claudy, Jr.

"Are They Flyers or Liars?" The Wrights Prove Their Case at Fort Myer

While a cynical press and public scoffed at their claims, the Wrights quietly gave up bicycle manufacture and spent full time building improved planes and making experimental flights in a cow pasture near Dayton.

Attempted exhibitions in 1904 came a cropper when wind and engine refused to cooperate. Thereafter, annoyed by public skepticism, the Wrights concealed their activities as much as possible, although by 1905 they had flown 24 miles nonstop.

At first the United States Government ignored the invention, although there was interest abroad. By 1907, however, the War Department agreed to buy a plane for $25,000 if it could fly for an hour at an average speed of 40 miles, carrying two men and enough fuel for 125 miles, and be transportable on Army wagons.

Above: In August, 1908, while Wilbur was giving triumphal performances in Europe, Orville hauled his plane to Fort Myer, Virginia. There he astounded a throng of officials by his skillful flights.

A crash (opposite, top) interrupted the tests, but they were completed a year later (opposite, lower). After six years the Wrights' struggle for recognition had brought results. In the eyes of the American public the Air Age had dawned at last.

←Orville flies at Fort Myer in the 1909 demonstrations. His brother and their mechanic, Charles Taylor, stand by a pylon whose falling weight catapulted the plane.

Photographs by Carl H. Claudy, Sr.

↑ Powered Aviation Suffers Its First Fatality: Lt. Selfridge, U. S. Army, Dies at Fort Myer

A shattered propeller brought Orville Wright's 1908 Army demonstrations to an abrupt end. The plane crashed from a height of about 125 feet. Orville suffered severe shock and fractures. His passenger, Lt. Thomas E. Selfridge, died of a fractured skull, the first person to lose his life in an airplane accident. Here an Army sergeant directs rescue operations while Maj. George O. Squier (in straw hat), Acting Chief Signal Officer, approaches. Carl H. Claudy, Sr., distinguished writer, took these historic photographs for the New York *Herald*.

↓ Evening sky silhouettes the Wright *Flyer* circling Fort Myer in a successful 1909 demonstration.

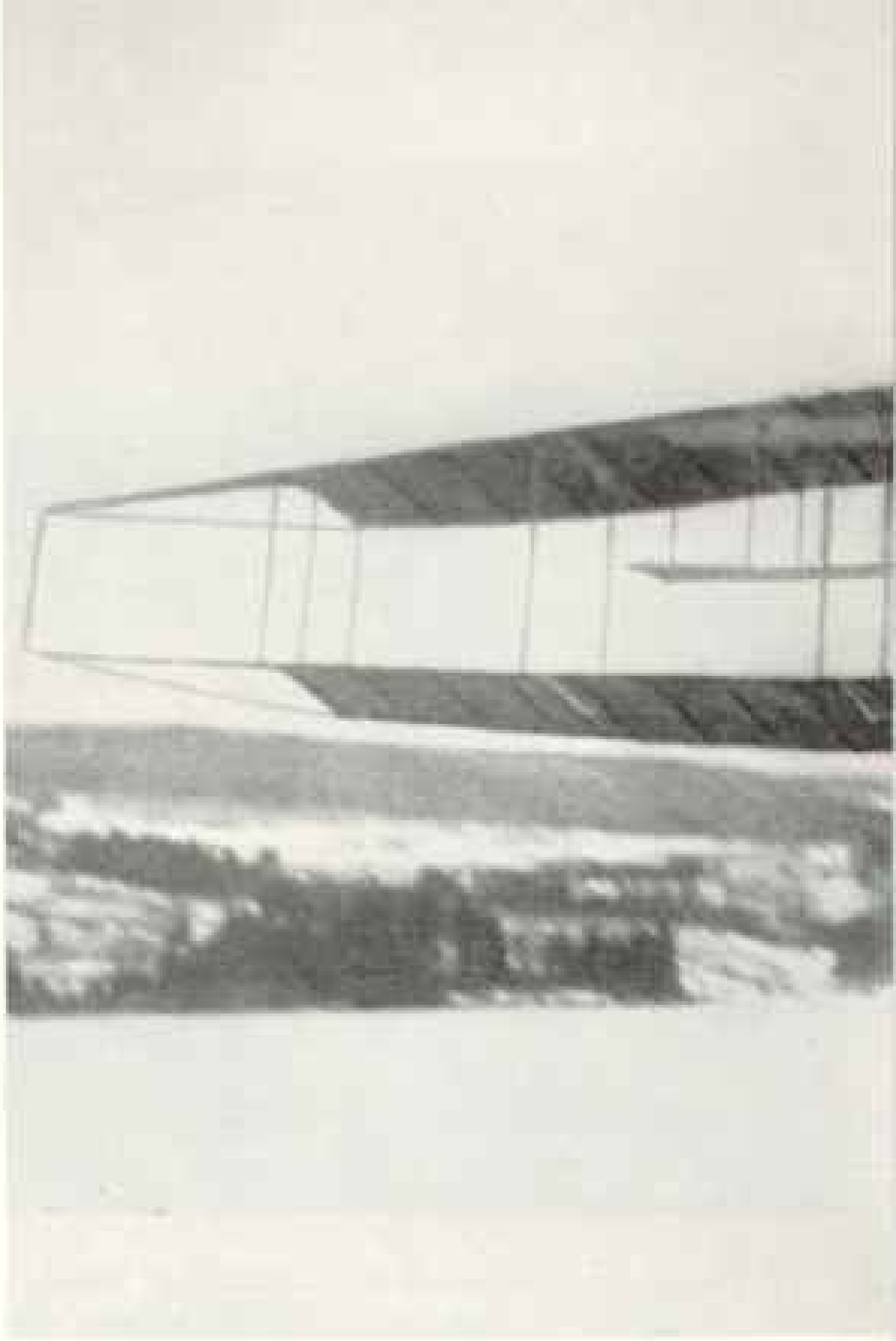
✈ John A. D. McCurdy Pilots *Silver Dart* Over Baddeck Bay, Nova Scotia, February 23, 1909—First Airplane Flight in Canada and British Empire

While the Wrights prepared to demonstrate their *Flyer* to an eager Europe, another group of pioneers was building and flying planes at Hammondsport, New York, and later at Baddeck. This was the Aerial Experiment Association, organized by Dr. Alexander Graham Bell and financed by Mrs. Bell.

The illustrious inventor of the telephone had experimented for years with enormous tetrahedral kites, hoping to find the proper design for a powered heavier-than-air craft. Believing in group research, he gathered around him in 1907 F. W. Baldwin and John A. D. McCurdy, young Canadian engineers; Lt. Thomas E. Selfridge (page 743); and Glenn H. Curtiss, a motorcycle racer and manufacturer who was called "fastest man in the world." Together these men built and flew four airplanes, all equipped with Curtiss's powerful light engines. McCurdy designed *Silver Dart*, last of the Association's four planes.

The five associates devised a hinged wing tip, a kind of aileron, whose movements controlled the plane laterally. The aileron, developed in the United States, proved more practicable than the Wrights' method of warping, or twisting, the trailing edge of the wing and became standard on all planes. However, the Wrights charged that the aileron infringed the basic principle of their wing-warping patent, and the courts sustained them.

Although the Association disbanded in 1909, it left a profound influence. Curtiss went on to become famous for flight records and for plane and engine design and manufacture.



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© H. M. Bennett

Courtesy Charles W. K. McCurdy

Drawn by Horse and Sleigh, *Silver Dart* Prepares to Make History's First Ice Take-off

The sun was shining on Canada's Baddeck Bay on the morning of February 23, 1909. Nearly 150 citizens of near-by Baddeck skimmed along on skates or stood talking in little groups. Presently a sleigh glided across the ice, towing the latest product of that group of inventors who worked at Dr. Bell's place, Beinn Bhreagh, which still overlooks the bay. Instead of skids, the new plane had a three-wheel undercarriage, and its wings tapered.

While Dr. Bell and the citizenry watched, *Silver Dart* sped across the ice, kicking up a cloud of snow as it took to the air. With John A. D. McCurdy at the controls, it flew across the wintry landscape for half a mile.

McCurdy, today the senior living pilot in the Commonwealth, can lay claim to a long string of aviation achievements. While working with Dr. Bell and the Aerial Experiment Association he became the sixth man in the United States to pilot a heavier-than-air machine.

In 1910 McCurdy won the world's biplane speed record at the second International Aviation Meet, in Belmont Park, New York. That same year he sent the world's first wireless from a plane aloft, the message going to the New York *World*. In 1911, above Daytona Beach, Florida, he received the first wireless from ground to aircraft.

McCurdy gave many demonstrations at premier aviation meets in Mobile, Atlanta, Norfolk, San Diego, and other cities. The Mobile *Register* reported on November 27, 1910: "McCurdy blew up a battleship yesterday. That is, he would have blown one up if the oranges he threw from his aeroplane had been filled with nitroglycerin and if the 12-foot squares of canvas lying on the ground in front of the grandstand ...had been the funnels of a man of war." From 1947 to 1952 McCurdy served with distinction as Lieutenant Governor of Nova Scotia.

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Canadian McCurdy Prepares to Dare the Shark-infested Crossing from Key West to Havana

On January 30, 1911, John A. D. McCurdy made the longest over-water flight, some 95 miles, from Key West to Cuba. A destroyer picked him up when his motor failed and dropped him into the sea near Havana. The use of a three-wheel landing gear as on this antique was revived in recent years for many modern airliners and warplanes.

Photograph by Marius Prieur-Branger

Lefebvre Circles a Pylon in Aviation's First International Meet: Reims, France, 1909

A quarter of a million people flocked to history's first major airplane races. They got their money's worth: 38 planes took part, and nine flew at one time. Blériot's plane caught fire and Delagrange's propeller broke in mid-air. Lefebvre dashed at the grandstand, turning away at the last moment. Records toppled during an exciting week: Latham climbed an unprecedented 508½ feet; Farman flew 118.06 miles without stopping; and Curtiss (below) burned up the course at 47.04 miles an hour, winning the James Gordon Bennett Trophy.

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Roger-Viollet

Dover's Cliffs Greet an Alien Bird as Louis Blériot Spans the English Channel

The globe began to shrink when Blériot's monoplane hurdled England's ancient moat on July 25, 1909. This exploit, performed without compass while the pilot was nursing a painful foot injury, did more to sell aviation to the world than any previous flight.

Blériot, taking off from Calais, landed 37 minutes and 25 miles later under the walls of Dover Castle. Still in his flying helmet, he talked to an agent of the London *Daily Mail*, which had offered a £1,000 prize.

Ivan Dmitri

U. S. Navy, Official

^ Sailors on Masts Watch Eugene Ely Land on History's First "Airplane Carrier"

Ely in 1911 proved carriers practicable by landing at 40 miles an hour on the stern of the cruiser *Pennsylvania*, which had rigged a deck platform scarcely wider than his Curtiss biplane. Ropes stretched between sandbags arrested his speed. Shortly after, he took off and flew 12 miles to an airfield near San Francisco.

The world's first *aircraft* carrier preceded the *Pennsylvania* by half a century. During the Civil War the *G. W. Parke Custis*, a remodeled coal barge, carried an observation balloon to spy on Confederate positions across the Potomac.

^ First Transcontinental Flight: *Vin Fiz Flyer* Advertises a Drink

Calbraith Perry Rodgers bridged the United States in 1911, flying from Long Island to Pasadena in 49 days, then as an afterthought on to Long Beach. He covered some 4,250 miles in 70 hops. Actual flight took about 82 hours; today's jet record is 4 hours 13 minutes. Sixteen accidents caused so many repairs that only the rudder and two wing struts were left of the *Vin Fiz* original. Its rudder sign publicized a soft drink whose manufacturer sponsored the flight. Rodgers was a grandnephew of Commodore Matthew Calbraith Perry, U. S. Navy, who opened Japan to the West.

Brown Brothers

National Archives

▲ Rickenbacker, America's Ace of Aces in World War I, Looks over His Spad

When Eddie Rickenbacker went to France in 1917 as General Pershing's staff driver, he was already famous as an auto racer. His knowledge of motors helped get him into flying, and he quickly rose to be commander of the 94th Aero Pursuit Squadron. Pilots idolized him for spectacular air duels; his leadership put the Hat-in-the-Ring Squadron ahead of all other American outfits. He was credited with downing 26 planes and balloons in seven months. The Congressional Medal of Honor recognized his valor. Today Rickenbacker heads Eastern Air Lines.

▼ Commander-to-be of Army Air Forces Pilots a Wright *Flyer* in 1912

Early in 1911 a West Point graduate named Henry H. Arnold (right) reported to the Wright brothers' flying school near Dayton. That year he became the 29th pilot licensed in the United States. In 1912 he made headlines by setting an Army altitude record of 6,450 feet. A five-star general by 1944, he played a major role in establishing an independent Air Force. General Arnold died in 1950. He was a member of the National Geographic Society's Board of Trustees for many years. His companion here was Lt. Follett Bradley, who also became a general.

U. S. Air Force, Official

Langley's Aerodrome Proves the Possibility of Mechanical Flight

Of all the scientists who sought to unravel the mysteries of flight, none saw success more cruelly withheld than Dr. Samuel P. Langley, Secretary of the Smithsonian Institution, 1887 to 1906.

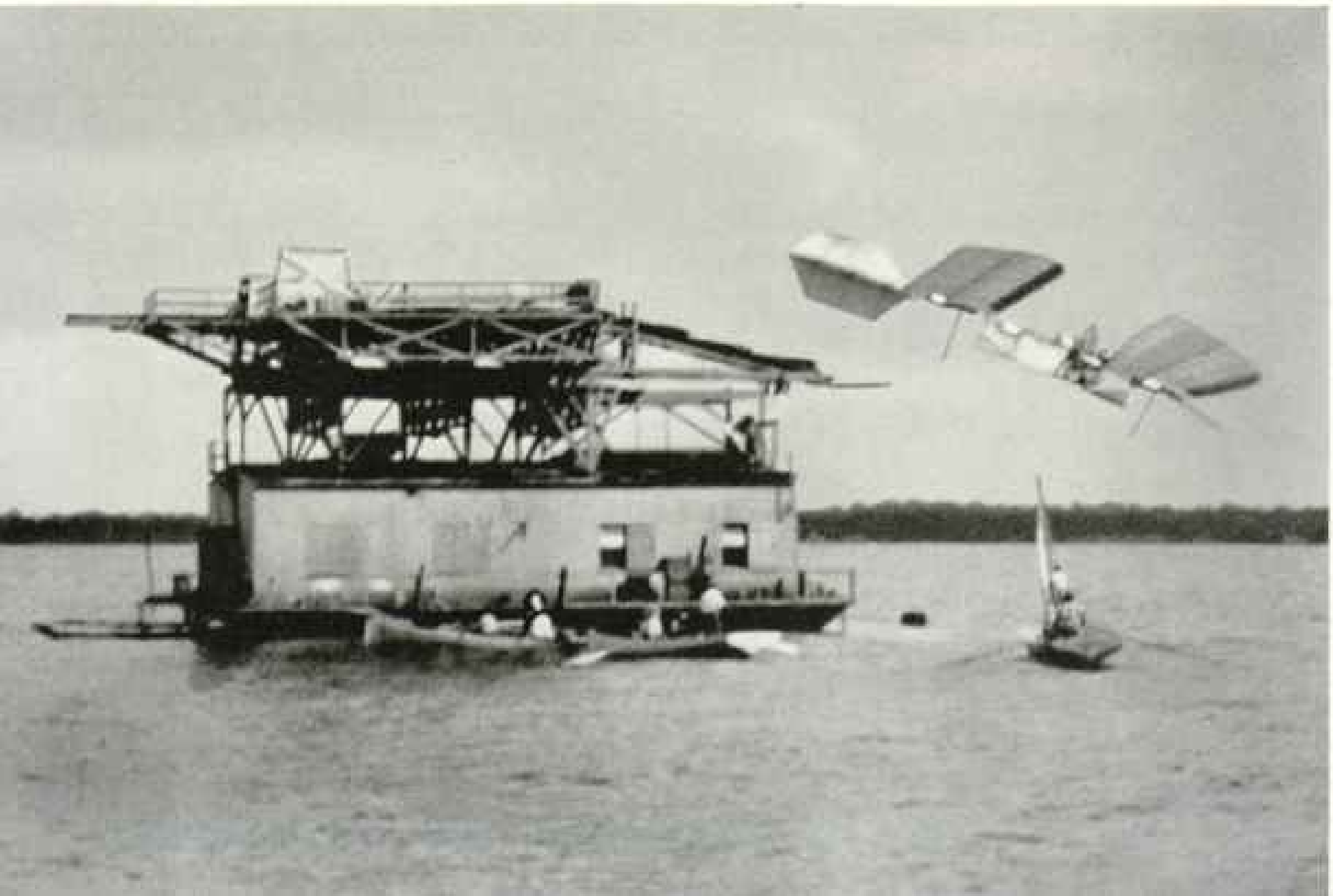
After extensive experiments in aerodynamics, Langley in 1896 designed this 15½-foot-long, steam-powered model "aerodrome" and launched it without a pilot above the Potomac River. Alexander Graham Bell, who watched it circle majestically for ⅝ of a mile and alight gracefully, wrote: "Anyone who saw it . . . must have felt that the age of the flying machine was at hand."

But bad luck dogged Langley's every attempt to launch a man-carrying aerodrome. Nine days before the epochal Wright flight in 1903, the scientist reluctantly gave up his experiments in the face of savage ridicule. Broken-hearted, he died in 1906.

Langley's work, however, gave significant encouragement to such pioneers as the Wrights, Bell, McCurdy, and Curtiss (pages 744, 745, 746).

Alexander Graham Bell

▼ October, 1903: The full-scale aerodrome plunges from Dr. Langley's Potomac houseboat after catching in the launching mechanism. Another attempt two months later met a similar fate. In 1914, after important modifications, Langley's craft did fly, with Curtiss at the controls.



National Archives

Santos-Dumont, in France, Mistakenly Thought His Plane Was First to Fly

Brazil's Alberto Santos-Dumont, famous in Europe and America in the early 1900's for balloon and dirigible exploits, flew this powered box kite successfully in 1906. The apparent tail (right) was the nose. So little known were the Wrights' earlier achievements that Paris hailed the diminutive daredevil as the world's first flyer. Another of his planes, the 259-pound *Demoiselle*, was the lightest ever built.

1917: Royal Flying Corps Pilots Train in Curtiss Jennies

Many a World War I pilot remembers affectionately the plane in which he learned to fly, the Curtiss JN-4, commonly known as Jenny. Although temperamental, this biplane was highly successful. After the war, Jennies sold for as little as $300; sometimes flying schools offered a new Jenny and flight training in a $500 package. Barnstormers using these planes aroused tremendous interest in aviation.

Brown Brothers

U. S. Navy, Official

Navy and Army Tame an Ocean and Girdle the Globe

▲ On May 16, 1919, three Navy seaplanes took off from Newfoundland, hoping to conquer the Atlantic. Two failed to complete the trip, but the NC-4 with a crew of six reached Lisbon via the Azores in 11 days, then flew on to Plymouth, England. It was the first aircraft to cross any ocean. Destroyers at 37-mile intervals patrolled the course. Amid ovations in Paris, President Wilson advised the flyers "not to get too high, for the higher you get the harder the fall will be." Navy men here check the NC-4 at Lisbon.

◂ When the U. S. Army Air Service announced plans to fly around the world in 1924, one observer opined that the pilots "might as well crook a toe in a trigger and get it over with." But two of four planes completed the 26,345-mile trip in 175 days. Here at Santa Monica, California, the flag plane *Seattle* prepares to take off for its namesake city, starting point for the flight. Three weeks later it crashed in Alaska.

Courtesy George Palmer Putnam

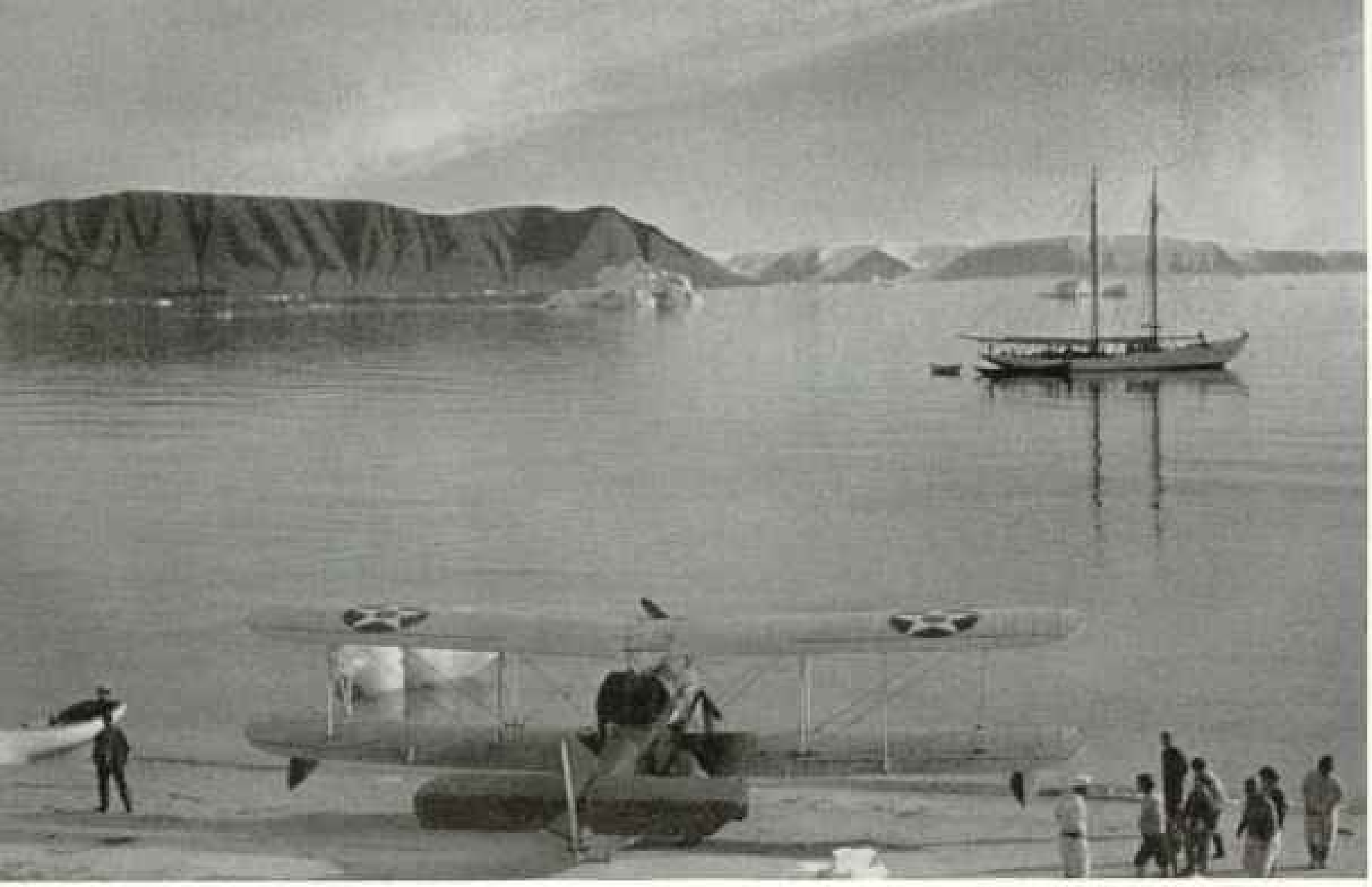
Admirers Mob Amelia Earhart After Her Nonstop Flight from Honolulu

Miss Earhart was the world's most famous aviatrix when she disappeared at sea in 1937 in an attempted round-the-world flight. She was the first woman to fly the Atlantic solo and to cross the American Continent nonstop. Her flights, her books, and her striking personality made her the idol of the crowds and gave tremendous prestige to aviation. Here she lands in Oakland, California, after her 1935 flight from Hawaii, the first solo over this route made by either man or woman.

England to Australia: Ross Smith Connects a Far-flung Empire in 1919

A $50,000 prize offered for the first flight of 30 days or less from London to Australia stirred Captain Smith of the Royal Flying Corps to attempt an 11,000-mile jump across Europe, Asia, and the East Indies. Flying a Vickers-Vimy bomber with three companions, Smith made the trip in 28 days. Collision with a hawk near Calcutta almost smashed a propeller. In Java the plane escaped from heavy mud by using an emergency runway of bamboo mats commandeered from homes.

Frank Hurley



Photograph by Maxwell Owen Williams

Richard E. Byrd: First to Fly Above the Poles

Rear Adm. Richard E. Byrd, recently elected a Life Trustee of the National Geographic Society, was first to make polar explorations by plane. From the air he discovered more than a million square miles of the earth's area.

In 1925, with Comdr. Donald B. MacMillan, he flew some 6,000 miles on an Arctic expedition sponsored by The Society in cooperation with the U. S. Navy. Next year he and Floyd Bennett flew from Spitsbergen to the North Pole and back.

After hopping the Atlantic in Lindbergh's wake, Byrd led the first of his expeditions to Antarctica and in 1929 circled the South Pole with three companions.

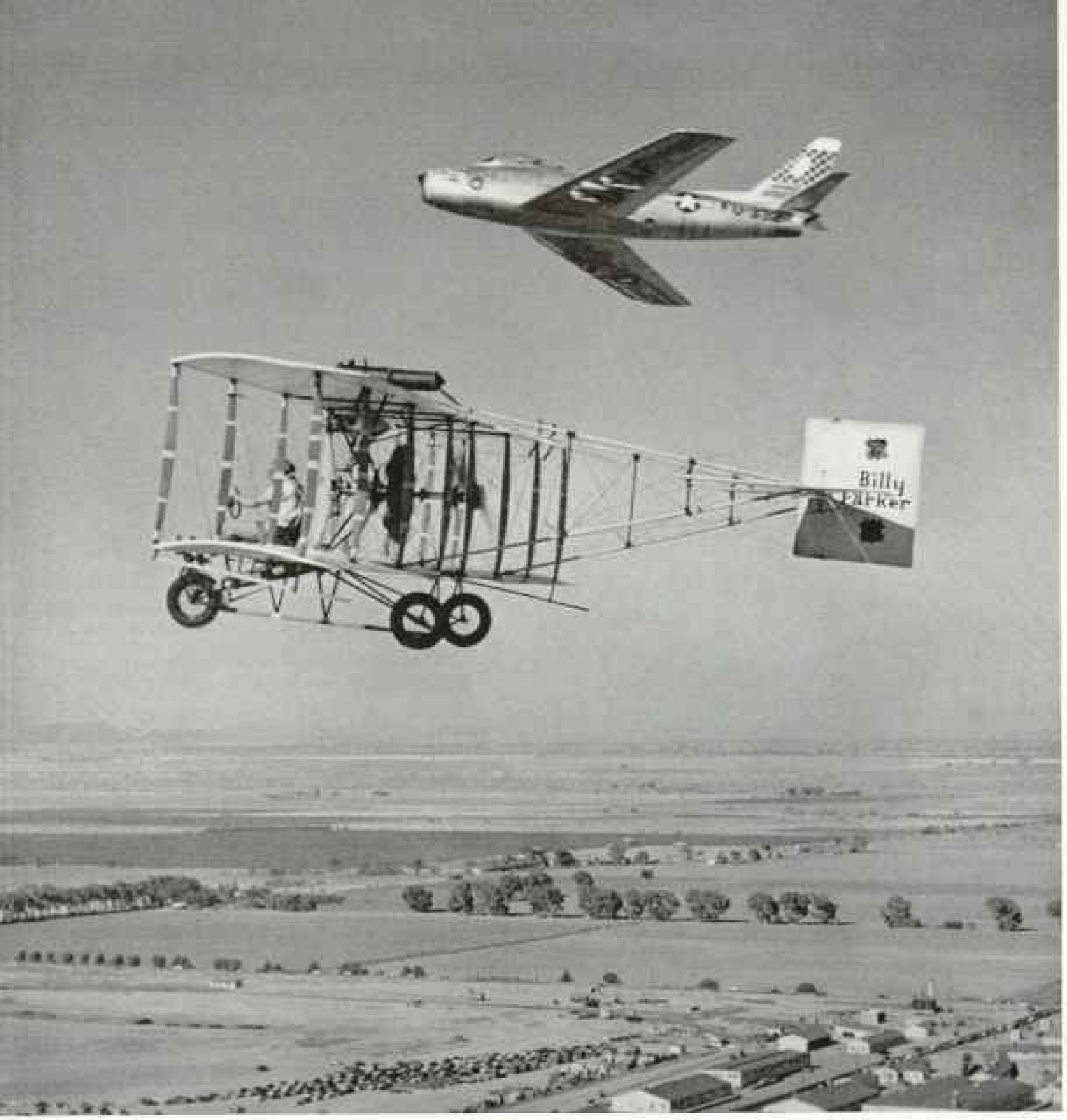
Above: Byrd's NA-1 and MacMillan's *Bowdoin* take shelter in Robertson Bay, Greenland, 1925.

< Planning his first Arctic expedition, Byrd asked the late Albert H. Bumstead, The Society's chief cartographer, for help in constructing a device that would simplify navigation in areas where the North Magnetic Pole made magnetic compasses useless. Mr. Bumstead solved the major problem in his home workshop, designing and building the Bumstead sun compass, here held by Byrd. The explorer returned it after his North Pole flight in 1926 with this inscription: "To Albert H. Bumstead—for getting us there!"

Donald E. Keyhoe; I. N. P.; Underwood and Underwood

A Man, a Plane, and an Ocean: Lindbergh Flies New York to Paris

Seldom has the world displayed such torrents of mass emotion as the Lone Eagle aroused by his 33½-hour solo flight across the Atlantic in 1927. Overnight his Ryan monoplane (above) and his shy smile became known to millions. He waved goodbye (left) on leaving New York and received a hero's welcome (below) at Croydon Airport, London, a week after the Paris landing. His feat gave aviation an immeasurable stimulus.



North American Aviation, Inc.

Four Decades of Air Progress: A Sabrejet Whistles Past a 1912 Pusher

"When peace comes, thousands of men and thousands of planes will be required for the mail service of the future, for policing the air, for aerial coast patrol, for aerial map making by means of aerial photography, for exploration, and for rapid transit of passengers and freight." When Robert E. Peary made this observation in wartime 1918, he could hardly have foreseen the frightening speed with which his predictions would be fulfilled and surpassed.

Peary's forecast was made at a time when a flight from Chicago to New York was dreaded for its hazards; when night flights were virtually unknown; when airports were scarce and commercial flights exceedingly rare.

How fast man has advanced in understanding the nature of flight is strikingly illustrated by these two planes over Luke Field, Arizona. Billy Parker's half-ton Curtiss was built chiefly by hand. North American's 7-ton F-86 Sabrejet was produced on the assembly line from 14,000 parts. The 1912 pusher biplane draws on 80 horsepower in doing a mile a minute. Sabre's General Electric turbojet engine delivers nearly 6,000 pounds of thrust, equal to about 12,000 horsepower at top speeds of more than 700 miles an hour. While the pusher's operator sits in the breeze and hedgehops, Sabre's pilot rides a pressurized cockpit to 45,000 feet and more.

Already experimental planes have exceeded 1,200 miles an hour. At these supersonic speeds, friction generates heat ranging up to 300° F. on the plane's skin. Most metals creep, and their strength seeps away (page 765).

As man looks forward to fleets of supersonic jet bombers and transports, to atom-powered aircraft, and to interplanetary flights, he cannot help pondering Orville Wright's words: "Isn't it astonishing that all these secrets have been preserved for so many years just so that we could discover them!"

Fact Finding for Tomorrow's Planes

A Little Fan-in-a-box Wind Tunnel Made Possible the Wrights' First Flight; Now Screaming Supersonic Winds Test Weird Shapes of Aeronautical Things to Come

By Hugh L. Dryden

Director, National Advisory Committee for Aeronautics, and
Life Trustee of the National Geographic Society

With Photographs by Luis Marden, National Geographic Staff

THE onsweeping stream of aeronautical progress has two aspects, one in the public view and familiar to all, the other more subtle.

The first is a succession of new and improved aircraft which establish the ascending series of performance records described in the daily press. Here are exploits by the spiritual descendants of Orville and Wilbur Wright, who transformed man's vision of human flight into reality at Kitty Hawk, North Carolina, on December 17, 1903.

The second aspect of aeronautical progress is the growing store of human knowledge that underlies and makes possible the practical accomplishments. This foundation is continually being deepened and broadened by research in the aeronautical sciences.

First Plane "Born in a Box"

The practical achievements of the Wrights were made possible by their own less-known activity in the field of research. Without it they could not have flown at all.

"Except for what we learned from our wind-tunnel experiments in 1901, we never could have built wings that would lift the machine and pilot with the amount of motor power then available," Orville Wright explained.

Their tunnel was little more than a box about as long as a coffin and 16 inches wide and high, with a fan that stirred a 27-mile-per-hour wind. But it proved that earlier tables of wind pressure were wrong and enabled them to design the wings—curved, or cambered, instead of flat—that first lifted men from Mother Earth in a powered, heavier-than-air plane. Thus the first successful plane sprang like a genie from a little box with a feeble fan at one end (page 765).

On this Golden Anniversary it seems appropriate to review this second aspect of aeronautical development, with which I have been associated all my life, and to assess our present position and the direction in which we are moving.

The airplane and I grew up together. Fifty years ago, when Orville and Wilbur first flew, I was five years old. I remember well the first airplane I ever saw. It was an Antoinette monoplane flown over Baltimore in 1910 by Hubert Latham, brilliant aviator, pioneer sportsman, and big-game hunter, who lost his life a year and a half later, not in an airplane but on the horns of a wounded wild buffalo in the French Sudan.

The flight and the accompanying discussion in the press stimulated me to my first aeronautical paper at the age of 12. Under the title "The Advantages of an Airship over an Aeroplane," I set forth that in the case of the airplane "the least break in the machinery will hurl the aviator to the ground" whereas "the airship has a gas bag to support it." I continued that "airships have the advantage of carrying many passengers, but the aeroplane can only carry one."

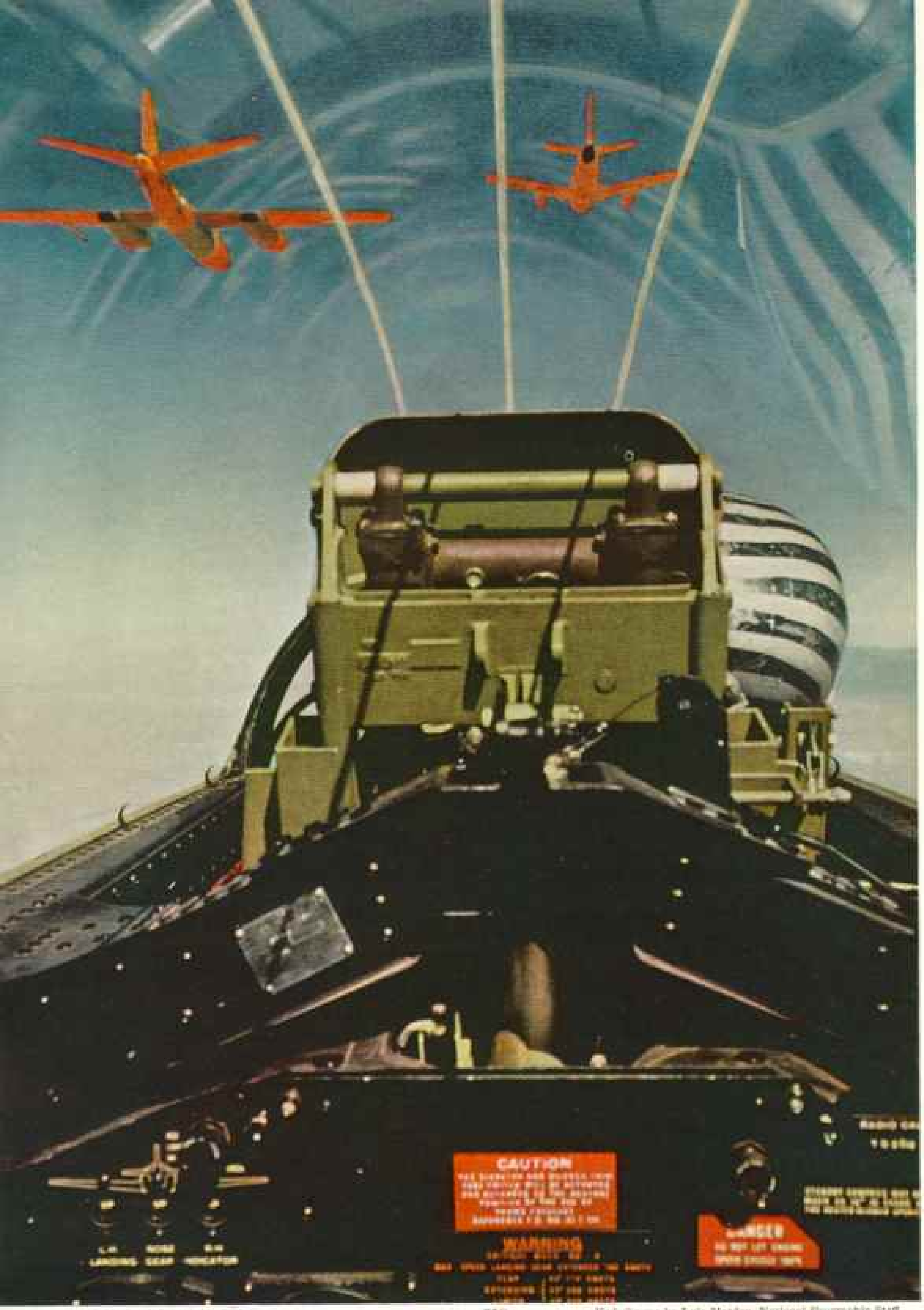
These statements, and the general conclusion that "the airship has the greater advantage for commerce and exploration, while for the sportsman the aeroplane would be the better," have been shown to be false by developments of the first half century, but my paper reflected the currently held views.

The Antoinette monoplane, designed and built in France, weighed about 1,250 pounds when fully loaded. Its maximum speed was 47 miles per hour. The engine was an 8-cylinder V type of about 50 horsepower.

Thus the first airplane I ever saw had four times the power of the original Wright plane, nearly 70 percent greater weight, and 50 percent higher speed. So much had the art advanced in seven years.

Speed Hits 1,238 Miles an Hour

By the time I made my first flight in an airplane—at Washington, D. C., in 1919—further great strides had been made. The plane was a Curtiss Eagle, piloted by Bert Acosta. This 8-passenger "aerial limousine, with plywood cabin giving full protection from wind, and reduction of noise so as to permit conversation," was one of the first American trimotored airplanes, powered by three Curtiss engines of 150 horsepower each. The weight was about 7,500 pounds and the maximum speed 107 miles per hour.



Kodachrome by Luis Marden, National Geographic Staff

Glowing Warplanes Play a Serious Game of Hide-and-seek in Desert Skies

Seen from a T-33 jet trainer, a Sabrejet (right) prepares to track down a B-45 bomber with radar over Rogers (Muroc) Dry Lake, California. Fluorescent paint distinguishes them from other experimental aircraft.

As compared with the Antoinette monoplane of nine years earlier, the Eagle biplane had more than double the speed, nine times the power, and six times the weight.

From these beginnings I have seen developments proceed along many lines. Some, such as the Diesel-engined aircraft and the Autogiro, have faded and died: others, such as jet propulsion and the helicopter, have surged forward in expanding accomplishment.

Speed has reached an amazing 1,238 miles per hour in the Douglas Skyrocket, an airplane developed for high-speed research under a joint military-industry-National Advisory Committee for Aeronautics program.

Gross weight has reached 358,000 pounds in the Convair B-36H bomber, with the equivalent of more than 44,000 horsepower at a speed "exceeding 435 miles per hour."

Our Navy's F4D, the Douglas Skyray jet fighter for carriers, averaged 753.4 miles per hour in four passes over a measured course on October 3, 1953 (page 768). This surpassed records set in rapid succession by the U. S. Air Force's North American F-86 and Great Britain's Hawker Hunter and Vickers Supermarine Swift. Our North American F-100 fighter flies at supersonic speed in level flight.

The British are pioneering in the field of turbojet transport, and their Comet cruises at nearly 500 miles per hour (page 736).

It's a Rare Plane That Knows Its Father

These present and all future generations of aircraft embody the cumulative total of knowledge in many fields of science and technology. Just as tracing a person's family tree leads to awareness of an ever-widening chain of ancestors whose genes have contributed to his physical and mental make-up, so each new aircraft reflects the research and experience of hundreds or even thousands of people at many institutions in many countries.*

For a number of years after the first flight, it was possible for any individual to learn all there was to be known about aeronautics and aircraft design. As recently as 1918, when I was working for my doctoral degree, I was assigned the task of reading and summarizing the knowledge of the physical principles employed in aeronautics.

The situation soon changed. Today it would be very difficult, if not completely impossible, for any one man to design a plane. Our new airplanes are the final product of a large organization of many specialists.

Much of our present work is secret, but here are some examples from the past:

During World War II the Germans captured one of our P-51 Mustang fighters and measured its performance. They were astounded because their tests showed that "the Mustang is far superior aerodynamically to all other airplanes." The Mustang wing was of a type first developed at the NACA in the years just before the war, a type known as laminar-flow wings. The NACA has designed and tested many "families" of wing sections, and most airplanes now flying use wing shapes of one of these families.

In early planes, including Lindbergh's *Spirit of St. Louis*, the engine cylinders extended freely into the wind stream, giving effective cooling but high drag. Research begun in 1927 led to the development of a metal cover over the engine—commonly known as the NACA cowling—which gave satisfactory cooling and greatly reduced drag.

In 1932 the NACA reported the results of a study to determine the best location of the cowled engine nacelle, and this location is still used in all modern piston-engined transports.

Newton "Proved" Flight Impossible

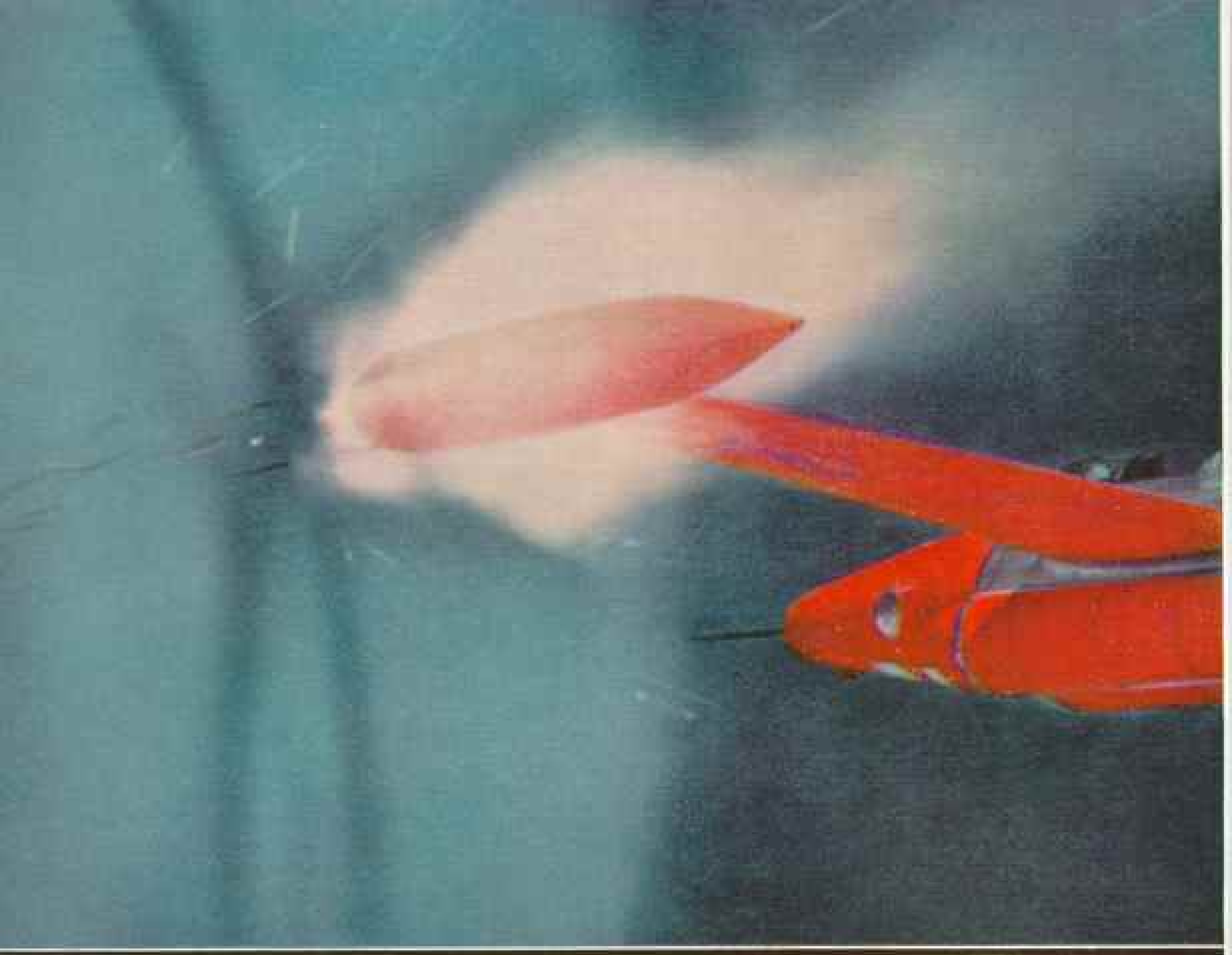
If any field of science is to be considered dominant in aeronautics it is aerodynamics—the study of the flow of air and the forces exerted on bodies moving through it. In such research our goal is to determine the best external shape of the airplane to give the desired lifting force with minimum drag and to provide satisfactory stability and control.

Isaac Newton in 1687 regarded air as made up of small particles moving independently. According to a formula he devised for determining the force of the wind on inclined surfaces, mechanical flight was impossible.

Early experimenters interested in the probability of flight tried many methods for measuring the lifting power of the air. Some, such as Otto Lilienthal in 1889, mounted surfaces of different shapes on scales and exposed them to the breeze. Others dropped models from high structures such as the Eiffel Tower or mounted them on cars or whirling arms. But natural wind is notoriously fickle, a large volume of still air is hard to find, and the moving car or arm produces disturbing air currents; so these methods have been abandoned except for special purposes (page 761). Best for most needs is man-made wind blowing through a tunnel (pages 763, 769, 774, and 775).

The first wind tunnel of which we have record was designed by F. H. Wenham about 1870 as an activity of the Aeronautical Society of Great Britain. It was 18 inches square, 10 feet long, and equipped with a 30-inch fan. The models were one foot square, and we now know they were too large in rela-

* See "New Frontier in the Sky," by F. Barrows Colton, NATIONAL GEOGRAPHIC MAGAZINE, September, 1946.


NACA
TEST
NACA III

Scorpion Fires Clusters of Dark Rockets from Flaming Wing-tip Pods

Northrop's F-89D all-weather interceptor flies faster than 600 mph. Its electronic eyes and nose search out an enemy in any kind of weather, day or night. Nearly as big as World War II's medium bomber, this fighter carries pilot and radar observer. Scorpion is the most heavily armed fighter-interceptor in the United States Air Force. With its 104 rockets, it stands guard against air invaders. A direct hit by a single rocket can destroy a bomber. Wing tips blaze like comets on firing runs.

This Rocket-shaped Model Will Fall 7 Miles

Scientists attach an instrument-packed drop model beneath a Northrop Black Widow at Ames Aeronautical Laboratory, an installation of the National Advisory Committee for Aeronautics near San Francisco. Released high above Rogers Dry Lake, the model will plummet from subsonic to transonic and supersonic speed. Peering from an eye within the fuselage, a motion-picture camera will record deflection of the falling airfoil. On some drops radar and optical equipment at ground stations continuously track the model during its plunge to earth.

An umbrellalike dive brake and a parachute, opened successively by automatic mechanism, slow down the model so that it merely buries its nose on impact.

The drop technique, evolved to test airfoils before perfection of transonic wind tunnels, still is used to solve certain problems.

Photographs and Illustrations by Luis Marden, National Geographic Staff, and Northrop Aircraft, Inc.

tion to the tunnel size to give accurate data.

Today the wind tunnel has become our most valuable research tool, and its growth in size and power matches the tremendous advance in performance, size, and complexity of planes.

Wind tunnels vary greatly in size and speed. Some have test sections only a few inches across, with wind speeds up to 6,000 miles per hour. One has a test section 40 by 80 feet through which the wind roars at a speed of about 250 miles per hour (page 764).

The wind tunnels now most in demand for NACA tests of the final design shape of our newest airplanes are the transonic tunnels with winds of about 760 miles per hour, the speed of sound at sea level. At transonic speeds the air flow is mixed, part slower than sound, part faster than sound. We still lack the mathematical means for predicting aerodynamic behavior in the transonic range and therefore must get our information experimentally.

Wind tunnels providing transonic and supersonic test speeds require large amounts of power. The largest of the NACA's supersonic tunnels (at the Lewis Flight Propulsion Laboratory, Cleveland) has a test section 6 by 8 feet and an operating speed twice that of sound. It is powered by three electric motors with a total of 87,000 horsepower.

Under construction today at NACA laboratories and at the Air Force's Arnold Engineering Development Center, Tullahoma, Tennessee, are five larger supersonic tunnels. One will reach a speed five times that of sound, or more than 3,000 miles per hour. Each of three will be powered by electric motors of more than 200,000 horsepower.

These supersonic tunnels must be heard and seen to be appreciated. As long ago as 1923 I was experimenting with propeller tip sections in a sonic-speed jet of air at General Electric's Lynn, Massachusetts, plant. Afterward when my colleagues and I walked out into the streets, we noticed that passers-by seemed unusually interested in our group. We later realized we had been unconsciously talking in very loud tones to compensate for the temporary deafness caused by working for several hours with our heads a few inches from a 12-inch sonic jet.

Tools Include Supersonic Rockets

Modern aerodynamic research uses other tools to advance our knowledge of transonic and supersonic flight. At the NACA Wallops Island station, on the Atlantic coast just south of Chincoteague Island, of wild pony fame, models of airplanes and missiles are propelled to supersonic speeds by rockets (page 778). Instruments in the model automatically radio the data we need.

Still another experimental method led to the first supersonic flight by man—by Capt. (now Major) Charles Yeager of the U. S. Air Force in the Bell X-1 at Edwards Air Force Base, California, on October 14, 1947. This method is the use of special research airplanes to provide experimental data beyond the range of performance attainable in tactical military or commercial planes (pages 766, 771).

Some of these planes, such as the rocket-powered Bell X-1 and Douglas D-558-2, are carried aloft by mother aircraft to conserve their fuel for brief moments of high-speed supersonic flight at high altitudes. Thus we can explore ever-new frontiers of higher speeds and altitudes, gaining information needed for designing tactically useful supersonic planes.

The NACA has extensive installations at Edwards, on Rogers (Muroc) Dry Lake.

High Speeds Bring "New-look" Planes

The pilots of military aircraft at the beginning of World War II discovered in practical flight what aerodynamic research workers had known long before—that speeds approaching that of sound introduce new problems and a need for different external shape.

At such speeds, air no longer flows freely but piles up ahead of the plane. Shock waves appear, and the drag of the best subsonic shapes increases enormously—so much so that the speed of sound came to be regarded as a "sonic barrier" (page 774). Planes became unstable and went out of control, sometimes with fatal results, when compressibility effects were first encountered.

For the new high speeds made possible by jet and rocket power, drastic changes had to be made in aircraft designs. Some of these "new-look" planes are pictured herewith.

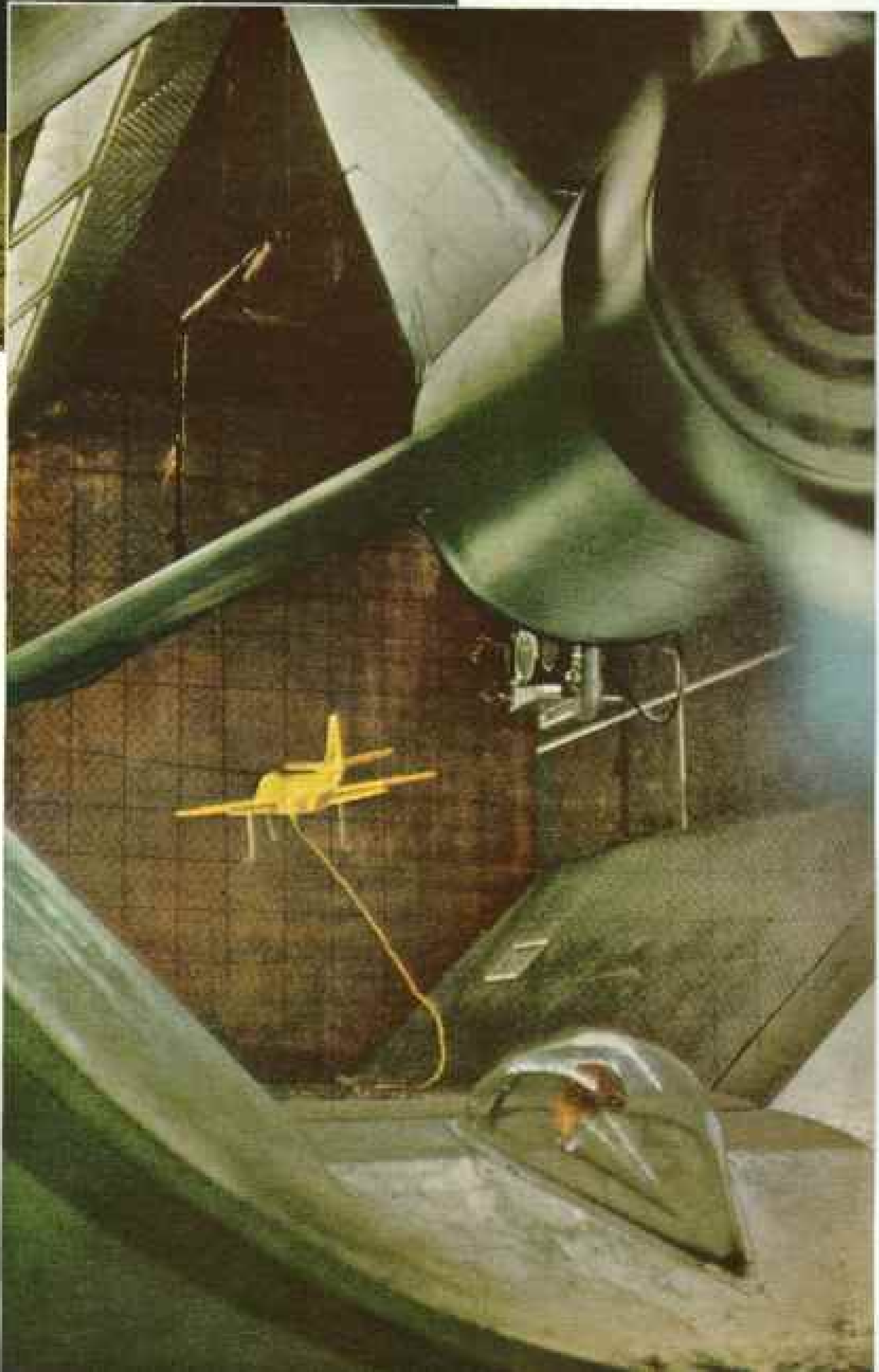
As a member of a special team from the U. S. Air Force Scientific Advisory Board, I spent V-E Day at the secret German aeronautical research laboratory at Völkenrode near Braunschweig. There we saw planes and models with sharply swept-back wings—like those of our present F-86—and many reports on this arrow-wing, or *Pfeilflugel*.

At the time, I was a member of the staff of the Bureau of Standards and did not know that R. T. Jones of the NACA had independently realized the advantage of sweepback for sonic speeds and had made tests in wind tunnels to verify his theories before the German information was available.

Another new shape is the triangular, or delta, wing, and we shall probably see additional airplanes using this configuration (p. 764). As higher supersonic speeds are attained, still other shapes will appear. I believe, for example, that wings will be shorter and wider, smaller compared with the body,

Flying Venetian Blind Goes Straight Up

The vertical-riser airplane uses conventional wings and propellers but takes off in direct ascent. Four highly cambered airfoils deflect the propellers' airstream down, giving vertical lift. The model illustrates the basic principle of the convertiplane, which takes off vertically, tilts wings forward, and proceeds horizontally. Some designers think the convertiplane may be one answer to operation of airliners from small fields. This model flies at the NACA Langley Laboratory in Virginia.



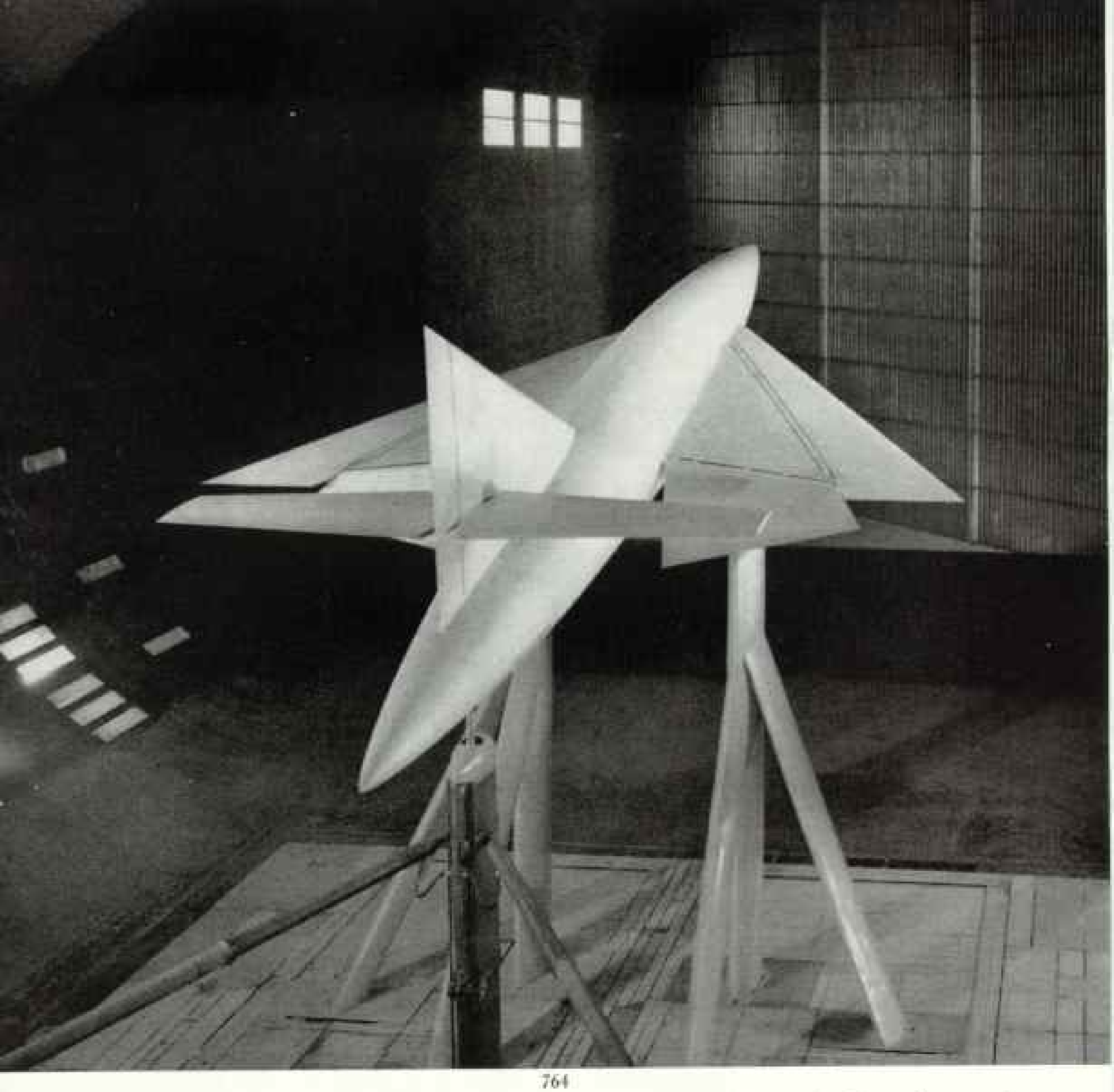
A Free-flight Model Hangs in Moving Air

Langley Laboratory's spherical wind tunnel must be the dream of any boy who builds model airplanes. The pilot sits under a plastic canopy and operates this model flying ahead of him. Electric impulses sent through the trailing wires transmit his control movements to the model, which yaws nervously from side to side.

This chamber is built in the form of a hollow ball so that air may circulate continuously without turbulence. The test tunnel (shown) hangs on supports inside the sphere; it is tilted downward so that the model is in a constant glide.

Air sucked past the model by the tunnel's huge propeller (foreground) flows smoothly up and around the sphere's curving walls and re-enters the test tunnel.

Kodachromes by Luis Marden, National Geographic Staff



and thinner, with sharp leading edges. Many promising ideas for piloted planes and guided missiles are under study in the aeronautical research laboratories of the world.

The best shape for transonic or supersonic speeds usually has poor characteristics at subsonic speeds. But supersonic airplanes must take off at relatively low speed and fly at all speeds from subsonic to supersonic.

Designers are solving the acute landing problem by varying the shape during flight, for example by movable flaps such as are used on conventional transport airplanes in landing, by flaps at the leading edge of the wing, and in a few cases by actually varying the sweep angle of the wing (page 769).

A branch of science related to aerodynamics, and companion to it in the development of many aircraft, is hydrodynamics, which deals with the forces exerted on bodies moving through water. Water-based aircraft are of great military value to the Navy for certain types of missions. Their performance has improved substantially during the first half century. Changed emphasis in design and new hydrodynamic knowledge have transformed the slow and heavy "ugly duckling" to an aerodynamically fair and fast "swan" with excellent water-handling characteristics.

Recent research by the NACA, the Navy, Convair, and others has led to the successful development of hydro-skis, relatively small elongated surfaces which permit high-speed water-based aircraft to land and take off on water and on snow or sod. The Sea Dart is the first high-speed military water-based airplane with hydro-skis (page 778).

If the proper external shape of the airplane —dictated by aerodynamic and hydrodynamic knowledge—is the first consideration of the designer, the second is surely that of the materials which make up the airplane and

Luis Marden, National Geographic Staff, and NACA

Wooden Box to Giant Steel Tunnel: Half a Century of Flight Research

To study aerodynamics, the Wright brothers in 1901 built a 16-inch-wide wind tunnel (page 757). Many years later fire ruined their handiwork. Franklin Institute, Philadelphia, preserves this reproduction. The tunnel's balance, which supported the airfoil, is the original. Fashioned from hacksaw blades, it was salvaged from the fire. Air-straightening honeycomb (rear) remains a valid principle today (opposite).

◂ Ames Aeronautical Laboratory's 80-foot-wide test section, the largest known, holds models even bigger than this 50-foot 2½-ton delta wing. It permits examination of supersonic airfoils at speeds up to 250 mph to solve landing and take-off problems.

their arrangement into lightweight structures of adequate strength.

When I first came in contact with airplane construction in 1918, materials and methods had changed but little from those used by the Wrights. The body of the airplane was of wood and metal construction. The whole was covered with canvas or linen, or with very thin panels of veneered wood.

During World War I, especially in Germany, all-metal construction was developed. A new material, duralumin, an alloy of aluminum with copper and small percentages of other metals, was introduced by Alfred Wilm, a German, in 1908. As it came into use in planes, strong dural sheet replaced fabric covering, and internal bracing wires disappeared.

Today improved light alloys of aluminum find extensive use for the primary structure of airplanes, for propellers, and for engine parts. In addition, modern aircraft utilize many other materials, including rubber, plastics, and glass.

As we begin the second half century, with airplane speeds rising farther into the supersonic range, and with missiles being flown at four times the speed of sound or higher, the need is arising for materials with better properties at high temperatures.

In sustained flight at a speed of 2,600 miles per hour at an altitude of 40,000 feet, air friction can heat up the skin of the missile to 900° F., although the air itself is icy cold —some 65° below zero. The aluminum alloys currently used lose almost all their strength at 600° F.

At lower supersonic speeds the material tends to "creep," or gradually stretch, under a constant load. The useful life of an airplane might be limited by excessive distortion of the wings after continued flight at high temperature. Depending on the temperature

Space-helmeted Mickey Admires His Test Pilot Dad's "Real Space Suit"

Maj. Arthur Murray, wearing the T-1 suit at Edwards Air Force Base, California, has piloted the X-5 for two years. His experimental jet has variable-sweepback wings (page 769). Mickey hopes to be a test pilot, too.

and load, the creep lifetime can vary between thousands of hours and a few seconds.

One older material, stainless steel, has properties suited to high-temperature applications. It has been used in experimental aircraft and in the Bell X-2 research airplane intended for research at high supersonic speed. Difficulties of fabrication are very great.

Another relatively new material, titanium, is well suited to intermediate temperatures and is coming into use, especially near the engine tail pipe of jet airplanes. At present the supply is limited and the cost very high, but rapid progress is being made in alloy development and fabricating methods.

Demand is steadily increasing, for titanium has many potential uses, not only in jet engines and planes but also in the automotive and ordnance fields. We may expect it to come into wide use in the next half century.

Because low weight is so important in designing efficient planes, the art of lightweight construction in other fields has developed almost entirely from aeronautical needs.

Once the situation was quite the reverse. In its beginnings aeronautical construction owed much to civil engineering practice in design and construction of bridges and buildings. Thus the Wright brothers were influenced by the earlier glider designs of Octave Chanute, a distinguished civil engineer and designer of railroad bridges. In early planes the structural frame carried all the load, and, like the outer walls of a building, the fabric, plywood, or thin duralumin sheet served only as a skin.

But as aircraft structural engineering matured, the thought of many pounds of material which served only as a covering became a challenge to human ingenuity. The result was a built-up structure with stiffened skin strong enough to carry the load.

Thinner Wings with Thicker Skin

In the thin wings now required for high-speed flight we use many spars or webs as stiffeners, and a thicker skin capable of carrying a larger stress.

Strength to resist steady loads is not enough. Gusts and maneuvers produce sharply varying loads. These must be measured accurately so that the necessary reserve strength, flexibility, and "fatigue strength"—strength under repeated loads—can be provided.

Preliminary studies indicate that planes flying at 20,000 to 30,000 feet encounter only one-fifth as many bumps as those operating below 10,000 feet. The coming jet transports will probably fly at 40,000 feet, where gusts will be relatively infrequent. However, during climb and descent the infrequent large gusts will produce the same or somewhat higher gust loads than those experienced by present slower piston-engined transports.

Under certain conditions, air load and structural deflection combine to cause a destructive vibration known as flutter. It is like the fluttering of a flag or the rapid buzzing of a Venetian blind in the breeze. Many engineers are busy with computations and experiments to prevent flutter of our modern airplanes and missiles.

A most difficult problem of the next few years is the structural aspect of air-friction heating foreseen as supersonic speeds go higher and higher. When an aircraft or missile heats up very rapidly and portions of it undergo rapid changes in temperatures, the temperatures in various parts become uneven, causing thermal stresses, distortion, or buckling. Some form of failure may occur—just as a cold milk bottle cracks when hot water is suddenly poured into it—or the airplane may suddenly develop flutter and be destroyed.

"Horses" That Weigh a Pound Apiece

The greatest single factor in the large gains in aircraft performance has been the development of aircraft engines of large power, low weight, and good fuel economy. The Wrights' first engine was a 4-cylinder, water-cooled piston engine of their own construction which gave about 12 horsepower. It weighed about 15 pounds per horsepower. Today's piston engines deliver 3,500 horsepower with a weight of about one pound per horsepower.

The success of the Wright Whirlwind and the Pratt & Whitney Wasp radial air-cooled engines in the mid-twenties led to their wide and rapid adoption. Lindbergh's *Spirit of St. Louis* was powered by the Wright Whirlwind. The present Cyclone, descended from the Whirlwind, has 18 cylinders in two banks, and the present Wasp Major has 28 cylinders in four banks.

Underlying the development of these remarkably compact and light engines, so indispensable to modern aircraft performance, are many feats of basic and applied research. For instance, the increase in compression ratio of engines and the development of special fuels which do not knock at the higher compression ratios make a fascinating story of cooperative accomplishment by the engine industry, the oil industry, and government. Automobile drivers benefit by this great effort.

Near the end of World War II the propulsion picture was revolutionized by the introduction of the turbojet engine. Like most developments, this one had its seeds in the past. A gas turbine appears in an English patent of 1791, and René Lorin, a Frenchman, proposed in 1908 that the exhaust of a piston engine be discharged through a nozzle for

Skyray Adapts a Fish's Clean Lines to Air →

Fish, moving through the dense medium of water, have nearly perfect streamlining. At extreme speeds air behaves on airfoils like water, and clean lines become increasingly important. Navy's Douglas-built Skyray is shaped like a ray, the winged fish.

Dr. Dryden, the author (left), outside a Langley Laboratory wind tunnel, watches a tufted grid make visible the airflow around a Skyray model tilted at a high angle of attack. Fluttering tufts of nylon yarn reveal turbulent air back of each wing tip.

Bottom center: The prototype Skyray is prepared for a test flight at Edwards Air Force Base. Designed for aircraft carriers, it is a short-range, extreme-speed interceptor.

Lower right: The Bell X-5 can vary wing sweepback on the ground or in the air. While advantageous at high velocities, swept-back wings have poor control characteristics at slow speeds. This experimental airplane takes off with wings in full forward (20°) position. When flying level at altitude it can move its wings back to as much as 60°. Three positions (20°, 40°, and 60°) show in this triple exposure. Before this single-jet could fly, aircraft engineers had to overcome the problem of the shifting center of gravity caused by varying wing positions.

↓ A long instrument boom attached to the nose of an F-86D at Edwards Base houses the air-speed indicator's Pitot tube and carries the pitch and yaw vanes that record up-and-down and side motion. Barber-pole stripes increase visibility of the boom.

 Kodachromes by Luis Marden


NAVY


U.S. AIR FORCE

jet propulsion rather than to drive a propeller.

But realization of the ideas of these optimists had to await advances in other fields, particularly the development of efficient lightweight air compressors and high-temperature-resistant materials for turbine blades and combustion chambers.

My first contact with this field was the result of a request from McCook Field to the Bureau of Standards about 1921 for a study of the practicability of jet propulsion. The study was made by Edgar Buckingham, and he concluded quite correctly that at 250 miles per hour the fuel consumption of the most efficient jet engine would be at least four times as great as that of a piston engine driving a propeller. I participated in the discussion of the draft of the report.

My next contact was in 1941 as representative of the Bureau of Standards on the NACA Special Committee on Jet Propulsion under the chairmanship of Prof. W. F. Durand. This committee stimulated the military services to contract with manufacturers of steam turbines for the development of a turbine-driven ducted fan, a small turbojet, and a turbine driving a propeller.

However, the Germans and the British had advanced more rapidly. The Germans had flown a Heinkel-178 airplane powered by a turbojet engine on August 27, 1939, and on May 14, 1941, the British had flown a Gloster airplane powered by the engine invented by that gifted Englishman, Frank (now Sir Frank) Whittle. Not until October 2, 1942, did a U. S. airplane fly with jet power, a copy of the Whittle engine. Not until January 21, 1944, did one of the original U. S. designs initiated by the Durand committee fly as a booster engine, and on January 1, 1945, as sole power.

Whittle's earliest patent was filed on January 16, 1930. When he submitted his engine to the government authorities in Great Britain, it was rejected as inoperative. I have heard Whittle state since that they were probably correct in their judgment at the time, but he himself did not give up.

The first German flight used an engine developed from patents of Hans von Ohain, who was totally unaware of Whittle's work.

Jet Engine Would Heat 6,500 Houses

A jet engine is fundamentally a device for converting fuel into heat and then developing thrust from that heat by squirting a jet of hot air to the rear. Any boy who has blown up a toy balloon and let it escape from his hands has observed jet propulsion in action. At low speeds the jet engine is not very efficient; the higher the speed, the more efficient it becomes.

A recent turbojet engine, the Allison J-71-A-1, weighs 3,650 pounds and gives a thrust of nearly 10,000 pounds. The heat generated is enough to heat 6,500 six-room houses in the climate of Washington, D. C. At 375 miles per hour, 10,000 pounds of thrust is equivalent to 10,000 horsepower; at 750 miles per hour, the same amount of thrust is equivalent to 20,000 horsepower.

One of the first discoveries about jet engines in flight was that when the airplane reached a high altitude the "fire" in the engine often went out, or flamed out, as the pilot would say. Unless he could restart his engine at a lower altitude, he had to make a forced landing.

Fortunately, at about the same time this problem was faced, the NACA's Lewis Flight Propulsion Laboratory in Cleveland had completed new research facilities which permitted duplicating on the ground the altitude operating conditions. The NACA collaborated with industry and the military services in the solution of this problem, with the result that jet engines can be operated dependably at altitudes more than twice as high as before this research program began.

Ceramels—Metals Plus Ceramics

The jet engine is dependent on advances in physics, chemistry, metallurgy, and their applications, for combustion occurs in air flowing at superhurricane speed and intense heat. To be even reasonably efficient, the jet engine needs to operate at temperatures approaching 1,500° F., and for the future we should like to go to still higher temperatures, perhaps to 3,000° F.

To cope with such terrific heat, new materials combining metals with ceramics, called ceramels or cermets, are under study, and methods of cooling the hot parts of the engine are being developed.

For supersonic propulsion with turbojet engines, it is at present necessary to augment the thrust of the turbojet by the use of afterburning, the burning of fuel in the tail pipe downstream of the turbine blades. There is enough unused oxygen in the jet flow to feed an afterburner because the combustion products in a turbojet must be greatly diluted with excess air to prevent destruction of the turbine blades. We may expect afterburning to become less and less necessary as effective means are devised for cooling the turbine blades or improved high-temperature materials become available.

Other types of power for superspeed include the rocket motor, with which sustained horizontal supersonic flight of a piloted airplane was first attained by the Bell X-1.

Another source of tremendous power and speed is the ram-jet engine, which depends on the high speed of the aircraft or missile

Spearfish of the Sky Is Needle-nosed X-3

Armed with a long bill, this Douglas-built research airplane was designed to thrust through the sound barrier to sample and measure the secrets of the mysterious supersonic region. Reaching into undisturbed air, the instrument boom records speed, pitch, and yaw.

Looking toward the day when airplanes fly 2,000 miles an hour, X-3 tests the straight stub wing, as opposed to the triangular delta wing.

Purpose of X-3, powered by two turbojets, is research by company, military, and NACA pilots. It is pictured here at Edwards Air Force Base.

Kodachromes by Luis Marden, National Geographic Staff

to ram air at increased pressure into the combustion chamber. It needs no compressor or turbine, but must be moving at high speed before it will go into action.

There is, of course, much speculation about the possible application of nuclear power to aircraft. In principle, the nuclear-fission process can be used as a substitute for the combustor in any type of power plant. But there are many difficult engineering problems, including that of shielding personnel from dangerous radiation. Shield weights are very great. Basic research on atomic power continues, and a nuclear-powered submarine will soon give us invaluable practical experience with nuclear power.*

Atomic-powered Plane Must Be Huge

Sir Harry Garner has estimated the weight of a nuclear-powered aircraft to be something like 500,000 pounds (71 tons heavier than the enormous B-36 bomber), and says he will be surprised if a successful airplane of this kind is achieved within the next 15 years.

So far I have attempted to give an impression of the vast foundation of scientific and technical activity in areas with which I have some direct connection. Advances in other areas are equally necessary, but I can hardly do more than list a few of them.

Modern aviation is greatly dependent on electronic devices. The oldest "black boxes" contained the radio transmitters and receivers. Now radio beacons and blind-landing systems, radar, navigation aids, recognition devices, bombsights, gun sights, and range computers greatly increase the utility of aircraft.

A growing new field is that of autopilots and servomechanisms which relieve the pilot from fatiguing tasks, supplement his strength, and react more rapidly to atmospheric gusts.

The acoustical experts have been called upon to soundproof airplane cabins and muffle engine exhausts, but the noisy turbojet has presented a new and difficult challenge. It is not too much to say that a large part of the future of jet transports and of present metropolitan airports depends on the success or failure of the experts' work in alleviating the thunder of low-flying or taxiing aircraft.

Faster and more detailed weather forecasting seems sure to come with new knowledge and use of high-speed electronic computers.

Of great importance is the science of aeromedicine. Military aviation particularly poses problems of enabling men to withstand violent "G" (gravity) forces, rapid changes in altitude (page 780), radiation, high and low temperatures, vibration, and noise. As aeromedicine and engineering work out solutions, civil aviation benefits too—for example, in pressurized cabins, oxygen equipment, heating, ventilating, and air-conditioning equipment.

In the preface to his book, *Frontiers of Flight*, George W. Gray points out: "Airplanes today fly faster than the craft of ten years ago, they fly higher and farther, carry heavier loads, are more controllable, and embody greater safeguards against the hazards of take-off, flight, and landing, because we know more aeronautics today than we knew ten years ago.

"And we know more aeronautics because a little group of fact-seeking men have devoted themselves to its study. The entire roster of aeronautical scientists and engineers in the United States is only a few thousand. They constitute an almost microscopic fraction of the population. And yet it is on this small group that progress toward conquest of the air depends." †

I would add to the group of a few thousand some thousands more, all laboring to extend the foundations, to pile stone on stone, to produce an unending sequence of better and better airplanes.

A Glimpse into the Future

Achievements up to now have stimulated the thoughts of men of vision to much more radical developments, beginning with transport of passengers and freight long distances at speeds of several thousand miles per hour.

From this it is but a step to consider vehicles which will become man-made satellites of the earth. A slight additional outreach of the mind suggests interplanetary travel, or, if that seems too great a step, at least travel through space as far as the moon.

I am reasonably sure that travel to the moon will not occur during my lifetime, but I am sure that the technical problems are solvable with a large but finite amount of manpower and money. The missing element today is a still broader experience in the pertinent sciences and technology. Experiment and more experiment, unanticipated scientific developments in apparently unrelated fields, and probably the loss of many human lives in hazardous pioneer flights will be requisite to attainment of this goal.

Kitty Hawk was the climax of the long period in which the dream of human flight stimulated the creative effort of inventors and scientists alike. Today, on the Golden Anniversary of Kitty Hawk, men are still dreaming dreams, stirred by longings for still greater accomplishment, this time to travel beyond the domain of the birds as far as the eye can see.

* See "Our Navy's Long Submarine Arm," by Allan C. Fisher, Jr., National Geographic Magazine, November, 1952.

† Quoted by permission of the publisher, Alfred A. Knopf, Inc., New York, 1948.

Navy's Skyshark Need Not Turn on Its Belly to Bite

Driven by turbines, two propellers rotating in opposite directions eliminate torque, a force which tends to roll a plane in the direction opposite to the propeller's spin. This Douglas attack bomber operates from carriers and short runways. Exhaust from turbine tail pipes gives added thrust.

Army's Jet Jeep Lifts Twice Its Own Weight

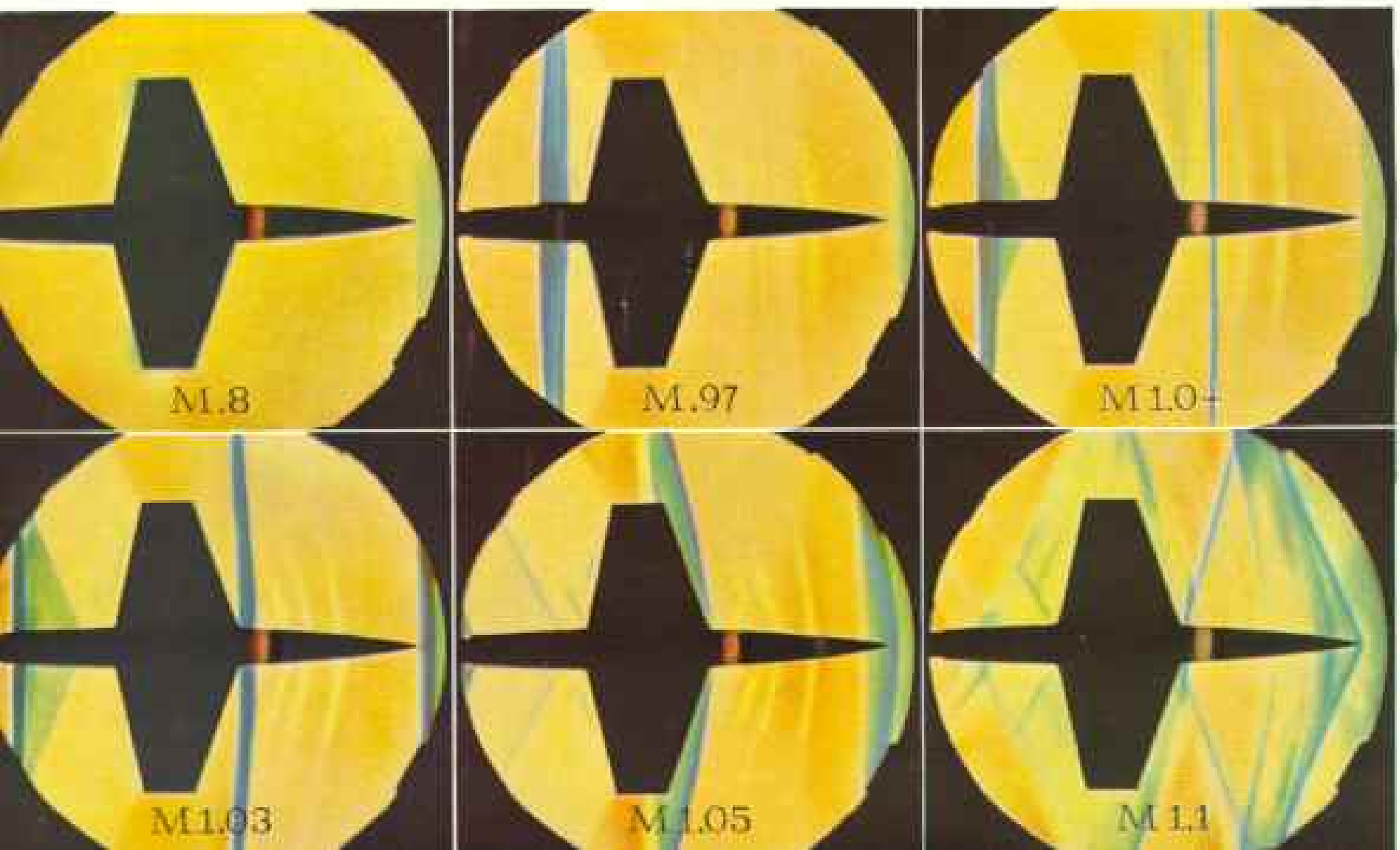
This pocket-size helicopter (the Jet Jeep) folds up for trailer transport. Pulse-jet engines at rotor tips operate on the fluttering-Venetian-blind principle used by Hitler's buzz bombs. The machine weighs 400 pounds, flies on one engine in emergency, burns anything from kerosene to high-octane gasoline, and takes off in zero weather in less than 30 seconds. Engines have only one moving part, and the craft uses not a single gear.

↑ Man-made Superhurricanes Roar Past a Swept-wing Model

Air attains twice the speed of sound in this wind tunnel. Plastic tubes connected with small holes distributed over the model's surface give pressure readings on a manometer board (right). Profile of colored liquid at differing heights shows how pressure varies over the wings at Mach 1.78 (1,330 miles an hour). The National Advisory Committee for Aeronautics conducts the tests in its Ames Aeronautical Laboratory.

↓ A Stub-wing Airplane Model Breaks Through the Sound Barrier

Air flows smoothly at subsonic speeds. Shock waves form as the aircraft moves faster. At exactly Mach 1 (760 mph, the speed of sound at sea level) a standing shock wave appears ahead of the wings. As the plane speeds up, this shock wave approaches the wings and bends backward. These are some of the first schlieren (shock-wave-visualization) photographs made in color. Figures on each picture show the Mach number.

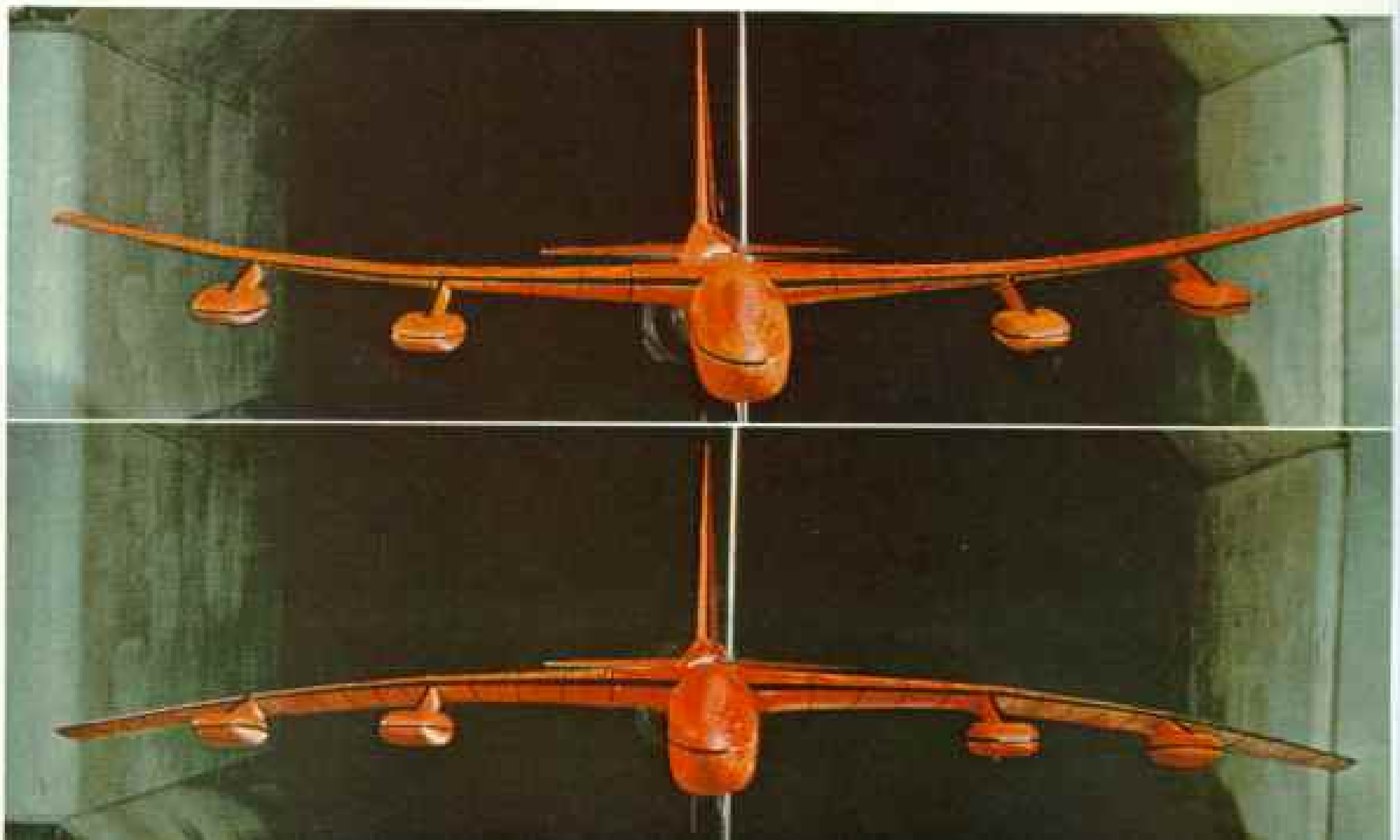


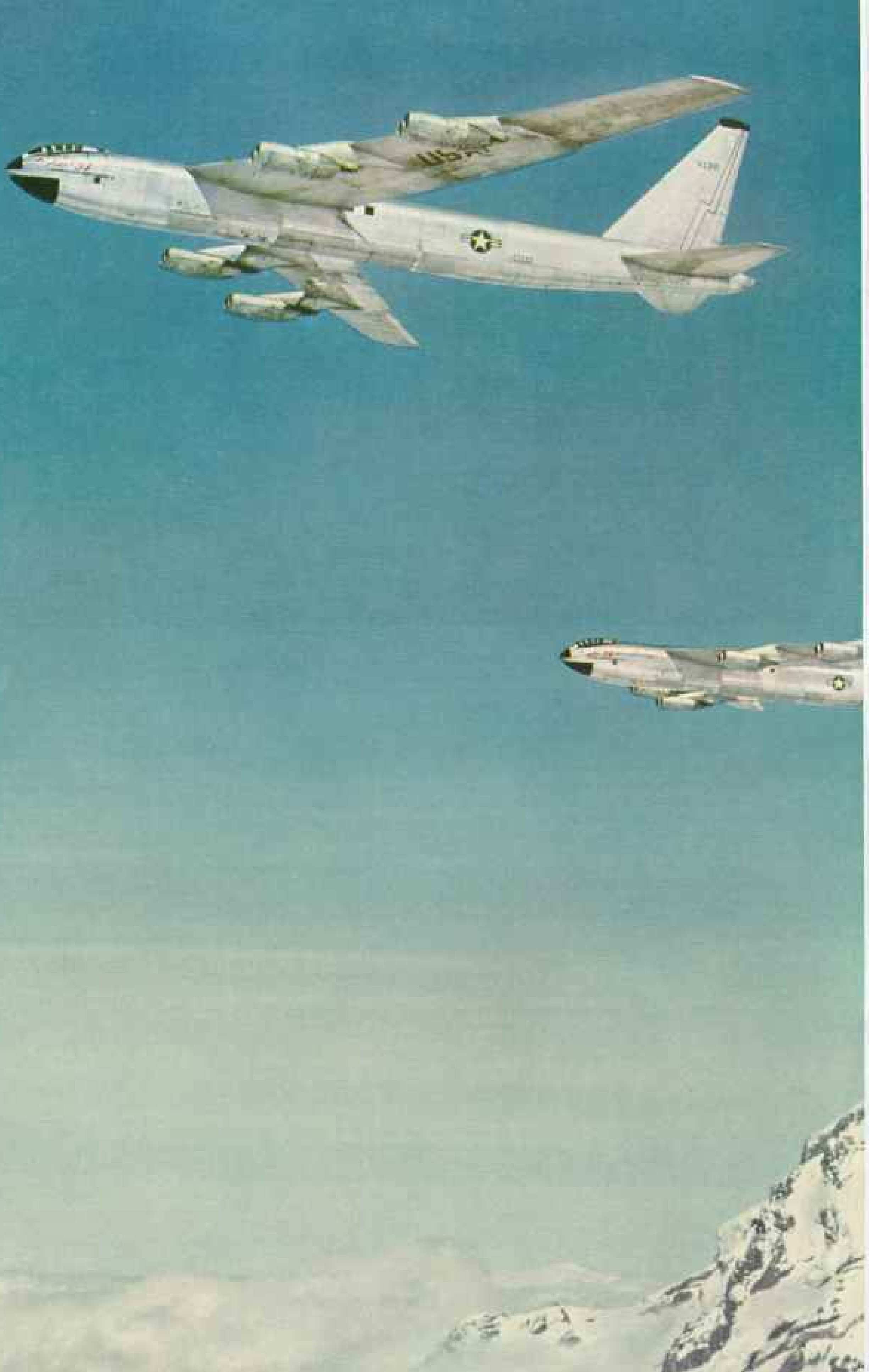
High-speed Aircraft, in Wind Tunnels and Out, Flap Their Wings Like Birds

Engineers used to treat wings as rigid units, but the long, thin, narrow wings of today's jet bombers pose a new problem: aeroelasticity.

In flight through turbulent air the Boeing B-52's wing tips may move in a 20-foot arc. To study such flapping and its effect on performance, these Seattle engineers mount an aeroelastic model of balsa segments strung on metal wingspars. They wear soft cloth overshoes to protect the tunnel's polished steel. The flexible model and steel-rod mount, both new to aeronautical research, were developed by the Boeing Airplane Company.

▼ A slow-motion camera records the flexing wings as this B-52 model rides up and down on its monkey-on-a-stick mount. Boeing's transonic wind tunnel, based on designs of the NACA, is the only one of its kind operated by private industry.





B-52 Stratofortresses, Vaulting Mount Rainier, Spearhead U. S. Airpower

Direct descendant of Boeing's long line of bombers, this 8-jet airplane has entered production; eventually it will replace the B-36 as the Strategic Air Command's intercontinental bomber.

These B-52's resemble the medium B-47 in the 35-degree swept-back wing and pod-mounted jet engines, but the 300,000-pound bomber has a 185-foot wingspan. The Air Force ordered the B-52 into production before the first prototype was tested, largely because of encouraging experience with the B-47 Stratojet. Boeing and the Air Research and Development Command jointly developed B-52.

Performance details are secret. The Air Force says only that the B-52 flies "very high" at "very high speed." This may mean speeds above 600 mph and altitudes above 60,000 feet.

Both B-52 and B-47 use air-to-air refueling to increase range. Flying tankers lower hollow booms as bombers nuzzle up to drink enormous draughts of jet fuel.

The weight of fuselage, equipment, bombs, and crew causes the long thin wings to curve upward in flight and beat up and down in turbulent air. Flexing wings act as shock absorbers, smoothing out the ride (page 775).

Today's jet bombers operate from heights and under degrees of poor visibility undreamed of in World War II. Like the B-47, the Stratofortress can fly a tremendous distance and drop its bomb load without once seeing the ground. Both bombers need long runways for take-off and landing. A ribbon parachute popped from the tail shortens the landing run.

Gen. Curtis E. LeMay's Strategic Air Command, which will operate the Stratofortresses, holds an unequaled safety record. This year, as in 1952, General LeMay received on behalf of his command the Daedalian Award, a silver trophy awarded by an organization of World War I aviators for safety in military flying. The service arm with the best safety record for 100,000 hours of flying gets the prize.

Extraordinary Aero from
Boeing Airplane Company

Fire and Water Attend the Birth of a New Sea Fighter

The Convair-built Navy Sea Dart is the world's first hydro-ski, delta-wing seaplane. Hydro-ski landing gear operates on the same principle as the water skis used by sportsmen. While taxiing slowly, the airplane floats on its fuselage, with skis submerged. As speed picks up, it rises and planes on the relatively thin, curved slats of the retractable gear.

Developed by Convair utilizing NACA research, the Sea Dart was tested as a model in the towing tanks at Langley Aeronautical Laboratory in Virginia. There Dr. Dryden (left) and John B. Parkinson watch a towing test.

Inset: To test the plane's behavior at extremely high speeds, models attached to the heads of rockets were fired at Wallops Island off the Virginia capes, 125 miles from Kitty Hawk where man first flew.

◂ Larger research models, powered with jet engines and controlled by radio, were built and flown by Convair.

Top: The prototype Sea Dart takes off from San Diego Bay.

Hydrodynamics, a branch of science related to aerodynamics, deals with the forces exerted on bodies moving through water. New knowledge and new designs have improved water-based aircraft substantially in recent years. Engineers today seek to build airplanes that float rather than boats that fly.

© Kodachromes and Ektachromes by Luis Marden, NACA, and Department of Defense

Airmen Briefly Achieve the Weightlessness of Space Flight

While in free fall men may forget gravity. Such falls last only a few seconds until parachutes open. For special tests flyers have fallen free for five miles at an average velocity of 180 mph.

Slow-motion film shows that professional jumpers are as individual as artists. Some go down with a swimming motion; some "walk" down, working arms and legs; others drop with mummylike rigidity (top).

These chutists jump daily at the Department of Defense Joint Parachute Test Facility at El Centro, California. Some jumpers have "hit the nylon" more than 400 times. Adepts land lightly on their feet, remain erect, calmly wrap up the canopy, and walk away.

Jumpers leaving a Navy R4D transport wear fluorescent suits that stand out on color film.

→Orange gores, for visibility against snow, identify parachutes for Arctic use.

El Centro tests more than man-carrying parachutes. Slit-canopy chutes released from landing airplanes brake them to a stop on the ground. Cargo-dropping parachutes carry loads from a few pounds to many tons. Amphibious Weasels require four parachutes, each 64 feet wide.

Since it was founded two years ago, the Facility has tested 15 models of the parachute, a device first proposed by Leonardo da Vinci, versatile creator of the *Mona Lisa*, more than four centuries ago.

 780 Kodachrome by Bert Corville; Lt. (j.g.) A. G. B. Grosvenor, USN, Pilot

▲ **Navy's First Operational Swept-wing Fighter, Grumman Cougar, Now Flies from Carriers**

▼ A researcher at Wright Air Development Center near Dayton, Ohio, shows what happens when a cockpit canopy blows out at 65,000 feet. Left: Holding a beaker of dyed liquid, he stands in a test chamber where air pressure has been lowered to the equivalent of 40,000 feet. Instantaneously (right), pressure drops to that of 65,000 feet—an "explosive decompression." The liquid geysers skyward, as the flyer's blood would vaporize internally if he were not protected by his T-1 pressure suit.

When pressure drops radically, arm and leg tubing inflates automatically, tightening the suit in a uniform skintight grip. If the pilot is subjected to an excessive gravity tug in sharp turns and dive pull-outs, certain areas below the waist inflate to prevent blood rushing from the head, the cause of blackout.

Designed by the Air Force's Air Research and Development Command, the suit has saved several lives and millions of dollars' worth of airplanes. It has been tested in a pressure chamber to 106,000 feet.

Ektachromes by U. S. Air Force

Illinois—Healthy Heart of the Nation

All America Mingles in the Prairie State, Industrial and Farming Titan Rich in Coal, Oil—and Mighty Chicago

By Leo A. Borah

Assistant Editor, National Geographic Magazine

Illustrations by National Geographic Photographers B. A. Stewart and W. R. Culver

ILLINOIS owes much of its early development and the phenomenal growth of its great city, Chicago, to geography.

Lying between the Great Lakes and the Mississippi River, the State from the beginning of its settlement was the crossroads of America. Emigrants from Dixieland found homes in its southern part. New Englanders and Scandinavians flocked to its northern portion, and Chicago received all races.

It is impossible to describe a typical Illinoisan, for in the population all America mingles.

Diversity Amid Flatness

Although Illinois is one of the flattest and least varied of all the States in topography, it shows marvelous diversity in other respects. This middle-western empire of 9,000,000 people ranks fourth in the Nation in farm production, fourth in manufacturing, first in rail mileage, third in banking assets, and second in wholesale trade, although only twenty-third among the 48 States in size. (See the National Geographic Society's new map, "The Great Lakes Region of the United States and Canada," a supplement to this issue.)

Coal underlies two-thirds of its fertile acres, and reservoirs of oil, tapped by pumps, many of them working away in the middle of cornfields, yield about 60,000,000 barrels annually. From southern Illinois comes more than half of the Nation's domestic shipments of fluorspar, a mineral used in the production of metals, ceramics, and fluorine chemicals.

The Prairie State is primarily agricultural, yet three-fourths of its population is urban. More than half of its citizens live in the metropolitan area of Chicago.

In 1830 Chicago was a frontier village of 50 people. The 1950 Federal census recorded 3,620,962 within its city limits—5,495,364 in its metropolitan area. In eight of the decades since its incorporation as a city in 1837 it has achieved increases exceeding 100,000; in five, gains of more than half a million (page 785).

Without attempting even to enumerate, much less describe, the myriad wonders of the mighty midland metropolis, I merely sketch some of its high lights.

Chicago sprawls over 212 square miles, bordering Lake Michigan for nearly 30 miles. Along the sparkling lake stretches a verdant fringe of beautifully kept parks, sites of notable public show places. On summer days hundreds of thousands of bathers disport themselves on the 22 miles of beaches.

Yachtsmen find breezy Lake Michigan as sporty as salt water. One summer when my family and I dropped in for luncheon at a lakeside restaurant, we watched the finish of a Star-class race in which a hundred trim little sloops competed. Larger craft skimmed along farther out or lay at moorings along the shore.

In Lincoln Park stand the Chicago Historical Society, the Academy of Sciences, a superb conservatory, and a famous zoo that displays its animals on a television show. Jackson Park has the Museum of Science and Industry, where many of the displays are operated by push-button control (page 792).

Near Jackson Park the University of Chicago lifts its graceful Gothic buildings in an attractive setting. The Oriental Institute, repository of priceless archeological treasures, lures throngs of visitors (page 787).

The Art Institute of Chicago and the exquisite Buckingham Fountain (page 782) grace Grant Park on the downtown lake front.

Overlooking the lake are Soldier Field, which seats 100,000; the Adler Planetarium, where stars and planets move realistically in a man-made sky; the Shedd Aquarium, with 10,000 specimens of fishes; and the Chicago Natural History Museum, in which dramatic exhibits tell the story of mankind.

Chicago Proud of Its "Front Yard"

Justifiably Chicago feels pride in its "front yard." I stood for a long time enchanted near the Adler Planetarium, looking across the harbor to skyscrapers against the sky line.

Much of the parkland has been reclaimed from swamps. A little distance offshore, connected by a man-made causeway, is one of three municipal airports.

South of the parks the water front bristles with smoke- and flame-belching steel mills, factories, and furnaces.

Six strange-looking structures thrusting up well out in the lake are "cribs" that serve as intakes for the city's drinking water. Lake water entering these flows through 63 miles of enormous underground tunnels to 12 land

▲ **Buckingham Fountain Graces Chicago's Front Yard on Filled Land Near the Lake. Colored Lights Make It a Fairy Palace by Night**

▼ Hotels and the towers of commerce form an imposing wall along Michigan Avenue's west side. They erect a kind of battlement against gusty winds sweeping from Lake Michigan. These bronze lions guard the Art Institute of Chicago, which is set amid the lake shore's Grant Park (page 788).

stations which pump it into the water mains.

Until 1900 the Chicago River emptied into Lake Michigan, polluting the water with sewage. Typhoid fever caused hundreds of deaths.

The city solved the problem by making the offending river run backward. To reverse the flow, engineers dug the south branch of the stream deeper than its mouth and connected that branch by a still deeper canal with the Des Plaines River, forming the Illinois Waterway to the Mississippi (see inset on supplement map).

Although Chicago is an inland city, it handles more water-borne traffic than the Panama Canal. Dutch, Swedish, and Norwegian steamship lines connect the city with European and North African ports during the season of navigation on the Great Lakes (page 794). Barges ply from here to New Orleans and other river cities. Annually lake and river cargo totals 46,000,000 tons.

A movement is now afoot to widen the Calumet Sag Channel and thus quadruple the barge traffic through that waterway. In 1848 the old Illinois and Michigan Canal gave Chicago its start in water shipping (page 802). If the Calumet Sag project goes through, cheap river transportation may launch another boom.

Hub of Rail, Highway, and Air Traffic

Truly, geography has built Chicago. Railroads, starting here with the old Galena and Chicago Union line in 1848, have made the city the busiest rail center in the world. Today it is served by 20 major lines operating almost half the total mileage in the country. It handles more freight traffic than New York and St. Louis combined, and its passenger train arrivals and departures, including suburban services, average 1,770 a day.

As in pioneer times, roads converge at Chicago. Illinois has one of the finest and most extensive systems of paved highways ever constructed. Some 500 big trucking companies, besides hundreds of lesser truck fleets, operate in and out of Chicago.

Following the pattern of roads, waterways, and railroads has come air traffic. Eleven major airlines, three feeder passenger lines, three air freight and express lines, besides numerous nonscheduled carriers, serve the city.

At Midway, busiest airport in the United States, 1,000 scheduled airline planes land or take off daily. Passenger arrivals and departures in 1953 totaled nearly 10,000,000.

Inland from the sumptuous water front Chicago has unsightly districts which have become more dilapidated and disreputable through the years. Many of these slums have been cleared, and others are in the clean-up process.

In objectionable neighborhoods the city condemns the land, moves residents to municipal or Federal housing projects outside crowded areas, and razes ramshackle buildings. The property thus cleared at public expense is sold cheap to private investors who build on it approved industrial plants or apartment groups. Taxes on the improved property reimburse the city for the cost of slum clearance.

I rode through one South Side district, not far from the University of Chicago, where an insurance company was replacing miserable hovels with handsome apartment houses surrounded by lawns and trees.

To cope with the downtown parking problem, the city is building a huge garage beneath a long stretch of Michigan Avenue.

Out of Slums, a Great Medical Center

A striking example of splendor replacing squalor is the West Side Medical Center going up in an area of tenements and junk yards. It already represents an outlay of $157,000,000. Completed, it will cost twice that amount.

It is one of the greatest concentrations of medical and related institutions anywhere. Within its borders are the University of Illinois College of Medicine, Loyola University's Stritch School of Medicine, the Cook County Graduate School of Medicine, and Chicago Medical School. In addition, the University of Illinois conducts a College of Dentistry and a College of Pharmacy, and Loyola a dental school. There are five hospitals, two schools of nursing, and a tuberculosis sanitarium.

Research, which goes on constantly, has performed miracles. Among the most striking is the research done on the use and application of the B. C. G. (bacillus of Calmette and Guerin) vaccine for tuberculosis.

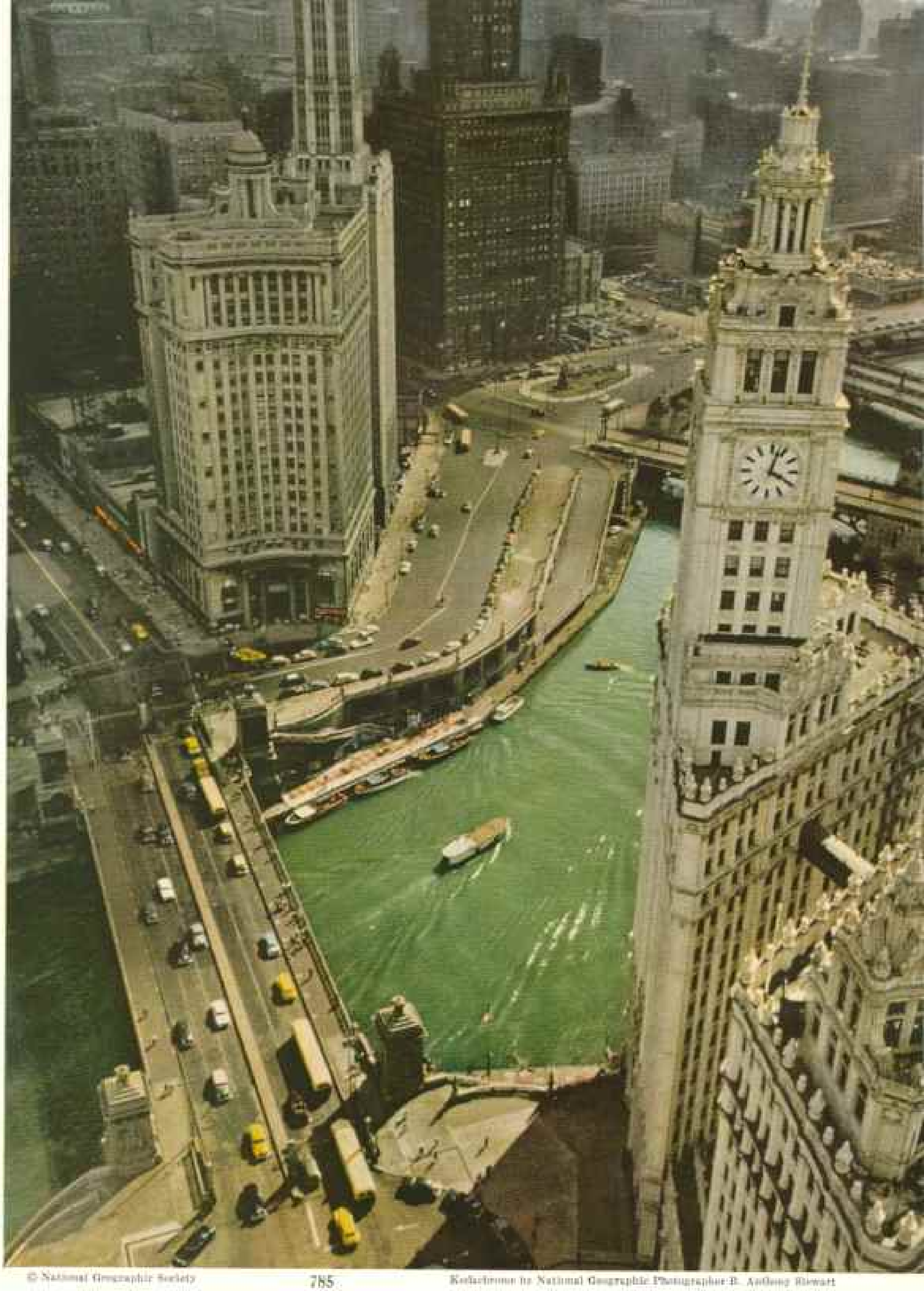
In a concrete-and-lead-walled basement room the 24,000,000-volt betatron invented at the University of Illinois is being used to treat inoperable cancer by the concentration of penetrating X-rays of high energy upon diseased areas.

Chicago claims an imposing list of "greatests" and "firsts," leading all other cities in the Nation in output of meat and packinghouse by-products,* telephone equipment, radios and television sets, railroad equipment, and a score of other products (p. 797). It fashioned America's first steel-frame skyscraper, its first Pullman car, its first real refrigerator car, its first third-rail system for electric railways, and its first successful reaping machine.

At the University of Chicago the first atomic chain reaction, precursor of the atomic bomb, was produced in 1942.

World's largest market for grain futures is

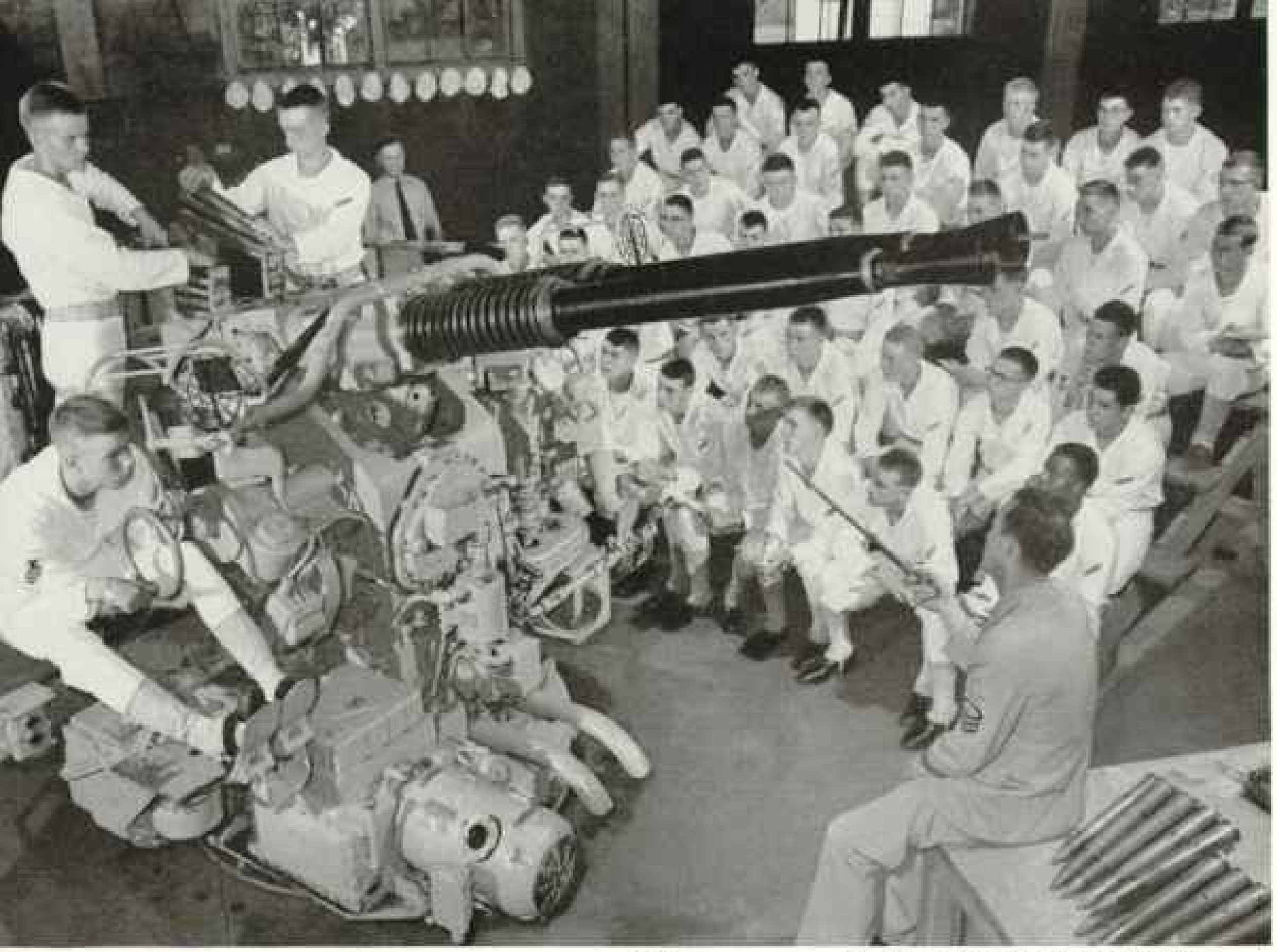
* See "America's 'Meat on the Hoof,'" by William H. Nicholas, National Geographic Magazine, January, 1952.



Kodachrome by National Geographic Photographer B. Anthony Stewart

Chicago's Skyscrapers Tower Above the Site of Old Fort Dearborn's Log Stockade

Wild onions fringed the Chicago River just a century and a half ago when the fort was the Nation's northwesternmost military outpost. Wrigley Building (right) and London Guarantee Building (across the Michigan Avenue drawbridge) guard the spot around which the infant Chicago developed in the 1830's. Double-decked Wacker Drive parallels the river. This picture was taken from Tribune Tower.



Recruits at U. S. Naval Training Center, Great Lakes, Learn to Fight Off Enemy Aircraft

Although Lake Michigan is 700 miles from salt water, trainees become seaworthy through practice with shipboard equipment (page 793). A chief petty officer instructs these men in firing a twin 40-mm. gun.

the Chicago Board of Trade (page 791), and largest market for futures in butter, eggs, and onions the Chicago Mercantile Exchange.

With 3,000 rooms—enough to lodge a guest in a different sleeping chamber every night for more than eight years—the Conrad Hilton, formerly the Stevens, is the world's largest hotel.

Merchandise Mart Is Buying Center

The Merchandise Mart, on the bank of the Chicago River, just north of the famous Loop business district, is the country's largest commercial building. With 93 acres of floor space, it has a daily working population of 20,000 persons. Marshall Field and Company built it in 1930 and sold it in 1945 to Joseph P. Kennedy, Boston banker and former U. S. Ambassador to Great Britain.

Often buyers from a big department store come to the Mart and order their entire stock of goods of all sorts from the samples on display. The building has a post office, bank, police force, fire department, railroad station, and restaurants to serve 30,000 diners.

Beneath the crowded streets of downtown Chicago lies a 62-mile tunnel system through which electric trains bring merchandise to the stores, haul heavy supplies to office buildings, and remove refuse.

At the invitation of company spokesman Harry J. Owens, I went through the R. R. Donnelley & Sons Company printing plant, which has an enormous volume of business. Its type-composing department is exceeded in size only by that of the U. S. Government Printing Office in Washington, D. C. The large plant occupies a parklike area on the lake front south of the Loop.

In one room I watched a battery of huge presses—some cost $750,000—printing five colors on both sides of paper simultaneously. The web of paper is fed into the presses at high speed, with no halts for shifting from one roll to the next, the supply being made continuous by means of an ingenious device called a "flying paster." Here are printed a wide variety of magazines and other publications.

Telephone Directories for 1,000 Cities

Donnelley's prints telephone directories for more than a thousand cities, towns, and villages. Proud of the company's accuracy, Mr. Owens pointed to the record for the Chicago Alphabetical Directory, in which

was reported only one mistake in three issues.

On opposite sides of one floor—carefully separated of course—the Sears Roebuck and Montgomery Ward mail-order catalogues are printed. Donnelley's printed, bound, and shipped some 67,000,000 mail-order books for three principal customers in 1952.

"Funny about these catalogues," Mr. Owens said. "When a minister of an Oriental country and his family visited us, the ladies said the only American publications they felt they could not go home without were mail-order books showing all the American fashions."

Culturally, Chicago has attained commanding heights. It has 20 colleges and universities and more than 200 technical schools. In music its symphony orchestra is famous, and its Art Institute ranks high.

There breathes something electrifying in the very air of the "Windy City." Whenever I come to Michigan Avenue, I feel a thrill of wonder, for this to me is one of the most exciting streets in America (page 783).

Sedate Evanston Offers Contrast

In quiet contrast to bustling, roaring Chicago is sedate Evanston, a residential college community of nearly 75,000. Evanston grew up with Northwestern University, which celebrated its 100th anniversary two years ago.

Northwestern University, chartered in 1851, opened on its lake-front campus in 1855 and graduated its first class—five students—in 1859. Because of the mingling of seafaring and academic life, the town was called "the finest New England village in the Midwest."

787

Colossal Stone Bull Guarded Ancient Persia's Throne Room

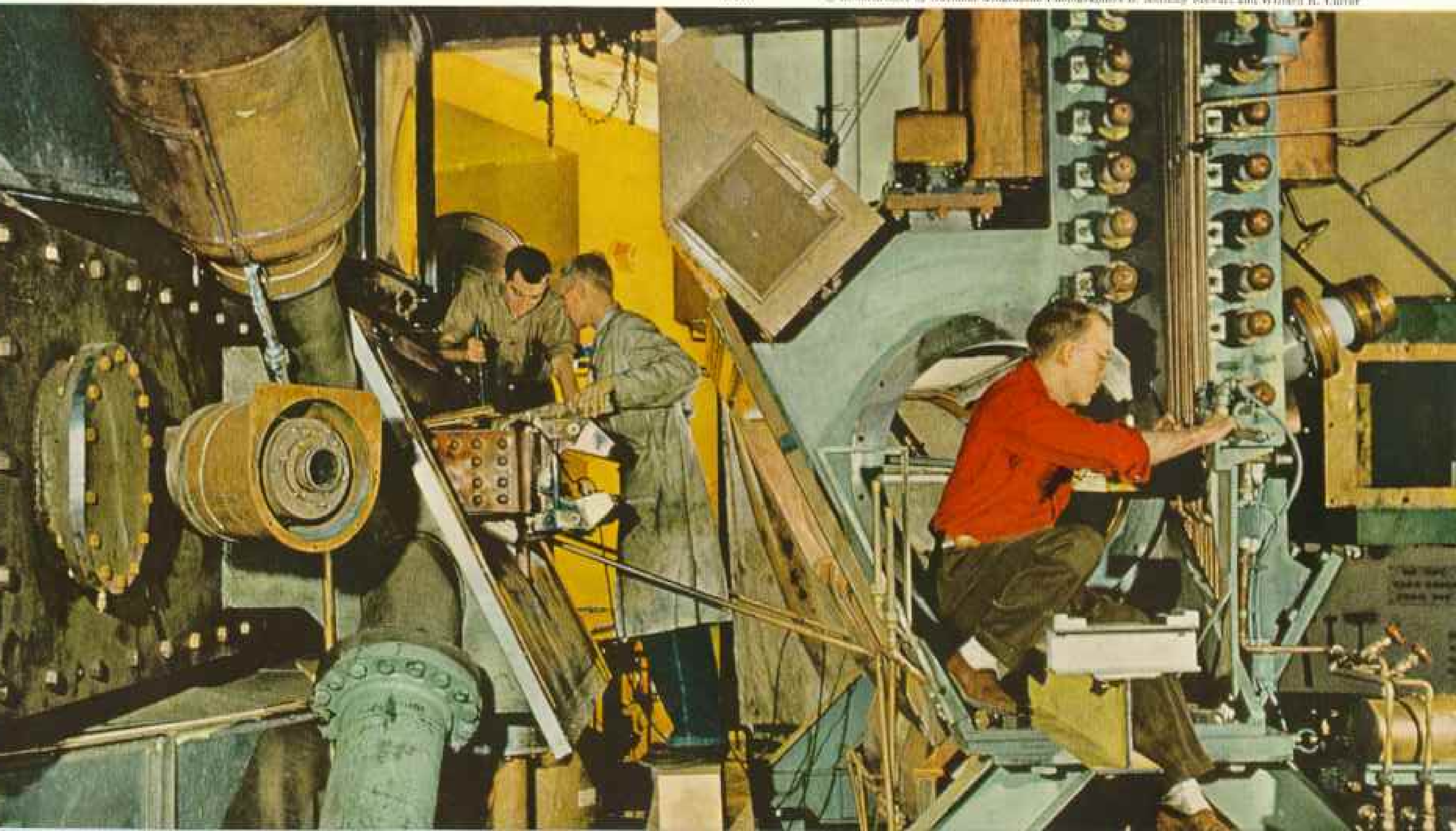
A University of Chicago expedition unearthed the 10-ton head and installed it in the museum of its Oriental Institute. Darius the Great's sculpture toppled when Alexander destroyed Persepolis, the Persian capital, in 330 B. C. Missing horns and ears were attached by dowels.

Visitors Leaving the Chicago Natural History Museum Face Grant Park and the Michigan Avenue Sky Line

Just as eastern school children make pilgrimages to Washington, D. C., so do midwesterners go to Chicago. Here Inner Drive sweeps in a graceful curve on the right. Outer Drive (not shown) skirts the lake shore. Towers of the Loop rise ahead.

Workmen Adjust the Radio-frequency System on the 450-million-volt Cyclotron at University of Chicago

This powerful atom smasher consists basically of two 14-foot magnets with a vacuum chamber between. A heated tungsten filament powered by high voltage strips electrons from hydrogen atoms, leaving heavy nuclear particles called protons. A radio-frequency system accelerates these protons almost to the speed of light.



← Grant Park Band Shell Attracts Chicagoans to Outdoor Concerts

One of the finest public amusement places in the city's "front yard" along Lake Michigan, the shell welcomes music lovers on fair summer evenings. Skyscrapers of the Loop provide a striking backdrop.

Kaufmann-Fabry

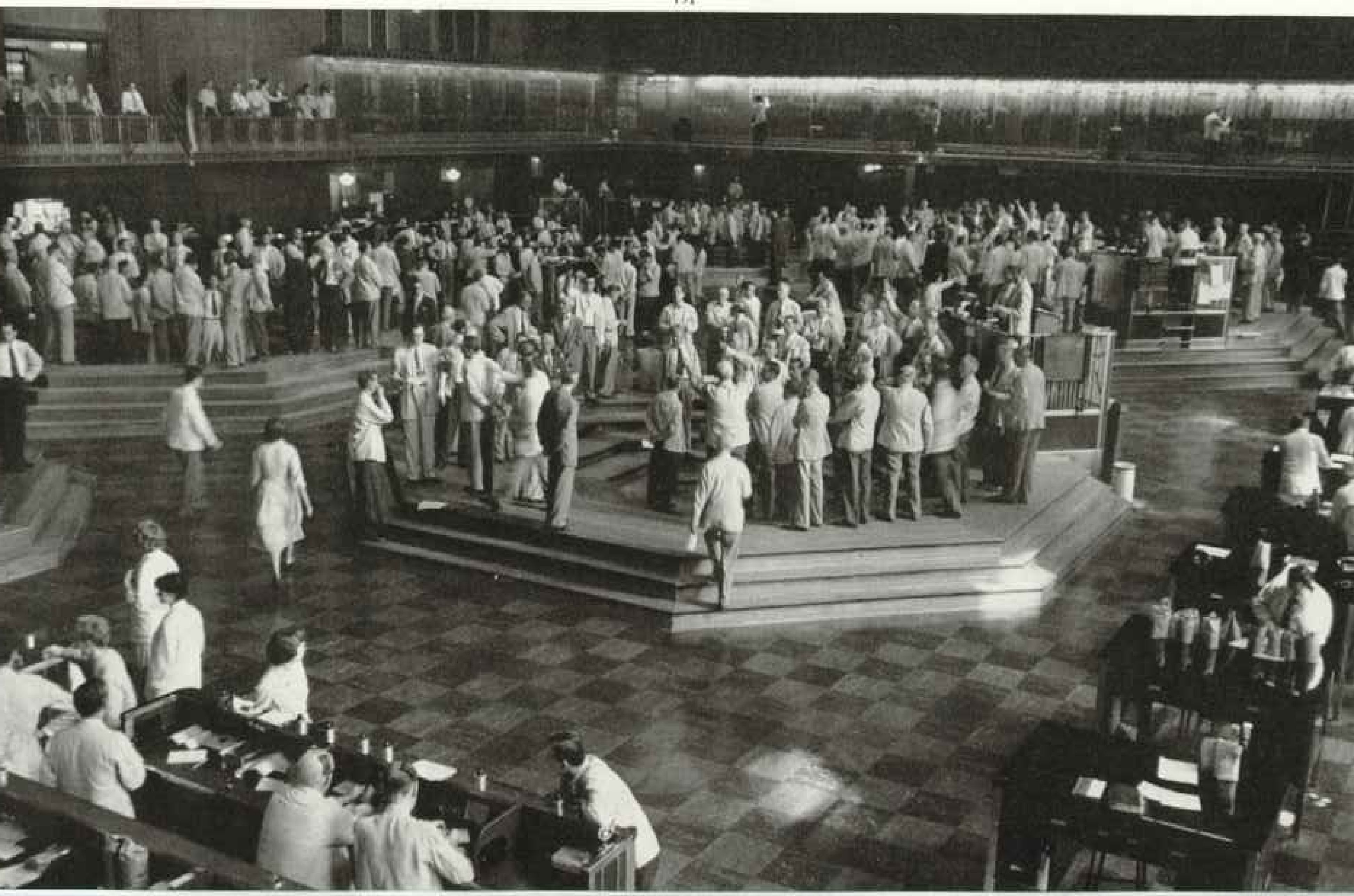
▼ A Tide of Buying Grips the Grain Pit

By far the largest exchange of its kind, the 1,422-member Chicago Board of Trade handles 85 percent of the world's trade in grain futures (page 784).

The exchange has witnessed booms and panics, successes and failures during its 105 years of operation. Frank Norris's novel, *The Pit*, dramatized the scene. On several occasions before World War I traders cornered the market, and only heroic measures averted national calamity. Today the Federal Government's Commodity Exchange Authority and the board's own code of fair play protect the interests of grain producers and consumers.

Though the pit impresses visitors as a veritable bedlam, its swift and abbreviated methods attain the peak of efficiency. A venerable gong opens and closes sessions. Prices are posted on blackboards along the balcony.

On the floor, corn draws the raised hands of traders in the center pit, soybeans hold the stage on the left, and wheat occupies the far right. Paper bags in right foreground hold cash grain samples from carload lots.



"Here Is Your Heart"

This health-education exhibit, designed by the University of Illinois, is displayed by the Chicago Heart Association in the Museum of Science and Industry. Made of wire, burlap, and plaster, the heart is 16 feet high. A million visitors a year walk through it. They see the intricate valve structure and hear the heartbeat's *lubb-dubb* sounds.

Kodachrome by National Geographic Photographer Willard R. Culver

Today Northwestern University has 13 schools and colleges on its Evanston and Chicago campuses.

Now that the University of Chicago has withdrawn from active participation in major intercollegiate athletics, Northwestern is the only Chicago area member of the Western Conference. Dyche Stadium, seating 54,000 spectators, is the scene of thrilling "Big Ten" football games and other major athletic events.

From 1857 until her death in 1898, Frances Elizabeth Willard, president of the Woman's Christian Temperance Union, made her home in Evanston. Rest Cottage, the modest home given her by the W. C. T. U., is preserved as a memorial and is not only open for inspection but has a library in connection with it.

Despite rather narrow, tree-lined streets, Evanston has won awards repeatedly as the safest place for motor traffic in the United States. The Traffic Institute established at Northwestern University in 1936 trains traffic policemen from all parts of the Nation and many foreign countries.

At Wilmette on the lake shore a few miles north of Evanston is the Bahai House of Worship, the white-domed temple of a faith founded in Persia a century ago by a religious leader, Bahaullah. Bahai temple is dedicated to the unity of all peoples and religions, universal education and language, and world peace.

Naval Training Far from the Ocean

To the north are Fort Sheridan, Army reception and separation center, and the U. S. Naval Training Center, Great Lakes, Illinois.

At Fort Sheridan more than 100,000 inductees have been processed since the beginning of the Korean conflict, and 500,000 men of World War II were discharged.

Between Pearl Harbor and V-J Day nearly 1,000,000 men received their basic training for Navy duty at Great Lakes (page 786). In October, 1948, a Wave recruit school was opened, then the only one in the Navy. It was moved later to Bainbridge, Maryland.

Factory chimneys dominate the sky line in North Chicago and Waukegan, though the latter is still the harbor for a fresh-water fishing fleet and has a big fisheries business. In the two cities there are 65 industrial plants. Waukegan was the birthplace of Benjamin Kubelsky, known to the entertainment world as Jack Benny. Surrounding this city is an area of pastoral beauty, dotted with dairy farms, pretty little lakes, and summer resorts.

Near the northeast corner of Illinois is Zion, religious community started by John Alexander Dowie, who believed the world to be flat even after he had made a trip around it.

On a sunny but bracing morning in late April, Louis Weber, reclamation engineer for the Illinois Coal Strippers Association, and I drove out of Chicago to start a tour that was to crisscross 1,800 miles over Illinois from the Wisconsin border, in the latitude of Boston, Massachusetts, to the southern tip, parallel with Norfolk, Virginia.

On our right as we threaded the traffic out of Chicago was Oak Park, once called Saints' Rest because of its many churches. This residential community with a population of 63,529 is the largest village in America; six trustees direct all municipal affairs.

Aurora Started as Two Towns

In the opening words of the State song, "By thy rivers gently flowing, Illinois," lies a fundamental theme of the Illinois story, for it was rivers, providing sites for mill dams, that attracted the early settlers. Most of the older cities and towns are located on the 200 rivers and streams in the State.

On both sides of the Fox River, about an hour's drive from Chicago, is Aurora, a farm town which has gone in for manufacturing in a big way. It started out as McCarty's Mills in 1834 when Joseph McCarty and his brother Samuel selected it as a site for a dam and a sawmill. Joseph McCarty had looked over Chicago but rejected it as "more promising for raising bullfrogs than humans."

Split by the river, Aurora grew up as two rival towns. The public buildings stand on neutral ground, the 10-acre Stolp Island in midstream. On the island stands the 21-story Leland Hotel, highest building in the State outside Chicago.

Aurora boasts that it makes everything from razor blades to road scrapers.

Near by is Mooseheart, the child city, owned and operated by the Loyal Order of Moose for the care and education of deceased members' children. Thousands of children have been educated here since the magnificent project was started 40 years ago.

In 1854 a group of 208 delegates to a "People's Convention" met in the First Congregational Church of Aurora and founded an antislavery party to which they gave the name "Republican." Aurora consequently disputes the claims of Ripon, Wisconsin, and Jackson, Michigan, to the title "Birthplace of the Republican Party." *

Our road north from Aurora took us through smiling farm country along the Fox River to Elgin, the watch city, which like Aurora began as the site of a mill dam.

Founded in 1835 by James T. Gifford, Elgin

* See, in the National Geographic Magazine: "On Goes Wisconsin," by Glanville Smith, July, 1937; and "Work-hard, Play-hard Michigan," by Andrew H. Brown, March, 1952.

A Swedish Freighter, Entering the Calumet River from Lake Michigan, Passes Docks Loaded with Coal, Grain, and Steel

Monica Smith has sailed through St. Lawrence River, Lake Ontario, Welland Canal, Lake Erie, Lake Huron, Straits of Mackinac, and Lake Michigan. Though an inland city, Chicago handles more water-borne traffic than the Panama Canal.

Moats but No Cages Separate Chicagoans and Polar Bears

Brookfield Zoo (Chicago Zoological Park) keeps mammals in surroundings simulating their natural habitat. Dry or water-filled moats prevent escapes. Some hilly backgrounds are composed of artificial rockwork tinted with fresco colors.

Brookfield's attendance is a million and a half a year. On some days as many as 50,000 people enter the gates. With one of the finest and most diversified collections in America, the zoo holds 700 mammals of 200 species, 2,300 birds of 375 species, and 600 reptiles and amphibians of 110 species. There is also a small exhibit of live invertebrates.

Polar bears follow the Arctic ice pack to accompany migrating seals, their principal food. In their native state they experience temperature changes as extreme as those in captivity. These bears were taken as cubs by sailors off the coast of Greenland. Here they beg visitors for peanuts and popcorn; they get a never-ending supply.

prospered early in its history, for it was on the stagecoach road that led from Chicago to the then thriving lead-mining city of Galena. By 1850 the Galena and Chicago Union Railroad had reached Elgin, bringing a temporary boom, but as soon as the line was extended to Rockford, passengers, instead of getting off to settle in Elgin, continued to the end of the line.

The situation was saved finally through Gifford's friendship with B. W. Raymond, third mayor of Chicago. When Raymond went into partnership with eastern investors to establish a watch factory in the Middle West, he gave Elgin the business.

That was the beginning of the Elgin National Watch Company. Two years ago it turned out its 50,000,000th watch.

I went along the assembly lines where deft workers were putting watch movements into cases and making adjustments—an extremely delicate procedure. Each day about 5,500 watches are turned out by the factory. Every part of the watch except the jewels is made in Elgin. The jewels come from Switzerland.

Northwest of Elgin we drove through a rather hilly, grove-dotted region of dairy farms. Fine herds of blooded milk cows grazed in green pastures near trim farm buildings. The principal towns are Marengo, home of a large mousetrap factory, and Belvidere, where sewing machines are made.

Rockford Machines Make Machines

Having been in Rockford for a few weeks in the first year of World War I, I expected to see familiar surroundings when we reached this manufacturing city of 105,438 people, third in size in Illinois. I failed to recognize anything about it except the beautiful Rock River and the fine trees that give it the nickname "Forest City."

Camp Grant, thronged with soldiers in my time, is now a municipal airport, and only a scattered few of the old war buildings remain as homes for industrial workers.

In 1917 the principal industries were the manufacture of furniture, knitted goods, and hosiery. Now, in terms of dollar value, the city ranks fifth in the United States as a producer of machine tools, "the machines that make machines." Furniture and hosiery (people of my generation surely remember the old Rockford seamless socks) are still made here, but metal wares have left them in the background.

With 400 factories making some 300 types of products, Rockford boasts that it is the most diversified city in Illinois. Many of the scores of manufacturing plants started as backroom shops of the clever Swedish artisans whose ancestors came to Illinois a century ago.

As we rode alongside the Rock River, I espied several crews of Rockford College girls rowing racing shells. Century-old Rockford College, which claims Jane Addams, a founder of Hull House in Chicago, as an alumna, is a distinguished school for women.

In its long roster of famous people Rockford lists also James Henry Breasted, renowned archeologist and author; Frank La Forge, noted composer; and Martin Johnson, world traveler and lecturer.

The homey old city of Freeport is only 15 miles from the Wisconsin border, in rich farm and dairy country.* At the village of Winslow near here my mother was born. My grandfather heard the Lincoln-Douglas debate in Freeport on August 27, 1858.

When Lincoln asked Douglas whether the people of a territory could lawfully exclude slavery before adopting a State constitution, the "Little Giant" replied emphatically that they could. By uttering this "Freeport heresy," Douglas split the Democratic Party and made possible Lincoln's election in 1860.

A model of prosperous stability, Freeport changes little through the years. It has well-established industries and a brisk trade as seat of one of the richest counties in Illinois.

Although Galena, now shrunk to a population of 4,648, sits dreaming of bygone glory on its rugged terraces above the Galena, formerly the Fever River, time was when it was the metropolis of Illinois and Chicago a mere trading post. The post office was established here in 1826, the first in northern Illinois. For more than half a century before the Revolutionary War lead was mined on the Fever River by the French, and the district figured prominently in the Mississippi Bubble promotion scheme of John Law in 1717.

Lead mining here became unprofitable in the middle of the 1800's. In the panic of 1857 the old town suffered seriously.

Grant Went Out from Galena to Glory

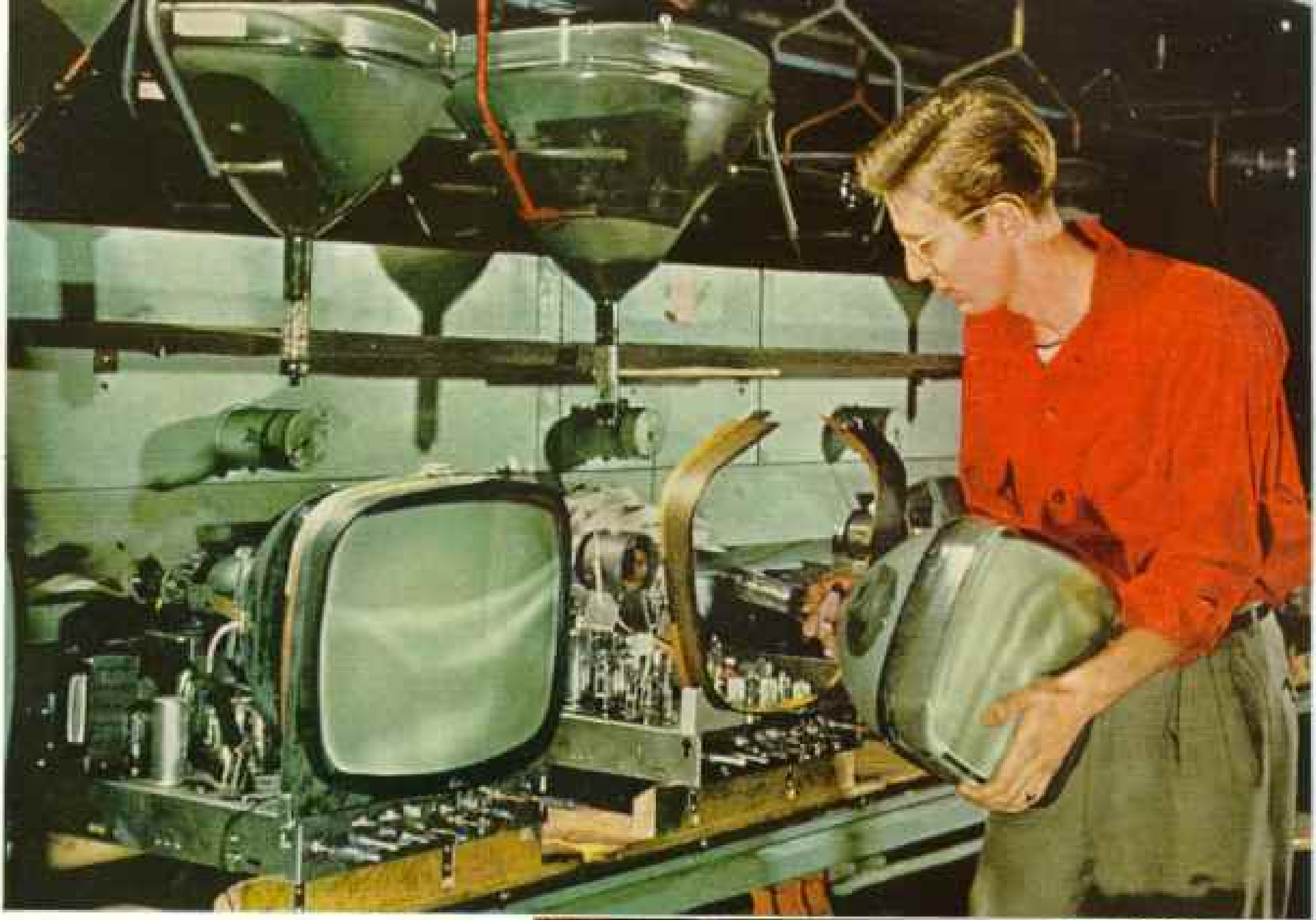
From Galena Ulysses S. Grant went out to duty as a colonel in the Civil War. He had been employed there in his father's leather shop. To Galena he returned in 1865, the conquering general, and received from the townfolk the mansion which still stands as he lived in it, a State-kept memorial.

Northeast of Galena, almost on the Wisconsin border, is 1,241-foot Charles Mound, highest point in Illinois.

Buds were just beginning to open on the trees when Mr. Weber and I left Galena and headed south along the Mississippi River. As

(Text continued on page 805)

* See "Deep in the Heart of 'Swissconsin,'" by William H. Nicholas, National Geographic Magazine, June, 1947.



Zenith TV Sets Speed Down the Production Line

This Chicago workman, having removed the picture tube from the overhead conveyor belt, adds it to the chassis. The chassis now goes to be assembled in a cabinet.

There are approximately 2,100 chances for trouble in one of these receivers, each of which has some 1,500 parts and 580 hand-soldered connections. Inspectors, therefore, make close checks—visual, mechanical, and electrical—as the chassis moves along the assembly line.

Dressmaking Replaces Mining in Herrin

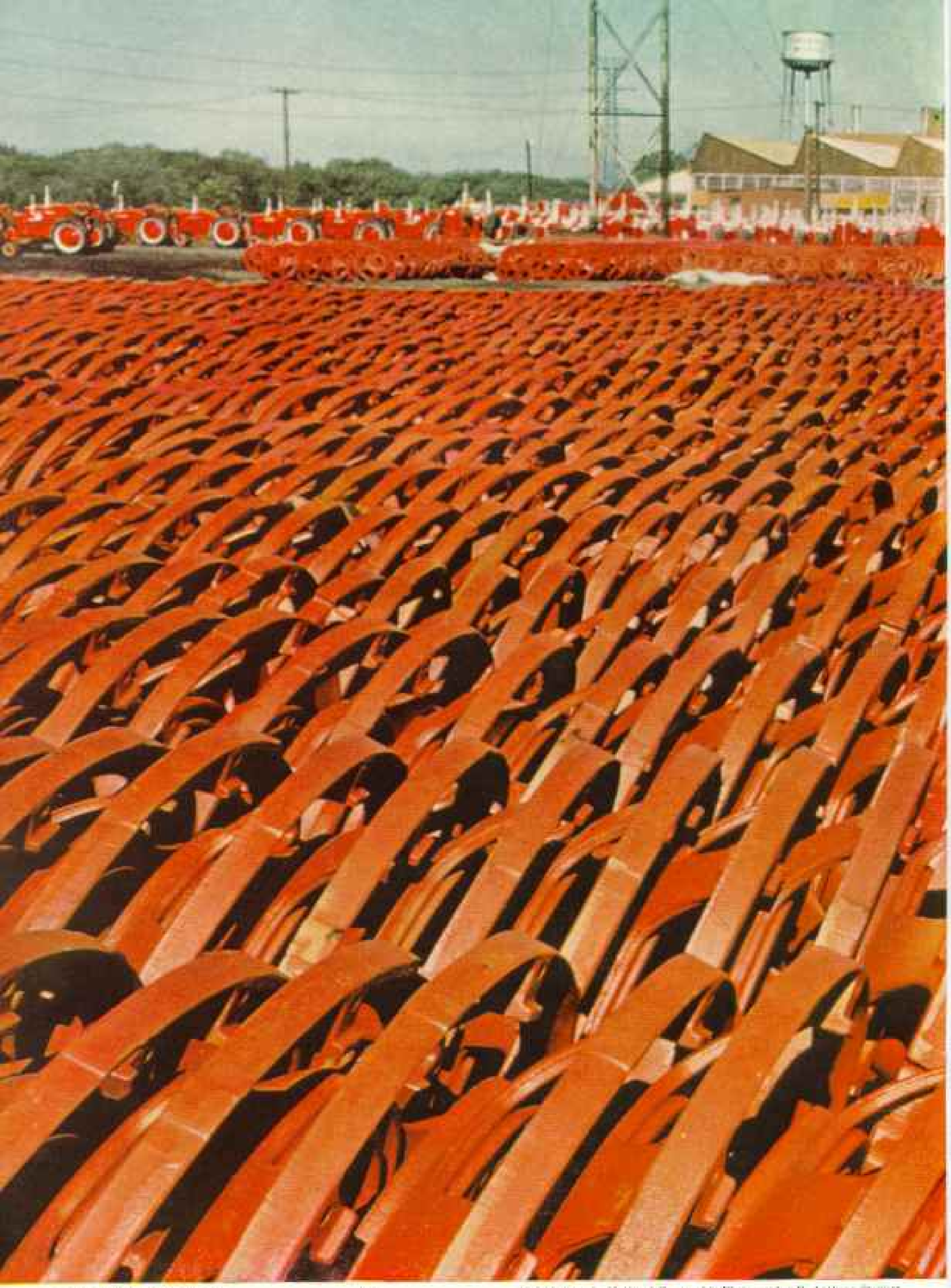
After Herrin's coal mines were worked out, new industries developed to keep the town's economy alive. Smoler Bros., Inc., a Chicago firm, decentralized parts of its business and established this plant, which employs some 500 people.

The checker inspects a consignment of dresses before they go to Chicago.

Kodachromes by National Geographic Photographers Willard R. Culver and B. Anthony Stewart

† Decatur Workers Take a Break on the Roof Garden of A. E. Staley Manufacturing Company, Processor of Corn and Soybeans (Inset)

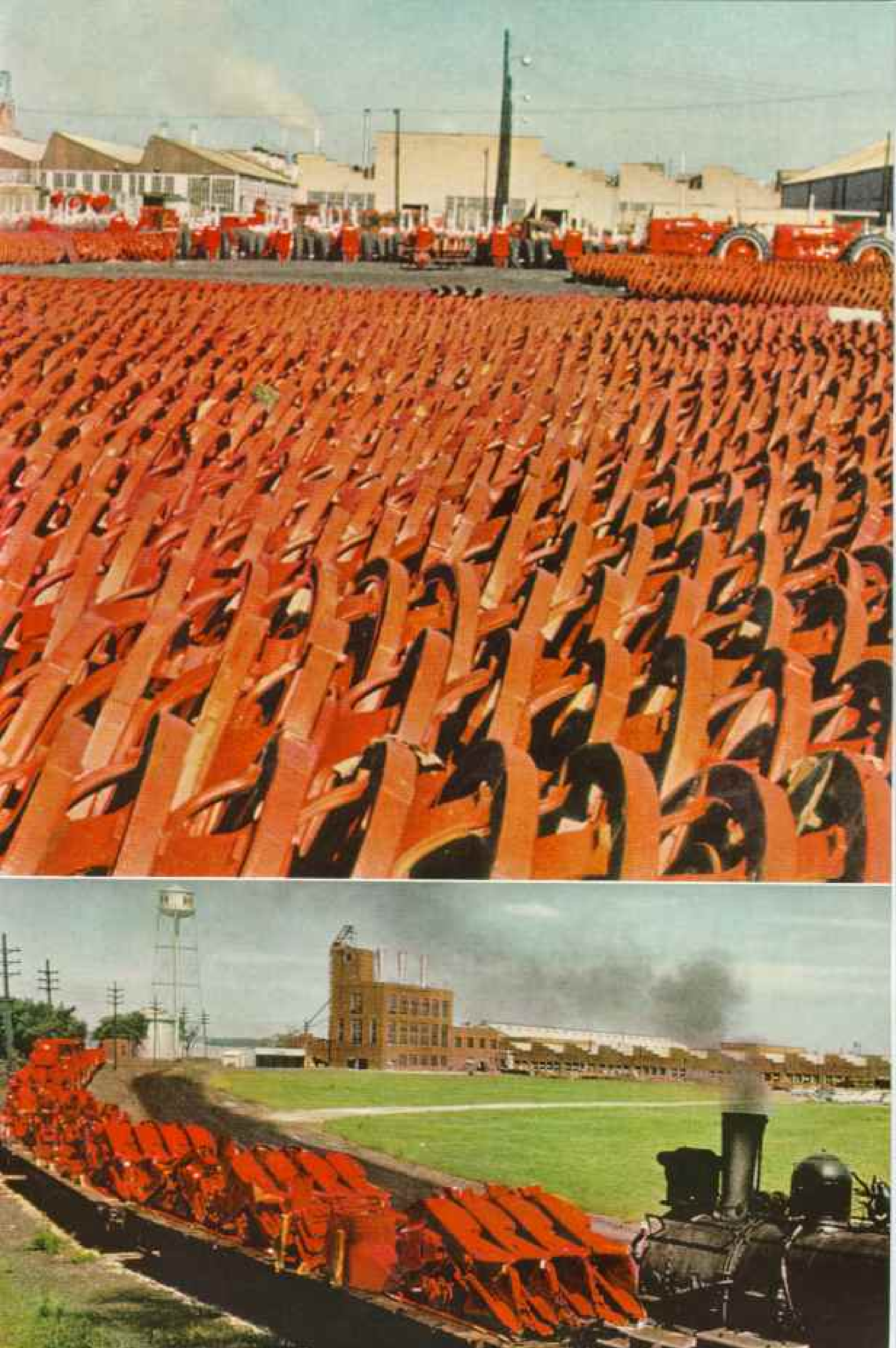
ⱶ A chaplain conducts religious services in one of the plants of R. G. Le Tourneau, Inc., manufacturer of heavy equipment. Attendance is voluntary, and employees are paid full wages for time spent in chapel services.



Kodachromes by National Geographic Photographer B. Anthony Stewart

600 Tractor Wheels Roll Daily from International Harvester's Rock Island Stockpile

➤ Corn pickers move by train from Harvester's East Moline Works to distributors throughout the Nation. Neighboring Rock Island, Moline, East Moline, and Davenport (Iowa) make up the world's farm-machinery capital.



Old Canal Locks Work No Longer at Channahon

Chicago was a sleepy settlement of squatters in 1830 when the Illinois and Michigan Canal was projected as a link between the Great Lakes and the Gulf of Mexico. Interest in the waterway, part of Illinois's feverish campaign for improvements in the 1830's, gave Chicago its first big push. Within three years the town was facing a prodigious population growth that has not yet ceased.

Completed in 1848, the canal's 100 miles connected Chicago with La Salle, at the Illinois River's head of navigation, and revolutionized the Midwest's transportation system. The wealth of the prairies now poured into Chicago rather than St. Louis, for the Great Lakes route to the eastern States was shorter than the Mississippi-Gulf coast passage.

Barge and packet continued to thread the little canal until the early 1900's. Another canal, the sleek and efficient Illinois Waterway, today parallels much of the abandoned ditch.

This old lock stirs memories of days when mules plodded the tree-arched towpath.

Belgian Horses Parade in the $2,000,000 Livestock Exhibit at the State Fair in Springfield

As the climax of five days of judging, champions and reserve champions of all breeds join in a mile-long line-up. Seen between these horses, Jersey cows move in the opposite direction. Inset: Marlene Born, the fair's queen, beams upon Leveldale Basis, the exhibition's 1951 grand champion shorthorn bull.

▲ Field Hands Near Mattoon Harvest 14-foot Broomcorn

Before the plants' heads can be cut off, the tall stalks have to be broken over. Curing sheds dry and bale the brushy parts for shipment to factories (below).

▼ Paris, Illinois, Workers Make the Finished Product—Brooms

Merkle Broom Co. employees scrape off seeds and comb out fibers on revolving cylinders. From this room the brooms go to machines to be sewn.

we rolled downstate, we plunged into the tide of advancing spring. Trees were in nearly full leaf at Cairo on our arrival there a week later. In southern Illinois spring comes nearly a month earlier than in the north.

Our road led us past Mississippi Palisades State Park, one of the finest of the 35 in Illinois, a rugged bit of unspoiled wilderness on high bluffs a few miles north of Savanna.

We found Moline and Rock Island humming with industry as usual. These towns, East Moline, and Davenport, just across the Mississippi in Iowa, are the "Quad Cities," the farm-machinery capital of the world (page 800).

The Quad Cities have six plants of Deere & Company, two manufacturing branches of International Harvester Company, Minneapolis-Moline Implement Company, J. I. Case Company, and many smaller concerns manufacturing agricultural implements.

In 1837, John Deere, a hard-working blacksmith, developed at Grand Detour, Illinois, a steel plow that would successfully "scour" in the sticky Illinois soil.

After a successful start in Grand Detour, Deere moved to the "nice little village" of Moline to take advantage of water power and cheap transportation. He manufactured 700 plows here in his first year.

Plow and Reaper Made Farmers Rich

By 1848 Cyrus Hall McCormick was manufacturing reapers in Chicago. The plow and the reaper launched Illinois on the way to farm wealth.

On a 1,000-acre limestone island in the Mississippi River across a moat from Rock Island and Moline is Rock Island Government Arsenal, making war equipment from ammunition belt links to 30,000-pound gun carriages.

With a population predominantly Swedish and Belgian, Rock Island and Moline retain only faint memories of the Sac and Fox Indians who once dwelt along the Mississippi bluffs. A 207-acre State park near Rock Island is named for the falcon-eyed chieftain Black Hawk, whose braves were defeated in 1832—the war in which Lincoln, a militia captain, said he had "many bloody struggles with mosquitoes."

From Rock Island my companion and I drove southeast across lush farmlands to Galesburg, at once a farmers' town and a railroad and manufacturing city. It is amazing how quickly industrial scenes give way to smokeless agricultural country in Illinois.

At Galesburg is Knox College, the "Old Siwash" of alumnus George Fitch's famous magazine stories of Ole, the Viking fullback who sulked and refused to play until he was initiated into several fraternities. Poet Edgar Lee Masters attended Knox long enough to flunk his Horace, Don Marquis called the school his "step college," and to Eugene Field it was "one of my numerous alma maters."

Although Carl Sandburg, distinguished poet and biographer of Lincoln, is not a Knox graduate, he took his degree at Lombard College, which later was absorbed by Knox. The house where Sandburg was born is now maintained as a show place.

Galesburg owes its beginning to Knox College, for the Reverend George Washington Gale brought the original 200 settlers here in 1836-37 to set up a Christian college on the western prairie. Beside "Old Main," still standing on the campus, Lincoln and Douglas held the fifth debate of their series.

Strip Miners Restore Land

Between Galesburg and Peoria Mr. Weber took me over a strip coal-mining operation. We crossed miles of "spoils," wastes of earth and rock ridges flung up by the scoops of the strippers as they cleared the overburden from beds of coal. Here and there pieces of "place" land had been left undisturbed, parts of farms still under cultivation.

"The companies buy up all of a farm, even though part of it does not contain coal or is unminable; this unmined portion is kept in cultivation," Mr. Weber explained. "Farming continues until stripping begins.

"We don't blame people for complaining about the unsightliness strip mining causes, and our job is to do something about this problem. We have planted 12,000,000 trees on thousands of acres like this.

"In years of intensive cultivation rainfall has leached down mineral nutrients from the surface until the soil will not grow crops without the addition of limestone and phosphates. Stripping brings up the mineral nutrients, and what we try to do is to grow humus builders.

"The coal under a farm is worth from 300 to 500 years of crops. Still, we don't like to cause wastes."

Mr. Weber drove the car into a long ravine-like pit where a gigantic stripper was scooping a 50-foot overburden from a thick layer of coal. With a bucket that took 40 cubic yards from the bank with each bite, it lifted the overburden and piled it to the side of a clearing about 100 feet wide.

We rode on the exposed coal to within 100 yards of the mighty machine. The scoop looked big enough for a two-car garage.

As soon as this strip is finished, loading shovels dig up the coal and put it into trucks to be hauled to the tipple. The shovels hold 7½ cubic yards, the trucks 38 tons. At the tipple the coal is washed and put aboard railroad cars for shipment to market.

Cairo Thrusts a Wedge into the Junction of the Mississippi (Left) and the Ohio

Southern Illinois is often called "Egypt" because of fancied resemblance to the Delta of the Nile. Cairo's name furthers the idea. Actually, the country, with its magnolias and cotton, suggests the Deep South.

807 Kodachrome by National Geographic Photographer B. Anthony Stewart

Towering Levees Have Protected the City from Disastrous Floods for a Century

Here the Mississippi at high water leaves Cairo dry while inundating cities upstream. Towboats and barges moored in the calm Ohio call to mind the days when 100 vessels were tied up at a time.

The overburden from the next strip is dumped into the empty pit, and this process goes on until the last cut of the job is reached.

"What happens to the last cut?" I asked the superintendent in charge.

"That fills with ground water," was the reply, "and becomes a lake. We have made 2,500 acres of new lakes and stocked more than half of them with fish."

Near Danville a week later we visited another strip-mining district where enormous dragline strippers were employed. Danville, home of Joseph Gurney ("Uncle Joe") Cannon, famous speaker of the U. S. House of Representatives, of which he was a member for 46 years, began as a village around a salt lick. Now it is a brisk manufacturing, farming, and strip-mining center.

In 1952 the strip mines in Illinois produced 17,000,000 tons of coal—slightly more than 37 percent of the State's total coal production. Thus far, 55,000 acres of land have been stripped. The companies have given clubs and communities large tracts for recreational uses.

William Cooke, president of the Illinois Coal Strippers Association and owner of the rich Little Sister mine south of Canton, is a reclamation enthusiast. He has graded 1,500 acres and put it to diversified farming.

Chief among his enterprises is a "pig hatchery" equipped to handle 10,000 pigs a year. His stock is an aristocratic cross between Hampshire hogs and the famous Danish Landrace breed. In a palatial farrowing house the pigs are left with the sows for three weeks, then put on a formula of synthetic milk containing penicillin, aureomycin, and terramycin. When they are eight weeks old, they are turned over to tenant farmers or sold.

Mr. Cooke goes in for everything on a grand scale. Finding that multiflora roses make animal-tight hedges, he planted miles of them.

Progressive Peoria, Industrial Giant

We went alongside the Illinois River northeast to Peoria, second city in Illinois with a population in 1950 of 111,856. One of the oldest settlements in the Mississippi Valley, Peoria in 1825 was the seat of the county of which Chicago was a tiny precinct.

Situated 130 miles southwest of Chicago on the Illinois River, most important link in the Great Lakes-to-Gulf waterway, Peoria has become an industrial giant.

The Caterpillar Tractor Co. is the largest of its 160 industries. In a similar enterprise Robert G. Le Tourneau, evangelist engineer who says, "God runs my business," started a big factory which he sold recently (page 799).

Perhaps the most famous Peorian of the past was the freethinker, Robert G. Ingersoll. The Most Reverend Fulton J. Sheen, Mr. and Mrs. Jim Jordan (Fibber McGee and Molly), and Charles Correll, the Andy of "Amos 'n' Andy," are present-day celebrities born in Peoria.

Peru and La Salle owe their early growth to the old Illinois and Michigan Canal, for Peru, founded in 1835, became terminus of the waterway completed in 1848. When La Salle built a steamboat basin, however, it took the canal trade away from its sister town. La Salle had its birth in 1827 when plans were started for the old waterway. The two towns were at the head of navigation on the Illinois River.

Peru's principal business wakes up more people than any other concern in America, for its product is alarm clocks—Westclox and Big Ben.

At Ottawa on August 21, 1858, the first Lincoln-Douglas debate attracted a crowd of 10,000, twice the population of the town.

Starved Rock State Park, second oldest State park in the Illinois system, is near Ottawa. With 1,437 acres of bluffs, canyons, and gigantic rocks, it offers rugged natural scenery.

Joliet a Great Wallpaper Center

With seven plants, Joliet has the greatest concentration of wallpaper manufacturing in this country. Here also is the world's largest nail factory and important works of the American Steel & Wire Division, United States Steel Corporation. The city lies on the Great Lakes-to-Gulf waterway, which carried 17,500,000 tons of barge freight through the Des Plaines River in 1952.

Besides its tremendous output of manufactured goods, Joliet produces what it proudly boasts are the best bands in the country. High-school youngsters here have won so many contests that few band musicians from other cities will venture to play against them.

Around Bloomington and its next-door neighbor Normal the rich black soil of the level Illinois prairies produces prodigious crops of soybeans and hybrid seed corn, insuring prosperity for the citizens of the two towns.

Of distinguished literary and national figures Bloomington has produced a proud quota; to mention just a few: Elbert Hubbard; Sidney Smith, creator of Andy Gump; Melville E. Stone, co-founder of the *Chicago Daily News* and first manager of the Associated Press; Adlai E. Stevenson, Vice President of the United States under Grover Cleveland; and his grandson Adlai E. Stevenson, former Governor of Illinois and recent Democratic candidate for the Presidency.

Bloomington claims the oldest Passion play in the United States, a 65-scene performance

809 Kodachrome by National Geographic Photographer B. Anthony Stewart

Meat Products Make East St. Louis a Leading Packing Center

Swift & Company's bacons, hams, frankfurters, and table-ready meats surround a tray of spices which are used in their recipes. The wire basket shapes a special product.

which has been presented annually twice a week in April and May for 31 years.

From religious pageantry to the circus seems a far cry; yet Bloomington has won fame for the trapeze performers who have prepared their acts there. Clyde Noble, retired member of the "Five Flying Fishers," says as many as 200 aerialists have trained in Bloomington at the same time. The tradition started in the 1890's with two farm boys, the Green brothers, who, after seeing a traveling circus, went home and practiced in the haymow till they had an act which later was featured in Barnum's circus.

To Decatur, founded in 1829, Abraham Lincoln came with his father's family as a youth of 21. He and his cousin, John Hanks, split rails for a living here in 1830.

When the Republican State convention met in Decatur on May 9, 1860, Hanks carried in two rails with a Lincoln banner, stampeded the convention, and defeated William H. Seward.

Nowadays Decatur is a railroad and manufacturing center making goods ranging from fly swatters to steel bridges. Its main claim to fame, however, is that it is the leading soybean processing center in America.

Mr. Weber and I visited the magnificent plant of the A. E. Staley Manufacturing Company, maker of soybean and corn products (page 798). It is the largest of five processing concerns in the city, which together can handle 50,000,000 bushels of soybeans a year.

From Decatur we swung south to Pana, a coal-mining town which paradoxically ships out annually to florists all over the country 20,000,000 cut roses. There are 60 acres of roses under glass in five big nurseries.

"How did you happen to start rose culture in a coal town?" I asked a rather taciturn owner of one of the largest nurseries.

"Well," he said, "we had five deep mines in the 1920's (there is no strip mining around Pana) and four railroads, but coal got so cheap we decided to try something else."

Surplus Crops Stored in Field Towers

Beside the road on our way to Springfield I noticed a large group of round towers. I had seen scores of these throughout the journey, often in fields far from market centers.

When I asked a farmer what they were, he said with a grin, "Those are monuments to legislative attempts to repeal the law of supply and demand. They are filled with soybeans, corn, and grain the Government has bought and stored to keep prices up."

Springfield, the State capital, is the heart of Lincoln Land. Though the Great Emancipator was born in Kentucky and grew to manhood in Indiana, he is best known to history as "Abe Lincoln of Illinois."

A two-story frame house, the only home Lincoln ever owned, is kept with some of the original furnishings much as it was when he and Mary Todd Lincoln lived in it. Open to the public, it annually attracts hundreds of thousands of visitors.*

A towering obelisk in Oak Ridge Cemetery dominates the Springfield sky line. There rests the body of the man who "belongs to the ages." The tomb is a national shrine maintained by the State.

Everywhere in the capital city I saw reminders of Lincoln. The Abraham Lincoln Hotel had a picture of Lincoln in every room, and his likeness even on the paper wrappings of the sugar cubes in the restaurant. Going about town, I counted 39 establishments using the word "Lincoln" in their names.

Springfield is a sprightly, prosperous city of 81,628 population, fifth in Illinois. Coal underlies even the capitol, and one deep mine was in operation until 1952 (page 815).

The Sangamo Electric Company is a major producer of electric meters and electronic equipment. Making road-grading and earth-moving machinery are Allis-Chalmers Manufacturing Company and the Baker Manufacturing Company.

Youthful Lincoln Worked in New Salem

Before starting out from Springfield for southern Illinois, Mr. Weber and I pursued history to New Salem State Park, the faithful restoration of the village where young Lincoln was by turns laborer, storekeeper, postmaster, surveyor, and legislator. We went on two miles to Petersburg to visit the grave of Ann Rutledge, at whose father's tavern Lincoln lived for a time.

Although legend says Ann was so beloved by Lincoln that her untimely death in 1835 almost ruined his career, scholars have been unable to substantiate the story. Whether or not the tale is true, Edgar Lee Masters' verse engraved on the girl's tombstone is exquisitely poignant:

> Out of me unworthy and unknown
> The vibrations of deathless music;
> "With malice toward none, with charity for all."

Carthage, a few hours' drive northwest of Springfield, still preserves the old jail where Joseph Smith, founder of the Church of Jesus Christ of Latter-day Saints, and his brother Hyrum were shot and killed by a mob June 27, 1844. They were being held awaiting trial on charges of destroying an opposition press in Nauvoo (page 816), a city the Latter-day Saints had built.

On a maple-shaded campus in Carthage is

* See "Vacation Tour Through Lincoln Land," by Ralph Gray, NATIONAL GEOGRAPHIC MAGAZINE, February, 1952.

National Geographic Photographer David S. Boyer

A Deaf Boy Learns to Speak at Illinois State Normal University

By mimicking the mouth movements of his teacher, by hearing her voice and his own powerfully amplified, and by comparing the vibrations in the two throats, the child masters pronunciation of words applied to objects put before him, such as the pictured doll and apple. Apparatus used in these techniques was originated by Alexander Graham Bell, inventor of the telephone. The girl taking notes hopes to become an instructor.

Carthage College, alma mater of my good friend, the late William H. Nicholas, an assistant editor of the NATIONAL GEOGRAPHIC MAGAZINE at the time of his death in 1952.

Our trip south began at Quincy, a comfortable old city on the Mississippi River. In the middle of the business district is a New England-type town square, Washington Park, where the Mormons rested on their flight from Missouri and where Lincoln and Douglas held their sixth debate on the slavery question.

The heyday of steamboat traffic on the Mississippi made Quincy a boom town before the Civil War. Now it derives its income from farm trade, modern industries, and the business of the Chicago, Burlington and Quincy Railroad. The famous stern-wheelers that once crowded its water front are but pleasant memories.

A sensible Quincy business woman said to me, "We don't have sudden bursts of excitement here. Most Quincy industries are conservative and long-established. Quincy is a city of prosperous contentment."

At Alton we entered one of the most intensely concentrated industrial areas in Illinois. The city, five miles north of the confluence of the Missouri and Mississippi Rivers, has the Owens-Illinois Glass Company, largest glass-container factory in the world, and the Olin Industries, Inc., makers of ammunition. Besides these there are big oil refineries, steel mills, a huge boxboard factory, and scores of smaller plants. Tows of laden barges pass constantly through a Federal lock in the Mississippi, and smoke from hundreds of chimneys lies heavy over the water front.

On high bluffs above the factory district, residential Alton is smokeless. I found Shurtleff College and Western Military Academy, where I was a faculty member at the beginning of World War I, not greatly changed.

Lincoln "Fought" Comic Duel Near Alton

Alton was the scene of the final debate between Lincoln and Douglas in 1858. Twenty-one years earlier the Abolitionist editor Elijah Lovejoy was murdered here while guarding his printing press from a proslavery mob.

Lincoln and James Shields met three miles from Alton to settle in a duel a dispute about newspaper letters—one written by Lincoln and the others by Mary Todd and Julia Jayne—which Shields said had libeled him.

Teacher Makes a Toy Horse from Paper, Paste, Paint, and Scrap Wire

University of Illinois Extension Service holds summer sessions in handicrafts for teachers and others who cannot go to the campus. This student takes the course at the Junior High School in Belleville. After 10 days of training she will return to grade school and teach her young charges to amuse themselves by constructing art objects out of household scraps such as newspapers, paper boxes, and wire coat hangers. Masks made from paper sacks decorate this wall.

Illinois Students Meet at the Library

Safeguarding more than 3,000,000 books and manuscripts, the University of Illinois library claims the largest collection of any State university. Only Harvard and Yale among privately endowed universities exceed its holdings.

These stone figures were carved by sculptor Lorado Taft, an Illinois alumnus of 1879, for his never-finished Fountain of Creation. Together with other objects from his studio, they were moved to Urbana-Champaign after his death in 1936.

814 National Geographic Photographer David S. Boyer

Armour Laboratories Pharmaceutical Center Processes Blood for Gamma Globulin

To obtain gamma globulin, a protein blood fraction used to give temporary immunity in poliomyelitis and other diseases, scientists use a battery of mixing tanks and centrifuges (the frosted cones). A second fraction, serum albumin, goes to the armed forces for use in shock. Blood comes via the Red Cross from donors across the country. Kankakee, scene of this operation, is one of the State's fastest-growing cities.

As the challenged party, Lincoln chose broadswords as weapons, and when his opponent saw him easily cutting twigs from a tree far above the shorter man's reach, the farcical "duel" ended before a blow was struck. Lincoln made a tongue-in-the-cheek statement which Shields accepted as an apology.

A leading stockyards and meat-packing center, East St. Louis has grown to a city of 82,295, fourth in size in Illinois (page 809). The famous Eads Bridge built in 1874 still carries rail traffic to St. Louis.

Belleville (page 812), virtually continuous with East St. Louis, is built on high bluffs. Near by is Scott Air Force Base with some 10,000 military personnel and 1,800 civilian employees.

Mr. Weber and I paused a few miles south of Belleville at a nursery specializing in white asparagus. To obtain long white stalks, the growers hill up the plants in high ridges. The blanched stalks are cut at the base as soon as shoots appear above the ground. Some of the asparagus spears we saw were two feet or more long, yet tender their entire length.

As we drove south from Belleville, we left the level stretches of corn land and came into hilly country that reminded me of Kentucky. Redbud was blooming by the wayside. Because of a fancied resemblance to the Delta

of the Nile, southern Illinois is called "Egypt." At Cairo (pronounced Care-o in Illinois) on the southernmost tip of the State the Ohio River joins the Mississippi. The two mighty rivers and their tributaries carry water from 30 States past levees which protect the old town (page 806).

Two high bridges loom above the embankments, one carrying traffic across the Mississippi from Missouri, the other, more than a mile long, spanning the Ohio from Kentucky.

Here spring wakes in February, ginkgo and magnolia trees thrive, and cotton is grown on thousands of fertile acres. The population of Cairo is 33 percent Negro.

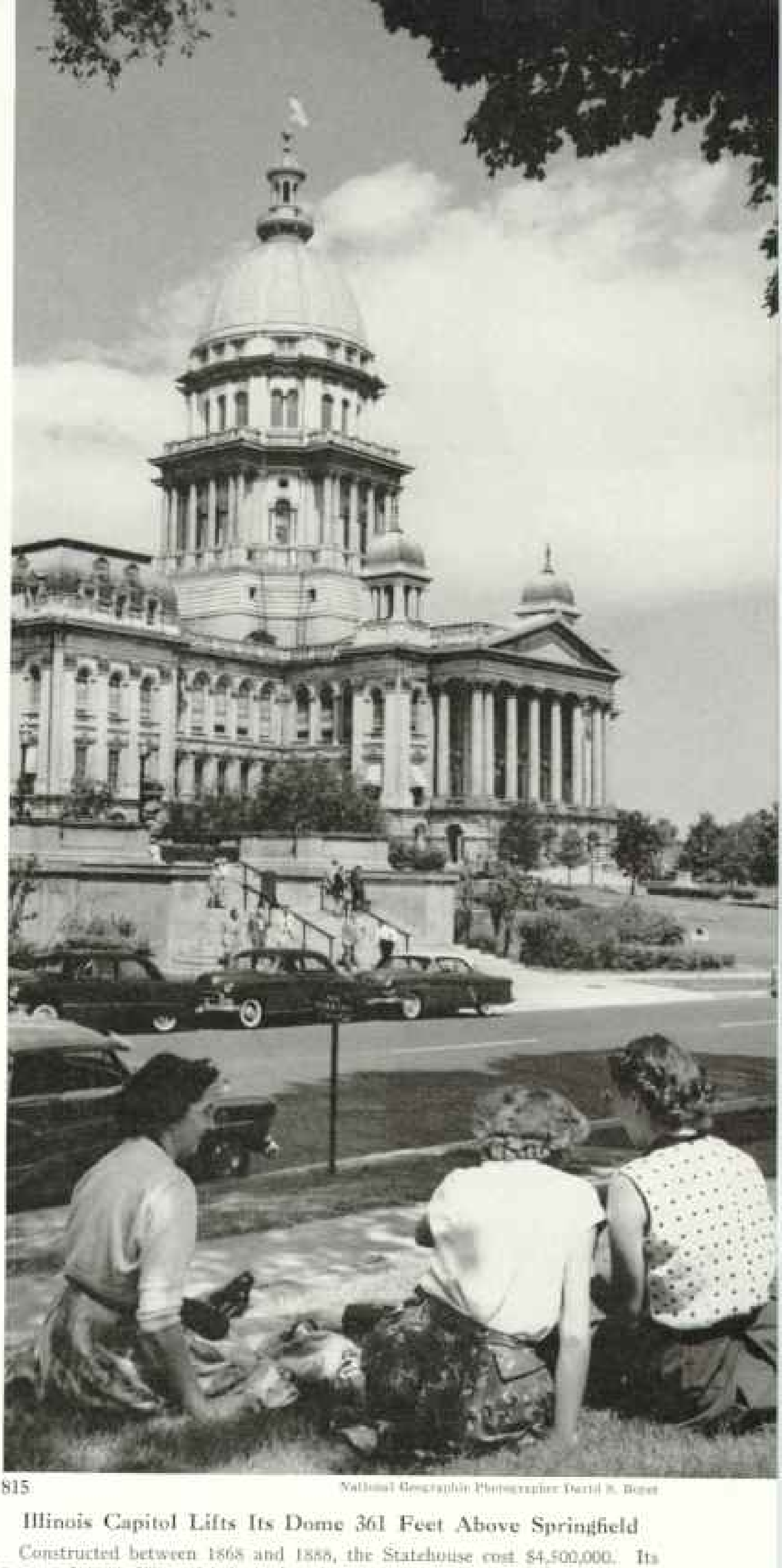
In the days when Cairo was in its glory as a river town, as many as 100 river boats were tied up along the Ohio levee at one time. High water lifted them above the wall so that people in the streets looked up at them.

Thirty miles up the Ohio from Cairo, Metropolis, which dreamed of being the "City of the West" in early steamboat days but withered when the river packets ceased to ply, now enjoys an influx of residents because of the huge 5,000-acre atomic energy installation across the river 10 miles west of Paducah, Kentucky.

The mines which supply a large proportion of the fluorspar used in this country are around Rosiclare. Some of the output has been mined under the Ohio River.

Now moved back from the calm-looking stream which can be cruelly treacherous is most of old Shawneetown,* but a few

* See, "Shawneetown Forsakes the Ohio," by William H. Nicholas, NATIONAL GEOGRAPHIC MAGAZINE, February, 1948.



815

National Geographic Photographer David S. Boyer

Illinois Capitol Lifts Its Dome 361 Feet Above Springfield

Constructed between 1868 and 1888, the Statehouse cost $4,500,000. Its 9-acre plot overlies a rich bed of coal. The last of Springfield's deep mines shut down in 1952 when most coal seams beneath the city and its environs became exhausted (page 810).

Cheese, Wine, Grapes Prosper Nauvoo, the Town That Died Twice

In 1839 Joseph Smith and the Mormons drained malarial swamps, built a town, and named it Nauvoo "the beautiful." Within two years they began erecting a massive temple. Nauvoo claimed 15,000 people when Chicago had 5,000. But by 1844 Mormons and non-Mormons were quarreling, and one day a mob in Carthage shot Smith and his brother. To escape persecution, the Mormons later abandoned Nauvoo and began their epic wagon journey into Utah.

In 1849 Etienne Cabet and some 200 French followers known as Icarians moved into the Mormon homes and started an experiment in communism. They took school-age children away from parents and returned them for visits on Sundays; they allowed only one man to handle money. But shirking and greediness undermined Utopia, and Nauvoo again was given to weeds and rats.

Today's 1,200 inhabitants undertake no revolutionary social experiments. They make a quiet living tending wineries, cheese caves, and limestone quarries. September's annual Grape Festival celebrates the Wedding of the Wine and Cheese.

Kodachromes by National Geographic Photographer B. Anthony Stewart

of the old-timers still cling to their homes on the bank.

Oil has brought wealth to Mt. Carmel, where 355 wells have produced 9,336,000 barrels since 1940. Now the yield exceeds 825 barrels a day.

We lodged for a night near Carbondale in a motel on the shore of Crab Orchard Lake, largest artificial lake in southern Illinois. Stocked with bass and bluegills, it affords good fishing.

In Carbondale is Southern Illinois University, second largest State-supported university in the State. It is called "the suitcase college" because most of its 3,000 students live in near-by towns and go home for week ends.

Peaches, apples, and other fruits account for much of the prosperity in Carbondale, although the city is near a coal-mining district.

I talked to R. D. Lane of the Central States Forest Experiment Station, who is initiating a program of research to determine the best way to reforest submarginal lands in southern Illinois. There are large tracts of merchantable hardwood timber in the hill country.

Near Du Quoin is the United Electric Coal Companies' Fidelity mine, largest strip mine in Illinois (page 818). On reclaimed land the United Electric owners have hundreds of acres of bearing peach and apple orchards, also pasture lands. Another large tract of spoils has been converted by the Coca-Cola Company into a picnic park and one of the finest trotting-race tracks on the Grand Circuit.

Over at Herrin deep-mine coal production has declined to the point where new industries must be established to take care of jobless workers. A big dress-manufacturing concern is one of the most important (page 797).

Center of Population Near Olney

We passed scores of oil pumps working steadily in the middle of cultivated fields as we rode to Dundas near Olney to see the monument that marks the center of population of the United States (page 820). Laughing, my companion suggested that we walk a few steps westward from the marker, for he said the center is shifting that way and he wished to be sure he had stood on the exact spot.

Cornfield oil wells were numerous as far north as Effingham. There I was interested in the Petty store, a small-city retail establishment which has won acclaim for its revolutionary cost-saving methods.

"No wonder Charlie Brown, our National Geographic Society chief auditor, is efficient," I remarked. "This is his home town."

Around Mattoon, north of Effingham, fields were being prepared for the planting of broomcorn (page 804), a crop grown in comparatively few areas in the United States.

In late afternoon we came into Champaign-Urbana, twin-cities seat of the great University of Illinois (page 813).

In the words of Lincoln's Gettysburg Address the university, which represents the whole State of Illinois in miniature, may be described as "of the people, by the people, and for the people."

All over the big campus, faculty and students (there are more than 18,000 students in residence and 3,000 faculty members) were engaged not only in academic courses but in research vital to business, agriculture, and public welfare.

Cure for "Tired Tracks"

Railroad officials came to the university scientists years ago with the problem of mysteriously cracking rails. Using an ingenious rolling load machine that in a week subjected a rail to the equivalent of a year's service, Prof. H. F. Moore found the cause of the trouble and proved that controlled cooling, earlier suggested in Canada, would put an end to what is called "rail cancer."

The research cost the railroads $200,000. Already it has saved them millions and insured against train wrecks caused by "tired tracks."

Prof. Joseph T. Tykociner pioneered in photographing sound on a motion picture film. As the result of such experiments, the world now has talking motion pictures.

Prof. Julian R. Fellows, because his wife was annoyed by the smoke and dirt of her soft-coal furnace, developed a downdraft furnace that not only does not smoke but saves coal by consuming more of the gases.

Awe-struck, I watched the "magic brain" of the University of Illinois computer multiplying two 12-digit numbers a thousand times in a second.

The betatron was invented by Prof. Donald W. Kerst. His 340,000,000-volt machine splits atoms and takes pictures through 20 inches of steel.

In the Morrow plots on the agriculture campus, scores of soil-fertility problems have been solved by experiments which have gone on continuously since 1876.

The university planted in its own greenhouses the first soybean seeds ever tested in the Middle West. By a determined campaign Dr. William L. Burlison sold to farmers the idea of growing the crop. Only 15,000 bushels of soybeans were grown in Illinois in 1914. In 1950 the State produced 95,700,000 bushels, worth more than $200,000,000. University chemists have discovered dozens of uses for the beans.

I found veterinarians and other scientists working on experiments that have conquered

Giant Shovels Dig Earth and Coal Near Du Quoin

Layers of bituminous coal underlie about two-thirds of Illinois. Stripped, many a farm has yielded a crop of coal worth hundreds of crops grown on the surface. Fields ripped apart become tumbled wastes known as spoils. Under a reclamation program spoils are being restored to forests, lakes, and farmlands.

United Electric Coal Companies, which extracts the fuel from this 6-foot seam, specializes in the planting of orchards on torn-up fields.

Removing overburden, the distant shovel takes 35-cubic-yard bites. Its smaller companion loads coal into a 38-ton truck. Taken to a tipple, the coal will be washed and graded.

∀ Oil Field Pumps Work Amid Corn

Although his lands produce 50 barrels of petroleum daily, Ben Young prefers to call himself a farmer. On his 400 acres near Odin he cultivates corn, soybeans, wheat, and alfalfa right up to the pumps. Like many other wells in Illinois, this one is flooded with water to speed up output.

820

Center of the Nation's Population Lies in a Southeastern Illinois Cornfield

Olney, a town close to the site, celebrated establishment of the location in 1951. A monument now stands on the spot (page 817). Since the 1950 census the true center has shifted slightly westward.

many diseases of stock, increased output of dairy products, made hens lay more eggs.

At its own airport the university maintains 37 airplanes, and 250 of the faculty are licensed pilots. They fly all over the State to conduct extension classes. By thus saving time, they are able to teach students in distant towns and return the same day.

In the autumn of 1952 on my first visit to the University of Illinois I saw a football game in the magnificent stadium which seats 71,000 spectators. The Illini that day defeated the University of Washington 48 to 14. As an alumnus and former faculty member of the University of Washington, I was a little downcast, but I enjoyed the spectacular performance of the 175-piece Illinois football band and their Indian dancer Chief Illiniwek.

To one who has deplored reports of irreligion in modern colleges, the University of Illinois offers heartening reassurance. There is no compulsory chapel, yet the students go to church.

Religion Flourishes in Illinois

Fourteen denominations have campus church foundations, and most of the churches are obliged to conduct two services every Sunday to accommodate the crowds of students who come voluntarily.

To me the sight seemed further proof that this country is still healthy at heart.

New National Geographic Map Presents the Busy, Historic Great Lakes Region

IN the heart of eastern North America lie five geographical features so huge that they could easily be seen from the moon with the naked eye. "Seas of Sweet Water" they were called by 17th-century French explorers. Today we know them as the Great Lakes—and perhaps no feature on the earth's old face better deserves the adjective.

Shared by Americans and Canadians, the Great Lakes influence the lives of millions in the most populous areas of the United States and Canada. Affecting climate, bearing ships, yielding fish and recreation, these gifts of ancient glaciers are bounties beyond price.

Now, in a new 10-color map, "The Great Lakes Region of the United States and Canada," the National Geographic Society presents these five fresh-water seas and all or part of 22 States and three Provinces.

More than 2,160,000 copies of this special supplement to the December NATIONAL GEOGRAPHIC MAGAZINE have been printed to meet the needs of The Society's world-wide membership.

Nearly 12,000 Places Shown

On wall or desk—or in the car—the map will serve as an ever-ready guide to one of the busiest, most productive, and most scenic areas of the world. Members will find it useful for reference also in reading the articles on Illinois and Ontario in this issue. It contains more place names—11,959—than any map ever before published by The Society.*

Notes in blue on the Great Lakes point out water links with their neighbors. Four of the notes refer to large-scale insets that hold a magnifying glass to canals, locks, and dredged river channels connecting the sweet seas. Through these passages glides an endless procession of ships hauling iron ore, grain, fuel, automobiles, and other merchandise—an annual tonnage exceeding that of all Uncle Sam's ocean-going merchant fleet. One inset shows how the Illinois Waterway bypasses to the Mississippi part of the Great Lakes' natural drainage to the St. Lawrence.

Many new features—roads and towns, military bases, canals, and dams—appear on this National Geographic map, 42 by 28 inches.

The atomic age is represented by Chalk River, in the Ottawa River valley, site of Canada's nuclear research station, and by two major centers for U. S. study: the Argonne National Laboratory near Chicago, and Brookhaven on Long Island, location of Brookhaven National Laboratory.

Railroads and highways lay a tight mesh of travel routes across the map area. Many of these thoroughfares follow pioneer pathways through the mountains and along the rivers toward the west. Transcontinental highway U. S. 40 roughly coincides with the old National Road that led settlers toward St. Louis.

Nine of the 10 largest cities of the United States (all except Los Angeles) appear within the mapped area. Three of them—Chicago, Detroit, and Cleveland—bathe their feet in the Great Lakes. Five States shown—New York, Pennsylvania, Ohio, Indiana, and Illinois—together have 48,000,000 people, 31 percent of the Nation's population.

Despite the map's emphasis on the tremendous development of man's works in this region, primeval spots remain. Roadless areas preserve wilderness conditions in Ontario's Quetico Provincial Park, in the northwest corner of the map, and in the adjoining U. S. Superior National Forest. In parts of the latter, even airplanes are forbidden.

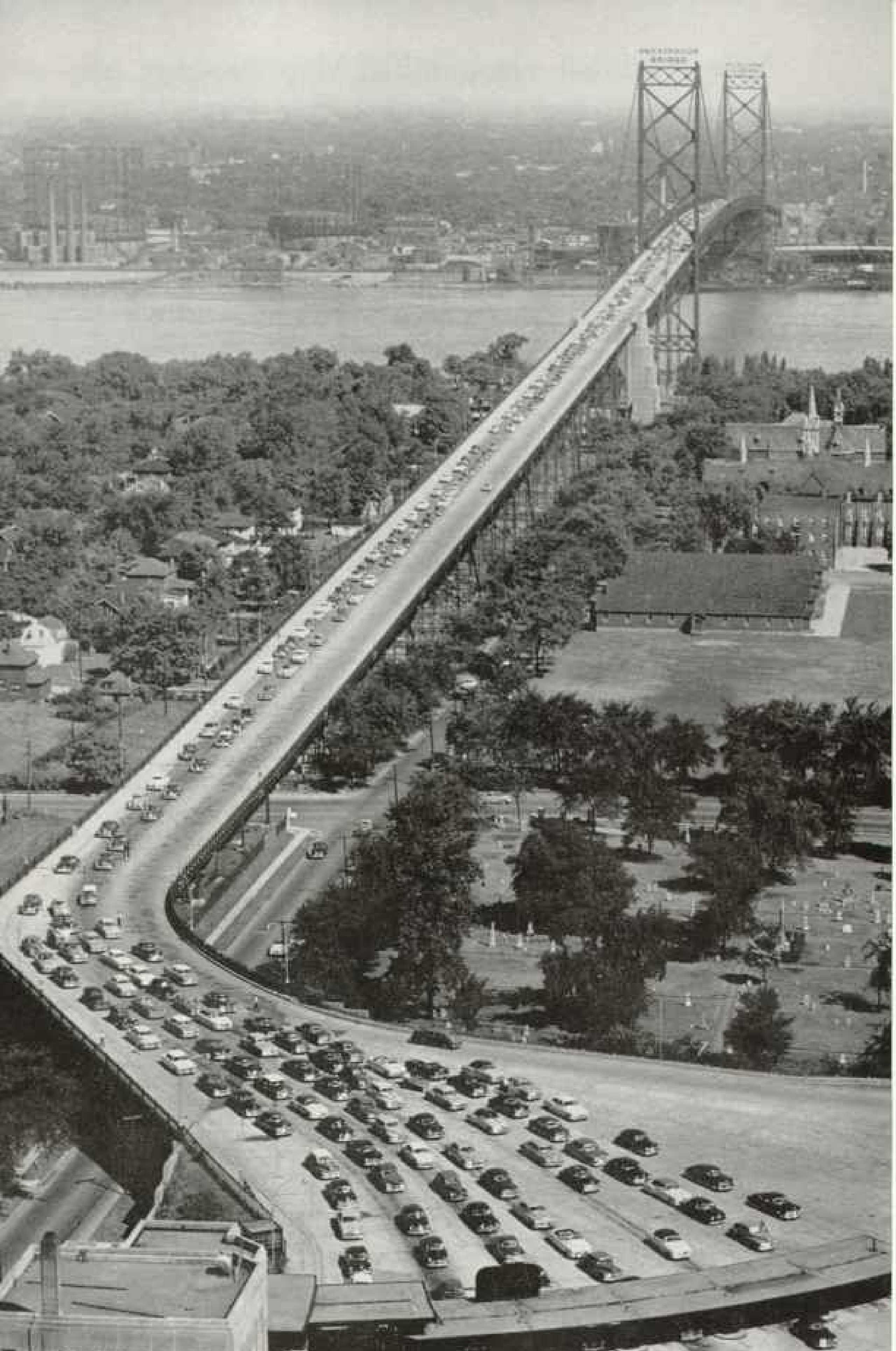
For 1,290 miles along the Great Lakes and the St. Lawrence River, Canada and the United States meet on a peaceful water boundary. A 48-mile stretch of this border, between Ogdensburg, New York, and Cornwall, Ontario, is the area involved in the proposed St. Lawrence Seaway and Power Project. Its proponents envision canals of 27-foot depth and a giant powerhouse with a hydroelectric output of 2,200,000 horsepower.

How the Great Lakes Got Their Names

Lake Superior, incidentally, is the only one of the five Great Lakes whose name has no Indian associations. French explorers called it *le lac supérieur*, meaning "the upper lake." No more apt designation could have been chosen for so majestic a body of water.

Huron tribes and Lake Huron took their names from a French epithet meaning "bristly savage." The name of Lake Michigan came from Algonquian words for "wide waste." Erie, possibly Indian for "long-tailed cat," named a tribe and the shallowest of the Great Lakes. Ontario is from the Iroquoian for "beautiful lake." Other rhythmic Indian names—Mississippi, Keweenaw, Winnebago, Ottawa, Menominee, and many more—stud the map, keeping alive memories of America's first settlers.

* Members may obtain additional copies of the map of the Great Lakes Region of the United States and Canada (and of all standard maps published by The Society) by writing to the National Geographic Society, Washington 6, D. C. Prices in the United States and elsewhere, 50¢ each on paper; $1 on fabric; Index, 25¢. All remittances payable in U. S. funds. Postpaid.



Ontario, Pivot of Canada's Power

Cities Burgeon, Pastures Sprout Factories, Forests and Mines Give Up Their Wealth in the Great Midland Province

By Andrew H. Brown

National Geographic Magazine Staff

With Illustrations by National Geographic Photographers B. Anthony Stewart and Bates Littlehales

AFTER 4,000 miles of travel through Ontario I felt that I had explored a whole country rather than just one of Canada's ten Provinces.

This was not surprising, for Ontario is larger than France and Spain together. It measures more than 1,000 miles north to south, linking polar bears and peaches. East to west it spans an almost equal distance, sharing the international border from New York State all the way to Minnesota.

The Province, furthermore, comprises a range of geography that many entire nations lack—from unpeopled wilderness to tightly cultivated farmland and teeming cities.

It is the very bigness of Ontario, plus the strength of great resources, that makes mighty this richest, second largest (after Quebec), and most populous Province in the giant country to the north.

Ontario faces the United States across four of the five Great Lakes (see map, "The Great Lakes Region of the United States and Canada," a supplement to this issue). She has lakes of her own up to 50 miles long and so wide you can't see across them. Her north-flowing rivers lace empty "bush" that would swallow half a dozen of our lesser States.

Though the northern reaches of Ontario are treeless shores battered by Hudson Bay ice floes, Pelee Point on Lake Erie carries the Province to the latitude of northern California; all, or parts, of 25 States lie farther north.

The strength of Ontario lies in its men, money, and machines, all at work boosting the productivity of farms and factories, mines and forests. Her people, a third of Canada's 15 million, produce 50 percent of the nation's manufactured goods, including almost a quarter of its enormous newsprint output.

Ontario has a near-monopoly of nickel. Mines in the vicinity of Sudbury furnish more than 80 percent of the world's supply of this vital steel-alloying metal (page 846).

The Province also pours out iron, gold, silver, cobalt, copper, and platinum—by value, a third of Canada's total mineral production. Ontario, in addition, leads all others in value of agricultural output, furs, and fresh-water fish.

Province Shows Frontier Spirit

Frontier vitality animates Ontarians. I felt it in remote mining and forest products towns. I felt it, too, near Niagara Falls, in one of the oldest settled parts of Canada (pages 833 and 835).

Deep underground, I watched workers completing the first of twin tunnels that soon would deliver Great Lakes water to the mightiest of all Niagara hydroelectric plants, the Sir Adam Beck-Niagara Generating Station No. 2. It is a 300-million-dollar project of the Hydro-Electric Power Commission of Ontario, known as "Hydro."

With Robert H. Saunders, chairman of Hydro, I picked my way through the cavernous excavation, so big that scattered light bulbs seemed like stars in space.

"In these tubes Niagara River water, under hydraulic pressure, will flow *uphill* five-and-a-half miles to a surface canal," said chairman Saunders. "Downriver the water will drop through turbines into the Niagara gorge. Added to present capacity, the new plant will generate enough power to run two cities as large as your District of Columbia."

Big magic! Yet in remoter parts of the Province a little power has gone a long way to change habits and energize local economy.

Only four years ago, at Rossport on Lake Superior, local residents witnessed the inauguration of a new era for their town, population 250.

By the light of an oil lamp a Hydro official pulled a ribbon that led onto the community hall stage a very small girl carrying a very large stork (cardboard). In its beak the bird bore an electric light bulb. As the Hydro man threw the switch flooding the whole village with light, cheers almost drowned out the singing of "When the Lights Go On Again."

Detroit's Sunday Motorists Stream into Windsor, Ontario

Canada's leading gateway, Windsor welcomes five and a half to six million U. S. visitors yearly. On August 2, 1953, Ambassador Bridge carried 9,500 automobiles out of Michigan. Almost 10,000 others bound for Canada used the tunnel beneath Detroit River, the world's busiest inland waterway.

Windsor Daily Star

824

North Bay Children Clothe a Frozen Playmate in Dad's Old Shirt and Mom's Lamp Shade

Boys and girls revel in Ontario's long winters. Ice hockey is king of games; every sizable town has several teams. Numerous rinks allow skating the year round (page 834).

A funeral director (pro tem) in black swallow-tail coat and stovepipe hat led the procession to interment of the Old Oil Lamp. Rossport boys fired a 6-BB-gun salute. Over the grave the funeral director read locally composed verses:

You're just a little coal oil lamp,
Though some are made for gas.
For years you served our homes and camps,
A tribute to the past.

We grieve to lay you in your grave,
Too bad that you are dead;
We can't forget the years you gave,
There are better lights ahead.

Nine-tenths of Ontario's people, almost all its agriculture, and most of its developed wealth occupy one-eighth of its area, the southeast corner (see supplement map). This "head" of Ontario joins the great body of its territory at an isthmuslike "neck" between Georgian Bay and the Ottawa River.

The head's brain is Toronto, capital and largest city of the Province and second city of all Canada, after Montreal. Flying to Toronto last June, I watched the city lift, Chicago-like, out of pale-green Lake Ontario. In an hour I was swallowed up in Ontario's administrative, financial, and cultural colossus (pages 832, 843).

Next morning, from the observation balcony atop the 32-story Canadian Bank of Commerce, tallest office building in the British Commonwealth, I looked down on the crossing of Bay and King Streets.

"That's 'Mint Corner,'" the guard told me, "named from the first initials of banks on its four corners—Montreal, Imperial, Nova Scotia, and Toronto."

Five of Canada's 10 chartered banks have headquarters in Toronto; they operate 1,721 branches throughout the nation. A Toronto host informed me, delighted to forestall any possible feeling of Yankee superiority, that his city's Stock Exchange last year did a greater volume of business than New York's. Speculative "penny" and "dollar" shares in mining developments sprouting all over Can-

Canadian National Railways

Pets as Well as Children Attend This Rail-borne School in the North Woods

Canadian National Railways' mobile classroom, with Fred Sloman as teacher and his wife as helper, serves small communities lacking schools. The car may stay several days or only a few hours.

ada gave the Toronto exchange this leadership.

To cope with commuter congestion, Toronto is completing a 4.6-mile rapid transit line. Scheduled to start operation early in 1954, it will run from Union Station north along Yonge Street, which is Toronto's Broadway and Fifth Avenue in one. A subway downtown, the line surfaces after three miles into an open cut that permits cross streets to overpass the rails.

"Our streetcars on Yonge carry 18,000 people past the Wellesley Street intersection during the daily homebound rush," Chairman William C. McBrien of the Toronto Transportation Commission told me. "The new subway, replacing the surface cars, will handle 40,000 an hour."

TTC's fares are low—three tickets for a quarter.

Toronto grew up close to the site of old Fort York, still standing after careful restoration. During the War of 1812, fort and town fell briefly to American invaders. The U. S. leader, Gen. Zebulon Pike (discoverer of the Colorado mountain later named Pikes Peak in his honor), died in the explosion of a powder magazine. Retiring, the American troops fired the legislative buildings.

Ontario's Seat of Government

Up handsome University Avenue I walked to Queen's Park, whose shady lawns are the setting for the brownstone Parliament Buildings.

Here convenes the Provincial Legislature, and here, from his second-floor office, the Honourable Leslie M. Frost, Premier of Ontario, can look south along University Avenue's array of office buildings: Ontario Hydro, big insurance companies, headquarters of pulp and paper mills—enterprises that reflect the wealth and prestige of the Province whose helm he holds.

University Avenue, too, displays a symbol of health for the Province—the Hospital for Sick Children (called "the Sick Kids"), largest child-care center on the continent.

826

Ontario Department of Lands and Forests

Indians, Stolid, Pleased, and Skeptical, Register Beaver Pelts in Benny, Ontario

Canadian law forbids sale of an unsealed pelt. These conservation officers thread metal seals (piled on counter) through eyeholes of furs at the Ontario Lands and Forests office. Like boxcar seals, the tags cannot be removed without destruction. Seals show dealers they are buying furs trapped legally. Each trapper must report the beaver houses on his limits; the standard quota is one animal from each house yearly.

West of Queen's Park stands the Province-supported University of Toronto, with 12,000 students. All Canada takes pride in "Varsity," as it is known (page 842).

At the University of Toronto Medical School the late Sir Frederick Banting and Dr. Charles Best discovered insulin—and saved millions of diabetics for useful, happier lives. Varsity medical scientists also discovered the anesthetic cyclopropane and learned how to produce heparin, drug that prevents blood clotting in operations on heart and blood vessels.

Varsity dominates Toronto's cultural life. A long list I read of the university's affiliates includes the Royal Ontario Museum, Royal Conservatory of Music, and David Dunlap Observatory. Seven thousand pupils attend the conservatory alone.

Crater Explorer Heads Museum

School children clustered around cases in the Royal Ontario Museum as Dr. V. Ben Meen, Director of its Museum of Geology and Mineralogy, showed me a model of Chubb Crater, meteorite blast hole in northern Quebec. Dr. Meen was leader of the National Geographic Society-Royal Ontario Museum Expedition to Chubb Crater.* In August of this year he located in northern Labrador another crater also believed to be of meteoritic origin.

Newcomers relish days in Toronto perhaps as much for the city's fine shops as for its sights or setting. Visitors from the United States look especially for china, silver, furs, and woolens.

Every year, in late August and early September, Toronto plays host to an average of 2,500,000 visitors attending the Canadian National Exhibition, biggest of its kind in North America.

Simply "the Ex" to Ontario people, it started as an itinerant agricultural fair, coming to Toronto for good in 1879. Fifty permanent buildings now house, each harvest season, a gamut of agricultural and industrial exhibits. Entertainment ranges from midway shows to classical symphony concerts.

Toronto's citizens are avid sports fans. Football is at least as popular as in the United

* See "Solving the Riddle of Chubb Crater," by V. Ben Meen, NATIONAL GEOGRAPHIC MAGAZINE, January, 1952.

States. But the sport of sports in Toronto, as in Ontario and all Canada, is ice hockey.

On a winter visit, I had come from dark streets into the sun-bright Maple Leaf Gardens, home of the professional Toronto Maple Leafs. Ice sparkled under dazzling illumination that set agleam skaters' jerseys and gay clothing of women spectators. The puck shuttled up and down the rink as players passed and stole it, checking abruptly amid showers of ice thrown up by skates.

That evening the home team edged out its bitterest rivals, the Montreal Canadiens.

From Toronto I set out through what Canadians call "Western Ontario," the Province's own "Golden Triangle" of agriculture and industry. The verdant region is a wedge separating Lakes Erie and Huron.

Actually, three-fourths of Ontario—the pioneer expanse north of Lakes Superior and Huron—lies west of Western Ontario. The name persists from a time when all of the Province that counted was the St. Lawrence River and lower Great Lakes regions.

827

Andrew H. Brown, National Geographic Staff

These Peary Relics Survived 47 Arctic Winters

In Ottawa, English glaciologist Geoffrey Hattersley-Smith shows the historic penciled note, piece of flag, and a can of the pemmican he found last May in a cairn at Cape Columbia, Ellesmere Island, while engaged in ice researches for the Canadian Government. Comdr. Robert E. Peary cached them in 1906, three years before he attained the North Pole. The note, protected in a mustard can, recorded his travels and objectives. "Last night," Peary wrote, "I killed 6 muskoxen just east of here."

All of what is now Ontario was part of the enormous territory of New France which the 1763 Treaty of Paris ceded to Great Britain. For a century and a half before, explorers like Champlain, La Salle (murdered by his men), Nicolet, Brulé (killed and eaten by Indians), and Radisson had urged their paddlers across this country to the Great Lakes and the Mississippi.

Ontario Settlement Had Slow Start

The first English settlement (1780) on the Niagara River soon was swelled by Loyalists fleeing the United States during the American Revolution and after. In 1812 the population of "Upper Canada," as southern Ontario then was called, totaled only 75,000, thinly spread from the Quebec border to the Detroit River. By 1837, however, 350,000 settlers had put down roots in the new land.

The Queen Elizabeth Way, popularly the "Q. E. Way," sped my exit from Toronto. This route parallels a growing industrial empire reaching from the provincial capital to Hamilton. Long glass-walled factories sprout from hayfields. At Oakville, Ford of Canada is completing a $32,000,000 assembly plant that will counterbalance Canadian General Motors' major assembly works at Oshawa, 30 miles east of Toronto.

Hamilton, "Pittsburgh of Canada," marks the west tip of Lake Ontario with industry's pillar of smoke. But the city has public gardens of striking beauty, too (page 841).

Blast furnaces and rolling mills of the Steel Company of Canada squat at the waterside. Biggest Canadian steel mill, it turns out nearly 2,000,000 ingot tons yearly.

Some 500 diversified plants have built up Hamilton to be Canada's fifth largest city; in Ontario, only Toronto is bigger.

The Province's captains of industry, I found, cultivate interests far removed from business duties. H. B. Greening, for example, who is president of the B. Greening Wire Company, was fully as eager to talk to me about

motorboats (he has owned 28) and hunting cheetahs (he may own one of these by now!) as about his firm's production of wire rope and screening.

Behind Hamilton lifts the sharp wall its residents call "the Mountain." It is part of the Niagara escarpment that shelters between its steep rise and Lake Ontario one of Canada's richest fruit belts, growing luscious peaches, strawberries, and grapes.

West of Hamilton I came to Brantford, hustling industrial city, home of internationally known Cockshutt Farm Equipment.

A crossing of Grand River, called "Brant's Ford" for the Mohawk chief Joseph Brant, named Brantford. The British government in 1784 granted the Mohawks and other Iroquois Indians land along Grand River in recompense for New York State homes and farms lost during the American Revolution.

Walter Rutherford, genial interpreter of Brantford history, took me out to Ohsweken, chief town of the near-by Six Nations Indian Reserve (page 842). George Green, Chief Little Bear, showed me where the Indians hold their remarkable "snow snake" races.

The Indians in winter build up a low snowbank a mile long, grooving the crest with a shallow trough. This icy track dips, rises, and gently curves, usually following a road.

Object of the contest is to propel a slim, 7-foot, hardwood wand, the snow snake, as far as possible along the track. The snake skates forward with painted eyes, its head weighted and banded with copper or lead. A finger groove notches the throwing end. Each Indian, holding his snake much as a pole vaulter grips his pole, sprints toward the end of the trough and launches the highly polished stick, crying "Hun-you, hun-you!"

Beware the Striking Snow Snake!

When a darting stick jumps the track, spectators scatter lest they be impaled. A game is two throws by each contestant; the winner, the player who gets the best distance, may propel his snake almost the full mile.

At Tutelo (Tutela) Heights, on a bluff above Grand River, we visited the house where Alexander Graham Bell vacationed with his parents. From near-by Paris, the inventor of the telephone in August, 1876, heard his father, eight miles away in Brantford, say, "Yes, Alec, it is I, your father speaking"—climaxing the first "long distance" call over wire. This followed his first transmission of speech by telephone in Boston on March 10, 1876.

A monument to Dr. Bell, who was one of the original members of the National Geographic Society when it was founded in 1888, dignifies a Brantford park. And at Tutelo Heights on September 12, 1953, two of his granddaughters, Mrs. Lilian Grosvenor Coville and Mrs. Nancy Bell Fairchild Bates, unveiled a new monument which designates the homestead a National Historic Site of Canada.

Amid farmlands flecked with dairy herds and studded with the fountain shapes of elms lie Kitchener and Waterloo, twin cities that form the hub of a cluster of market and manufacturing towns—Guelph, Elmira, Stratford, Preston, Hespeler, and Galt. Guelph is seat of the Ontario Agricultural College.

With a Kitchener businessman I visited a few of the 169 local industries. Almost all, I learned, sprang up from small shops where a man and his sons or brothers worked with bare hands, a few tools, and a knack for making something useful.

Rubber and Insurance Centers

Today furniture plants and textile mills; tool and other metal works; glove, shoe, and leather-goods shops; electrical-appliance firms; and the needle trades carry on that craftsman tradition. Kitchener, home of B. F. Goodrich and Dominion Rubber, is also a Canadian leader in rubber products.

Contrasting with this industrial hustle is Waterloo's status as "the Hartford of Canada," with home offices of six insurance companies. Kitchener has restored as a shrine the steep-gabled boyhood home of the late William Lyon Mackenzie King, Canada's Prime Minister for 21½ years.

Men with beards and wives with headshawls or prayer caps, many clad all in black, stroll Kitchener and Waterloo streets. Half or more of the cities' people are of Pennsylvania Dutch ancestry, descendants of emigrants from Pennsylvania's Lancaster County, mostly between 1800 and 1810. Until World War I, Kitchener was called Berlin.

Severest in appearance and most uncompromising in custom and belief are the Old Order Mennonites and the Amish. The latter even refuse to wear buttons, feeling they make too much show (page 838).

One Sunday morning, on an earlier visit, my

(Text continued on page 837)

Canadian Mounties Guard Peace Tower in Ottawa →

A melodious 53-bell carillon gives the 300-foot memorial to the dead of World War I a voice as familiar to Ottawa residents as Big Ben's is to Londoners. The electric sign, which says "Long Live the Queen," is French Canada's salute to Elizabeth II.

Red serge tunics and yellow-striped breeches are dress uniform for Royal Canadian Mounted Police detailed to Parliament Hill. In extreme cold they wear shaggy buffalo coats and muskrat caps. A few Mounties still function on horseback; far more in cars and motorboats, on motorcycles and dogsleds.

Ottawa's Towers of Government Face the Factory Chimneys of Hull, Quebec

Stately Parliament Buildings and substantial business blocks on Ontario's side of the Ottawa River embody the dignity and stability of older parts of Canada. Hull, in Quebec, has its roots in an equally historic conservative society, largely French-speaking and Catholic. Its E. B. Eddy Company paper mill (left center) and Canada Cement Company (right background) symbolize the exploitation of forests and minerals in the vast wilderness that makes up most of Canada. Hull was founded around 1800 by Philemon Wright, a Massachusetts man.

The Ottawa River, flowing here from left to right, rises in Quebec. In its middle and lower course it forms the Ontario-Quebec boundary for 375 miles. Each summer it carries downstream thousands of cords of pulpwood, some of which is piled along the far shore and floats on the river.

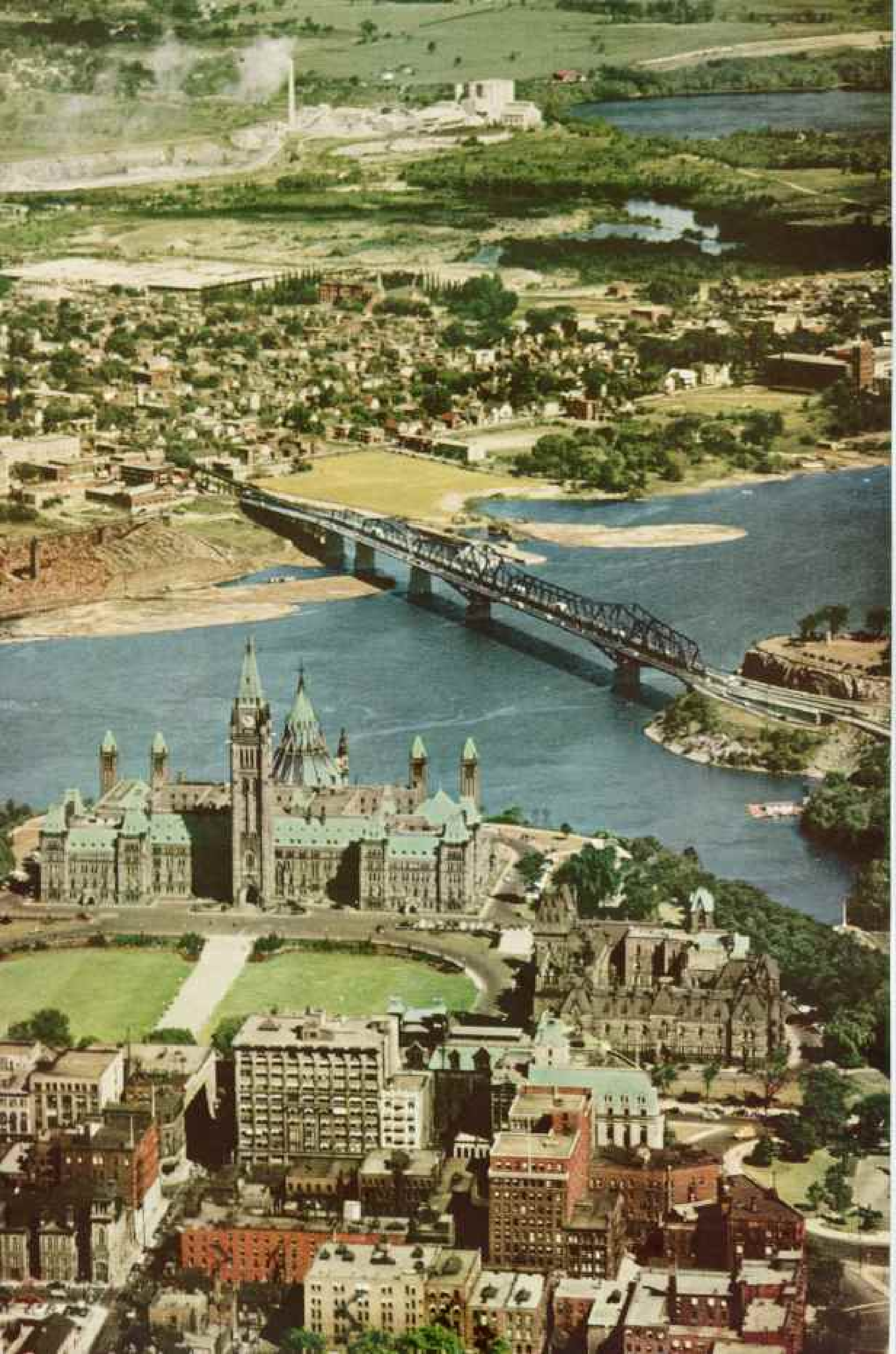
Canoeing up the Ottawa 340 years ago, the French explorer Champlain found his way blocked by Chaudière Falls (out of picture at left). Since the day his Indian guides threw a tobacco offering to the spirit of the cataract, Ottawa has grown to a city of 202,000.

There was no Dominion of Canada when Queen Victoria in 1858 named Ottawa seat of government of Upper and Lower Canada. In so doing, she set aside the claims of older towns like Quebec, Montreal, Toronto, and Kingston. With Canadian Federation in 1867, Ottawa assumed rule of the greater nation.

Gothic structures on three sides of the grassy park comprise the Parliament Buildings. Oldest are the East Block (right) and the West Block (left), built between 1859 and 1865. Fire in 1916 destroyed the Centre Block except for the cone-roofed Library of Parliament. Rebuilding, including the new Peace Tower (page 829), was completed in 1920 save for some decorative carving, which may take 10 years to finish.

Rideau Canal joins the Ottawa River close to the Alexandra Bridge (page 848).

Kodachrome Aero by George Hunter



Sailboats Scud Across Toronto Harbour in Lake Ontario. Towers of Canada's Second City Tooth the Skyline

Toronto (population, 675,750) is a busy lake port; it also receives ocean-going ships that climb St. Lawrence River locks. In the Dominion, only Montreal (1,021,500) is larger. Flower beds here decorate the island grounds of the venerable Royal Canadian Yacht Club, which counts 2,200 members and 220 boats. ▼ Ontario provides the finest view of Niagara's American Falls. Two boats, both named *Maid of the Mist*, carry visitors close to the 167-foot cataract.

Limberlost Lodge Skiers Hitch a Ride from a Sleigh Party

Bound for the rope tow on a below-zero morning, skiers get an assist from sleigh riders on a blood-tingling dash through spruce and birch near Huntsville. Last year Ontario was host to 15 million visitors, including thousands of winter sports fans.

Young Skaters Smile Approval at a Friend's Performance

Many Ontario youngsters would rather skate than eat; the Province has dozens of ice rinks. Professionals from five countries operate a midsummer figure-skating school at Schumacher in the gold-mining north. This girl executes a spiral at Toronto's Granite Club.

Frost King's Glittering Touch Creates a Crystal Bower

Freezing spray blown from Niagara's Horseshoe Falls coats a willow with fantastic festoons of ice. Even in winter Niagara Falls attracts admirers in a never-ending stream. These girls bundle up against January cold.

© National Geographic Society

Kodachromes by National Geographic Photographer Bates Littlehales

Leatherworker and Canteen Girl Touch Up an 1860 Uniform at Old Fort Henry

This college-student guardsman takes part in summer parades and gun drills enacting history for visitors. The craftsman uses old-time tools; the girl aide is an innovation. Kingston's stone fortress was built between 1832 and 1856.

Air Force, Navy, and Army Officers Teach at Canada's West Point

A cadet (left) reports to three instructors in the Royal Military College in Kingston. Anchor, eagle, and bomb in the coat of arms symbolize the three-service college. Also at Kingston are Canada's Army Staff College and National Defence College.

host drove me out into the winter countryside. A bitter wind dusted ditches and fence rows with blowing snow. The landscape, though in January drab, looked etched and orderly. Clustered farm buildings were like buttons gleaming in the rumpled quilt of fields and woodlots.

We were bound for Conestogo Meetinghouse, a place of Mennonite worship beside the Conestogo River. Names of both are a slightly different spelling of Conestoga, Pennsylvania, from which the covered Conestoga wagons rolled northward 150 years ago.*

When we arrived the service was still going on. The yard held 145 black buggies and seven black two-horse rigs. Blanketed horses, standing in their traces, were tied to hitching rails.

Soon the doors opened and spilled out 400 adherents of the Old Order of Woolwich Mennonites. Men came out one door, women and children from another. Coats, hats, bonnets, scarves, stockings, shoes were black.

Sturdy parents stowed blanketed children on laps, at their feet, behind seats of the open buggies. At a smart clip, horses trotted out the gate. Dry grass along the ditches leaned before the gusty wind. Wives opened black umbrellas for windbreaks.

The procession streamed up the straight dirt road. Some turned left and some right at side roads. We stood watching until leafless groves and tawny fields swallowed the last black buggy.

It was a scene 100 years old, a Currier and Ives print come to life.

Around another Mennonite meetinghouse huddled perhaps a hundred automobiles, every one black.

England in Canada

Near the heart of Western Ontario stands London, on the Thames River, whose streets bear such names as Oxford, Waterloo, and Piccadilly. The University of Western Ontario is here, and Springbank Park, one of Canada's loveliest. A multitude of thriving industries makes everything from locomotives, hardware, and refrigerators to beer, biscuits, and breakfast foods.

At Sarnia, the St. Clair River, outlet of Lake Huron, separates Ontario from Michigan. The Blue Water Bridge arches over the hurrying waters to Port Huron, Michigan. An international port, Sarnia had calls last year from ships of nine European countries.

Expansion of fuel, chemical, and synthetic-rubber industries has doubled Sarnia's population in the last eight years. Here rise steel trelliswork and convoluted piping of the refinery of Imperial Oil Limited that gulps Alberta petroleum delivered by tanker. Eastward from Sarnia a pipeline carries oil products to cities of the Lower Lakes.

"An oil gusher drilled in 1861 at Oil Springs 20 miles southeast of Sarnia was among the first commercial wells in North America," Dr. J. L. Huggett of Sarnia Refinery told me. "We still have productive wells there, around Petrolia, Oil City, and Oil Springs, but they're dwarfed now, of course, by the Alberta fields."

Versatile Synthetic Rubber

Polymer Corporation Limited, Canada's only synthetic rubber manufacturer, buys light hydrocarbon gases, including ethylene and butylenes, from Imperial Oil next door and sells by-products to neighboring Canadian Dow Chemical.

For Polymer's 30 types of rubber the market is reliable; three-fifths of all new rubber consumed in Canada is synthetic.

"Here's a list of some 870 articles made of synthetic rubber," said Polymer's sales manager, handing me a fat booklet. "You'll find not only tires and tubes, but also briefcases, floor tile, footwear, conveyor belts, even bowling balls."

None of these remotely resembles the creamy curds I watched form in the coagulation tanks, or the amber-colored rubber "crumb" and sheets feeding off the dryers.

At Windsor I reached Ontario's—and Canada's—southernmost projection, the peninsula between Lake Erie and Lake St. Clair.

Windsor, Canada's Detroit, stands just across the Detroit River from the U. S. city whose chief industry it has made its own (page 822). Here are the principal plants of Ford Motor Company of Canada and Chrysler Corporation of Canada. Windsor, in addition, is Canada's pharmaceutical capital, with Parke-Davis, John Wyeth, Sterling Drug, and R. P. Scherer all based here.

Fronting on the world's busiest inland waterway, Windsor stands also at a major rail and air crossroads. It faces a growing export outlet for its 470 industries in the U. S. Middle West, and at its back door lies the richest farm and city market in Canada.

With James Dykes of Windsor's Chamber of Commerce I watched riggers finishing a steel tower for a cross-river power line between Windsor and Detroit. As we moved through tall grass and reeds for a closer view, a handsome ring-necked pheasant rose in a whir of wings.

"You've got so much game it gets underfoot even in your cities!" I exclaimed.

"Or else the survivors have discovered that

* See, in the National Geographic Magazine, "In the Pennsylvania Dutch Country," by Elmer C. Stauffer, July, 1941, and "Pennsylvania Dutch Folk Festival," by Maynard Owen Williams, October, 1952.

Alan Bigler, Kitchener-Waterloo Record

Amish Folk in Waterloo View a Conestoga Wagon Twice Their Age

This 153-year-old vehicle carried Mennonite settlers from Lancaster County, Pennsylvania, to Ontario. When Waterloo County celebrated its centennial in 1952, the wagon was restored to running condition. Trucked to Lancaster County, it was driven back 475 miles, re-enacting the Mennonite trek (page 828).

Main Street is the only place they're safe from American hunters," Dykes replied with a grin.

Mild climate and fertile soils characterize Canada's "Sun Parlor" east of Windsor. Here is Ontario's corn belt, one of its richest truck-farming areas, and the source of almost four-fifths of Canada's soybeans. Along Route 3 through Essex County, jokingly called "Tobacco Road," Hiram Walker, the distiller, pioneered Canadian tobacco culture.

Northwest to Lake and Forest

Returning to Toronto, I set out on a swing through far-western Ontario, the realm of lake and forest, mine and paper mill. The first stage, to Sault Ste. Marie, was by air. An hour out of Toronto farms thinned out below and roads grew rare.

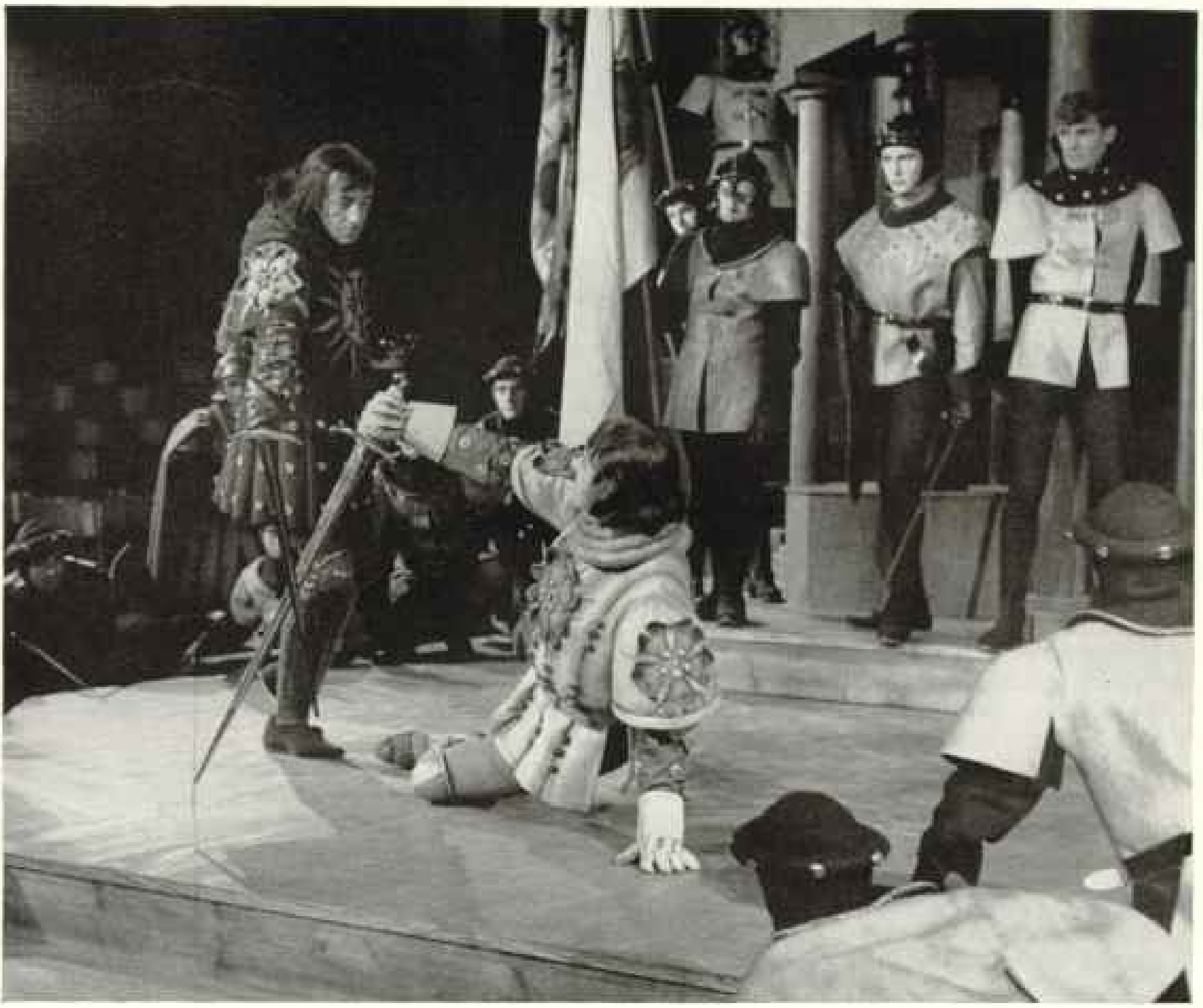
At the Canadian "Soo," big brother of Michigan's Sault Ste. Marie across the St. Marys River, I watched lake freighters move through the lock from Lake Superior to Lake Huron's level. This and greater locks on the American side keep busy shuttling back and forth the long, low-hulled ships that carry most of a continent's iron ore and much of its wheat and fuel.*

Two firms—Abitibi Power & Paper Company and Algoma Steel Corporation—are the Canadian Soo's chief employers and leading money-makers. Algoma gets much of its ore from its own siderite mines at Wawa.

"Nearest Canadian town to us of any size is Sudbury, 160 miles east," an Algoma Steel man told me; "so our high school teams schedule most of their games across the border.

"Our boys have to know both U. S. and

* See "Work-hard, Play-hard Michigan," by Andrew H. Brown, NATIONAL GEOGRAPHIC MAGAZINE, March, 1952.



Swords Clash in the Shakespearean Festival at Ontario's Stratford

Stratford, on its own River Avon, has a Shakespearean Garden as well as Romeo and Falstaff Streets. In 1953 director Tyrone Guthrie, actor Alec Guinness, and actress Irene Worth came from England to take part in a 6-week festival attended by 65,000 playgoers. Here Guinness as Richard III bests fallen Richmond.

Canadian football rules," he went on, "and on several points they don't agree. We play on a longer field, have 12 men on a team instead of your 11 and three downs instead of four, don't have the fair catch, and limit interference beyond the scrimmage line."

I could imagine a player, dazed by a hard tackle, trying desperately to remember whether he was playing in Canada or the United States!

Bound north from the Soo I rode the scenic Algoma Central and Hudson Bay Railway to Franz, changing there to a Pacific-bound express of the Canadian Pacific Railway. The new train fled on west through encroaching forest, past many lakes. Emerging on the rugged, rocky Lake Superior shore, it dropped me at Marathon, sprung full-grown from the wilderness between 1944 and 1946.

The pulp mill of Marathon Paper Mills of Canada now supports most of the 2,000 people of the frontier town it brought into being.

The mill's wood comes by river drive and tow from forests as far as 100 miles north. Grant D. Ross, mill and town manager, showed me barked logs crowding into the chippers and, at the production end, snowy-white stacks of baled sulphate pulp. Shipped to finishing plants in Wisconsin, most of the pulp goes into food packaging.

Remoteness Breeds Self-sufficiency

Isolation makes for teamwork among the townspeople of Marathon. The editor of the local paper had offered to drive me around town. "Sorry," he apologized, when we made rendezvous, "the sun's shining today, and I've got to help pour concrete for the kids' new wading pool."

Remoteness, too, throws heavy pressure on facilities for recreation and self-improvement.

Delmer Earle, director of recreation, showed me handicrafts shop, bowling alleys, billiard room, and library of the Community Hall, and told me about his winter ballet school, weaving classes, and dramatic club.

Mill manager Grant Ross typifies the self-sufficiency and versatility that become second nature in far-off Marathon.

Ross's daughter grew interested in stars, so he built a 6-inch reflector telescope. A frieze of handmade model autos, perfect in detail, decorates his living room, and he showed me gems and local stones he'd cut and polished. When talk slowed down, Ross stepped to an electric organ and played, beautifully, a half-hour of melodious classics.

"Where'd you take lessons?" I asked.

"Taught myself," said my host.

Clifford Graham is Marathon's police chief and fire chief, too, a dual role that gave him a memorable morning shortly before I met him.

A woman—call her Mrs. Jones—phoned Graham's home at 5 a. m. to report her house filled with smoke from paper burning in the furnace. Graham, half asleep, reached for the nearest clothing, which happened to be his police chief uniform.

"Nothing wrong here," said Graham, arrived at Mrs. Jones's. "Just open the flue and the smoke'll clear right up."

Hardly back in bed, Graham was awakened again, this time by a fire alarm calling him back to the same address. Graham gritted his teeth, donned his fire chief uniform, and rode the fire truck to Mrs. Jones's.

More smoke. Mrs. Jones more excited. "The police chief was just here," she reported. "He said nothing was the matter. Now see what's happened!"

"Oh, him!" said Graham scornfully. "Don't believe that ignorant fourflusher. He doesn't know a fire from a Shriners' parade. I'll open this furnace flue, and you'll be breathin' fresh air in no time."

The distraught lady expressed her thanks, and fire-and-police chief Graham walked down the path, still anonymous—he was sure—to Mrs. Jones.

Headlight Dazzles Moose

The caboose of a fast freight carried me westward to Terrace Bay. "Extra 4017 West," with two Diesels up front, hauled 70 cars loaded with 681 tons of autos, car wheels, farm machinery.

"You should be up ahead with the engineer," said conductor George Gordon. "Every train scatters moose and bear. By the time the caboose passes, they're gone in the bush.

"Locomotives kill 'em by the dozen, mostly at night. Moose seem dazed by the headlight. They'll stand there, stubborn, and try to face down tons of steel movin' 50 miles an hour."

"Why do they come out on the tracks?"

"Some say the Diesel engine horn sounds like a moose call and draws 'em onto the track. A lot come out of the bush just to lick up the salt that drips on the ties from refrigerator cars."

Knocked Out by a "Buck Amuck"

Later I heard of a railway lineman who was knocked out and off his moving gas speeder near Sioux Lookout by a frightened deer. Coming to, he stumbled to a way station and got first aid for the sharp attack of "buck amuck." His unmanned speeder, jammed in a switch, was blasted loose by an express.

Terrace Bay, still shiny new in bright paint, had the same genesis as Marathon: spruce-clad hinterland, rail and water transportation, United States demand for paper products. The LongLac Pulp and Paper Company, a subsidiary of Kimberly-Clark of Neenah, Wisconsin, operates Terrace Bay's big sulphate mill whose output of bleached pulp goes to the United States for fabrication into paper and tissue products.

In youthful Terrace Bay nearly half the children are below school age. Of the 350 schoolgoers, only 50 were old enough for high school this fall.

Nipigon River once foamed and swirled from Lake Nipigon to Lake Superior. Its waters, a mecca to fishermen, gave up the world's record brook trout, a 14½-pound fish caught in 1916.

Today three power dams have gentled the Nipigon until it has little white water left. Pulpwood, run downstream by the thousands of cords, also discourages anglers.

Though the days of its superlative sport are past, the Nipigon still gives up fine fish. At Pine Portage powerhouse a fisherman unrolled wet newspaper to show us three brilliant-hued speckled trout fresh from the river.

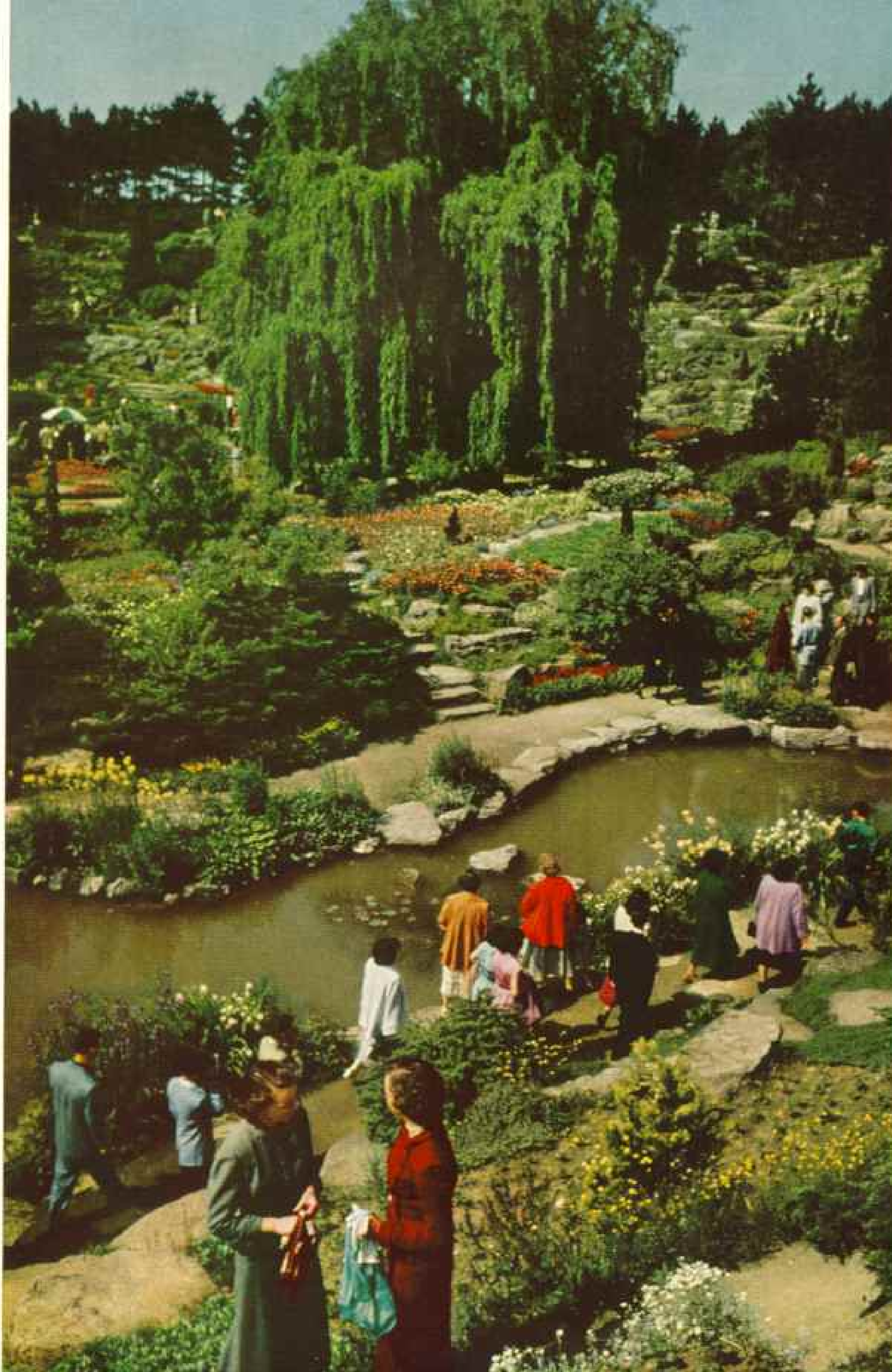
"The two big ones'll weigh between five and six pounds," he said. "The smallest won't go much over three."

At Lake Nipigon's outlet I watched the tug *Nipigon* of the Abitibi Power & Paper Company spill into the river a boom of 7,000 cords of spruce pulp logs worth $150,000.

The pulpwood sticks floated free in a "bag" of boom logs chained end to end. Skillfully the *Nipigon's* skipper nudged the raft of wood toward the river channel. From a steel-hulled

(Text continued on page 849)

Paths of the Rock Garden in Hamilton ▸ Wind Among 4,000 Species of Plants



↑ Hart House Is the Social Focus of the University of Toronto

With 12,000 students, the University of Toronto is one of the Dominion's educational strongholds. Canadian leaders fondly acknowledge earning degrees from "Varsity," as they call it. Coats of arms of European universities top the fireplace in Great Hall, the undergraduate dining room.

← Indian Mask Grins Toothily

Symbol of benevolent power, this grotesque likeness of a supernatural being finds use in secret rites, usually to drive out bad spirits and disease. This image was carved on the Six Nations Indian Reserve near Brantford.

Toronto's Skyscrapers →

Ontario's capital thrives amid a network of booming factory towns. Stock exchange and many banks make the city their home. A third of the country's buying power is concentrated within a 100-mile radius.

Here a freighter unloads coal near Victory Mills, an oilseed extraction and malt plant. Tall Royal York Hotel rises close to Union Station (far left). Canadian Bank of Commerce building, city's highest, soars 32 stories (page 833).

Kodachromes by National Geographic Photographers B. Anthony Stewart and Bates Littlehales

▲ **Baby Sleds Replace Carriages in the Snow Country**

Brightly painted homes contrast with winter whiteness in Kapuskasing, a newsprint town in Ontario's northern wilderness.

▼ **Brooms Smooth Ice for a Curling Stone Nearing the "Button"**

Women players at North Bay's Granite Club wear favorite tartans. Each teakettlelike stone consists of 44 pounds of granite.

← Red Eyes Weep Fiery Tears as Slag Cascades by Day and Night

Every half hour a train dumps ladles of molten slag hauled from the smelter of the International Nickel Company of Canada at Copper Cliff, near Sudbury. Mines in this vicinity produce four-fifths the world's supply of nickel, a metal essential to many alloy steels.

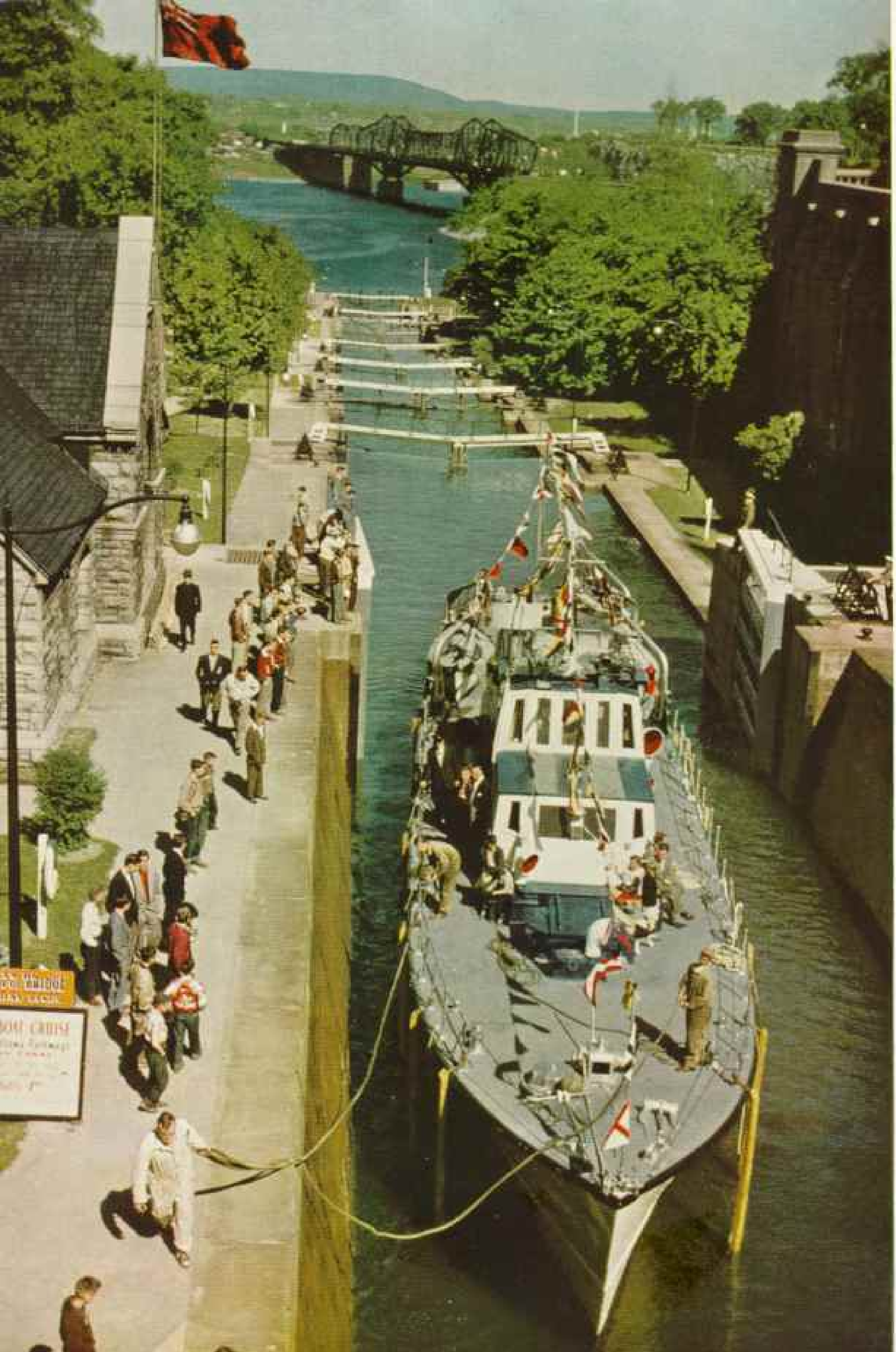
A third of Canada's minerals, by value, comes from Ontario. The province is the sole Canadian source of cobalt and platinum. It leads all others in gold and copper.

↓ A Pulpwood Load Packs a Snow Road

Loggers cut and stack the pulpwood deep in the bush. Loaded on horse-drawn sleighs, the wood is carried to a collecting point and transferred to tractor-drawn sleighs, which haul it to a frozen river. When spring thaws the ice, the pulpwood floats to the mill.

This load was cut by the Spruce Falls Power and Paper Company from Crown timber limits bigger than the State of Connecticut.

Inset: Rudolph Dunn works in the drive down the Aguasabon River.



work boat, men swung open the downstream side of the boom like a gate. Against the upstream side the *Nipigon* pushed with all its power, "punching the bag."

A logger, dancing on a boom timber, called out, "Shove her, boy! Shove her till she says 'Goodbye!' "

Yielding to wind and current, the mass of pulpwood slowly moved away on a new lap of its journey to the mill.

On the northwest shore of Lake Superior I came to Port Arthur and Fort William, cities Ontarians lump together as the "Lakehead." They grew up at a historic beachhead, where early fur traders shouldered canoes and packs and struck out overland, then on by lakes and streams to the Lake of the Woods, Winnipeg, and the wild northwest.

Transfer of goods between Great Lakes and the Canadian West still is the Lakehead's primary reason for being.

Between them, Port Arthur and Fort William run an ore-loading dock, four newsprint mills, and 25 fluted, cubistic grain elevators.

Grain Elevator a Dusty Giant

Wearing a white smock to keep off grain dust, I went through Saskatchewan Pool 7 elevator, which projects 1,300 feet into the lake to allow ships to load direct. If cut in half horizontally, the beehive interior would reveal 810 "cells," or bins.

I watched automatic dumpers tilt loaded grain cars to empty them as a man might tip a box of sugar. Before shipping, Pool 7's nine million bushels of wheat, oats, rye, and barley would be sorted into 150 grades.

At Steep Rock Iron Mines, 115 miles west of the Lakehead, I stood on the brink of a rusty excavation 350 feet deep and 200 yards wide. We watched power shovels far below dumping 7-ton bites of iron ore into burly Diesel trucks. A company engineer pointed out wave-worn shores hundreds of feet above the present workings (page 851).

"Ore we're scooping up now once lay under 150 feet of water, 80 feet of blue clay, and 100 feet of iron ore already removed," he said. "Ancient glaciers had dropped chunks of ore in the bush round about. They were clues to iron under Steep Rock Lake.

"Before mining could begin, our engineers had to blast out a bypass to divert the river feeding the lake, pump it out, and dredge away the thick layer of clay, rubble, and mud overlying the ore."

All these steps, each Gargantuan, in time were taken. From the exposed lake bottom were retrieved an old double-bitted ax and musket, a silver watch, and a chest empty save for a Union Jack and a rubber ball.

The erstwhile lake bed has revealed a far more valuable treasure, high-grade iron ore deposits totaling perhaps a billion tons. Open-pit mining has already yielded more than nine million tons. Underground mining, recently begun, will supplement open-pit operations.

South of Steep Rock lies Quetico Provincial Park, an unspoiled recreation area of pine-clad camping sites and fish-filled lakes. All of far-west Ontario is a sportsman's paradise.

Ontario, in fact, suffers from a surfeit of wilderness play space. Recently, the provincial government had to declare northernmost reaches amounting to a fifth of its territory a "hinterland area." Entry to them by anyone not a resident is prohibited. Reason for the restriction is to avoid the expense, effort, and occasional bad feeling resulting from searches (sometimes in vain) for lost sportsmen and inexperienced adventurers.

Ontario in Cross Section

An air and train trip from Toronto 500 miles due north to James Bay taught me more Ontario geography.*

Near Lake Simcoe my plane left farmland behind. Below lay the dividing line between softer, more recent geologic strata and the hard edge of the Canadian (or Pre-Cambrian) Shield, with its ancient, flinty rocks, nubbly landscape, and countless lakes. To the north, in the Shield, farming is generally unrewarding, but forests millions of acres in extent grow spruce, pine, birch, and poplar.

Cars moving northward along Highway 11, escape route from cities' heat, were headed for lake shores dotted with cottages and inns.

Far west I could see Georgian Bay, but not the bass and muskies that frequent its ledgy shallows. Ahead lay that principality of play, the Muskoka lakes and Lake of Bays, and presently we skirted the edge of lake-splashed Algonquin Provincial Park. Everywhere the sun beat down on a holiday land of perennial enchantment, as popular with U. S. visitors as with Canadians.

After a brief halt at North Bay, scene last

* See "Map of Canada, Alaska, and Greenland," a supplement to the NATIONAL GEOGRAPHIC MAGAZINE for June, 1947.

A Staircase of Locks Lifts Boats in Rideau Canal

This waterway connects the Ottawa River at Ottawa with Lake Ontario at Kingston. It was built by Lt. Col. John By as an emergency route in 1827-32, when Canadians feared Americans might blockade St. Lawrence commerce. England shipped kegs of silver half-crowns to meet the canal's payrolls.

Devoid of military or commercial use, the Rideau today floats pleasure boats and canoeists. Flag-bedecked *Rideau II* honored Elizabeth II during Ottawa's celebration of her Coronation last June.

spring of a uranium flurry when townsmen vainly swept their yards with Geiger counters, the plane crossed the campers' paradise of Lake Timagami. Soon northern Ontario's chief mining region came into view. There lay the silver town of Cobalt, and then we flew between Canada's richest gold-producing areas, Kirkland Lake-Larder Lake and the mineralized rock reef known as the Porcupine.

Timmins in the Porcupine district, "the biggest town in Canada," never has been incorporated as a city, despite its 27,700 population. Here, under moss of a portage route, so goes the story, Benny Hollinger and Alec Gillies in 1909 found lump gold that bore the imprint of the boot calks of generations of trappers and fur traders. Today, Hollinger Consolidated Gold Mines, at the site of the discovery, is Canada's second most productive, surpassed only by Kerr-Addison Gold Mines in the Kirkland Lake district.

Between touch-down at Porquis Junction and flight's end at Kapuskasing the spruce forest reached unbroken to the flat horizon.

At Kapuskasing, an orderly paper mill town, new home developments intrude on the surrounding sea of forest, like coral colonies building out a reef (pages 844 and 852).

Nursery Grows 20,000,000 Trees

I watched Spruce Falls Power & Paper Company pulp cutters nibbling away at timber limits that cover an area bigger than Connecticut (page 847). The company hopes tree growth on this vast reserve will keep ahead of cutting, fire, and insect damage.

To hedge their bet, however, they already have set out several million 4-year-old spruce raised from seed at their own Spruce Falls Forest Nursery, where I saw 20,000,000 trees growing, many less than an inch tall.

At Camp 68 we lunched with woods workers on tomato juice, soup, three kinds of meat (including steak), potatoes, carrots, pies, jelly roll, canned plums, coffee.

Woods life, while no bed of roses, differs mightily from its rugged prototype of not-so-long-ago. Base pay, for one thing, has gone up 60 percent since 1945.

"Camp 68 is typical of living conditions now," Fred Flatt, woodlands manager for the company, told me. "You saw the panel buildings, modern plumbing, and bunkhouses free of crowding. Why, we even issue flannelette sheets and pillowcases!

"Some change from the old days," Flatt went on, "when the men slept crossways on long double-decker shelves, climbing in over the footboards. 'Muzzle-loading bunks,' we called 'em, where a spruce rail, the 'snortin' pole,' separated each man from his neighbor. Bedding was hay or spruce boughs, food mostly sowbelly, beans, and dried fruit. Nowadays—well, you ate their grub."

At Cochrane I boarded the Ontario Northland Railway's twice-a-week train, the "Polar Bear." Its passenger and freight cars run on Ontario's northernmost tracks to Moosonee near the foot of James Bay.

The 186-mile right-of-way is a trough between green walls of forest. It follows the Abitibi and Moose Rivers past sawmills, pulp-cutting camps, clusters of Indian tents. Passengers were mostly vacationists, woods workers, and Indians.

End of steel was close to the wide Moose River mouth, where the tidal fall uncovers sand flats that force even a canoe to zigzag. Two days before our visit, we heard, Moosonee was Ontario's hottest spot—92°. Yet a trader's wife told me ice floes still jammed the east coast of Hudson Bay.

By boat we crossed to the island where stand the white, red-roofed buildings of the Hudson's Bay Company's second oldest post, Moose Factory, founded in 1672.

It was Sunday, and I attended worship with Moose Factory whites and Indians in historic St. Thomas's Church. The Suffragan Bishop of Moosonee, the Right Reverend Neville Clarke, led this English service. His Cree language service would follow in the afternoon. Indian beadwork decorated moosehide altar- and pulpit-cloths.

Kingston Epitomizes English Ontario

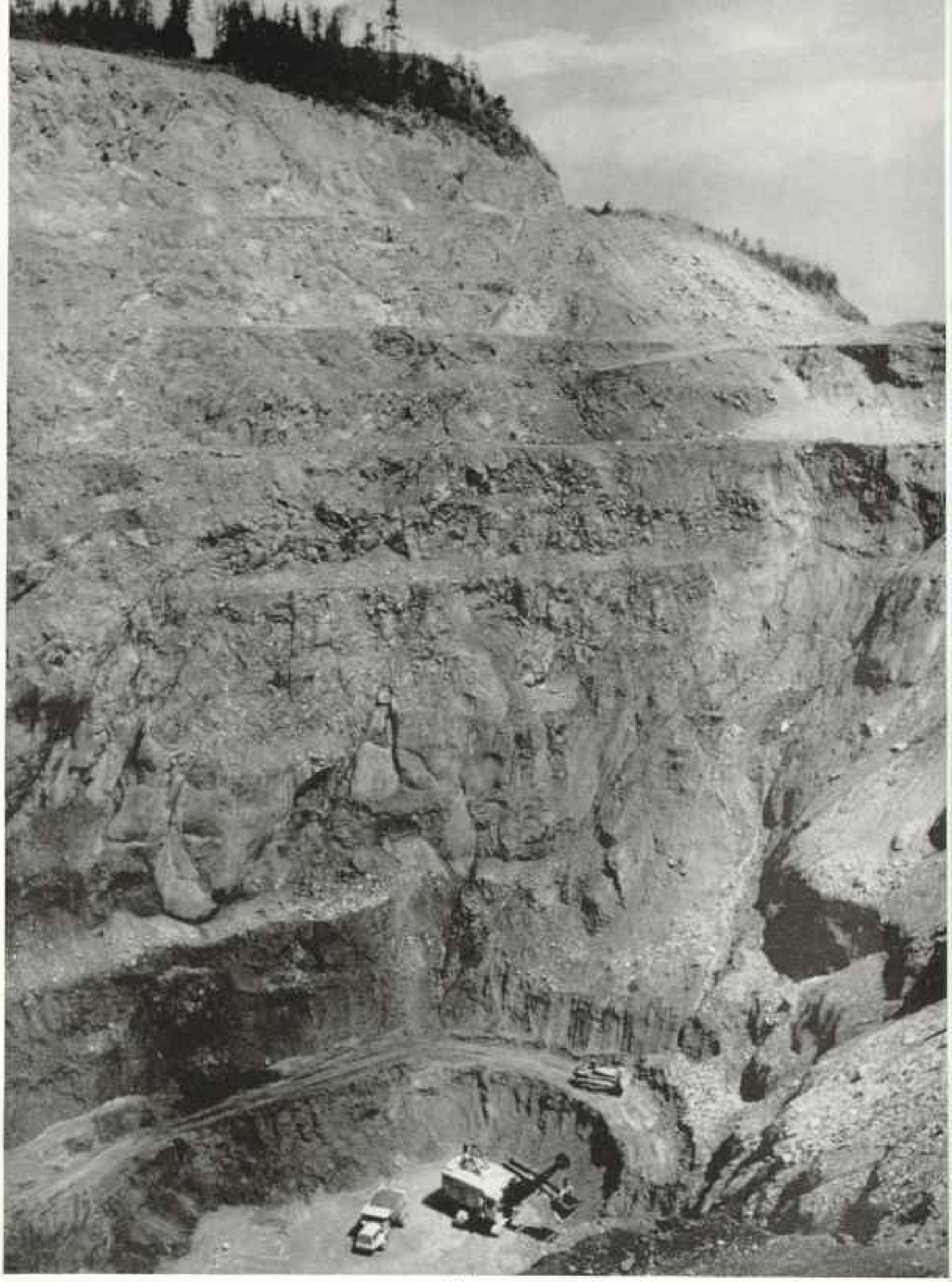
Back in the south, I turned into the last leg of my journey, through eastern Ontario to Peterborough, Kingston, and Ottawa.

Peterborough has given to canoes and boats built there a name as familiar to Canadians as is Old Town to Americans. The pleasant city stands on the Trent Canal where it overcomes Otonabee River rapids by a series of locks that include a 65-foot hydraulic lift, the world's highest with a lock chamber that rises and drops. Peterborough welcomes vacationists and fishermen to the Kawartha Lakes.

Venerable Kingston, capital of United Canada from 1841 to 1844, stands where Lake Ontario spills its waters into the St. Lawrence River and the maze of channels that create the Thousand Islands.

Kingston suggested to me an English shire town. Public buildings have solid dignity; small shops friendly unpretentiousness; leafy streets and parks a restful sense of the worth of time itself. Yet it's a busy city, with boat and locomotive works, a nylon mill, and the fabricating and forge plant of the Aluminum Company of Canada, Ltd. Here, too, is Queen's University, its ivied halls and shady walks reminiscent of old New England schools.

Kingston and military tradition are insepa-



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Engineers Diverted a River and Drained a Lake to Get Steep Rock's High-grade Iron

Removal of lake-bottom clay and rubble, beginning in 1944, has uncovered one of North America's outstanding iron ranges. Open-pit operations already have yielded nine million tons; now underground mining has begun. This electric shovel takes 7-ton bites. Lake water formerly lapped just below the spruce trees (page 849).

Canada's Boundless Forests Yield Four-fifths of the Newsprint Used by U. S. Papers

Kapuskasing employees of Spruce Falls Power & Paper Company display customers' wares. *New York Times* owns 49 percent of Spruce Falls common stock. Canadian newsprint enters the United States duty free.

rable. Fort Frontenac arose here in 1673. And this was Canada's naval base in the War of 1812. Today, Kingston is the seat of the Royal Military College (page 836). On a hill overlooking it squats Fort Henry, built in its present form between 1832 and 1836. Its purpose was to defend Canada against a possible American invasion during the prolonged period of strained relations following the War of 1812.

I ended my Ontario odyssey on a bluff where the capital of Canada lifts towers and chimneys above the coiling current of the river that shares its name—Ottawa.*

Skyline focus of this city of 202,000 is the imposing Parliament Buildings where cabinet and legislators govern the 15 million people of the second largest country in the world, after the U.S.S.R. (pages 829, 830, 848).

In Ottawa I ate pemmican 47 years old. Granular and tasteless at first savoring, it developed flavor as I chewed it. The trail meat, canned by Armour and Company, was from a case left with other relics at Cape Columbia, Ellesmere Island, by Admiral, then Commander, Robert E. Peary in 1906 (page 827).†

As I strolled with Ottawa friends through Major's Hill Park, the Peace Tower carillonneur flooded the evening air with the tintinnabulation of his 53 bells. We paused at Nepean Point across the river from the factories and homes of Hull, Quebec (page 830).

This outlook over the soil and industry of Ontario's French-speaking neighbor Province seemed an appropriate reminder of federal responsibility and the wisdom of Queen Victoria's choice of this city as capital.

To east and south Ottawa stood shoulder to shoulder with the cultivated, older part of the nation, the historic stronghold of Canadian character and traditions. West and north stretched out spaciously the forested, mineral-rich bush country, lavish contributor already to national prosperity, but promising for the future much, much more.

* See "Exploring Ottawa," by Bruce Hutchison, National Geographic Magazine, November, 1947.

† See "We Followed Peary to the Pole," by Gilbert Grosvenor and Thomas W. McKnew, National Geographic Magazine, October, 1953.

Jericho Gives Up Its Secrets

Beneath a House in Earth's Most Ancient Town, Scientists Discover a Family Group of 7,000-year-old Portraits

By Kathleen M. Kenyon and A. Douglas Tushingham*

With Illustrations from Photographs by Nancy Lord

EARLY this year, as members of our joint U.S.-British expedition dug for the second season into the ruins of Neolithic Jericho, a human skull lay partly exposed in the side of one of our trenches. But one never goes burrowing about an ancient site just to remove things. Maintaining a straight, vertical edge on an excavation, so that layers marking successive settlements may be recorded accurately, is a cardinal rule of modern archeology. So there we left it.

Remains of Neolithic men are too important to be ignored, however. Neolithic means "new stone age," when man stood at the very threshold of his long march toward civilization. One of the objectives of our expedition was to learn more about these users of stone implements who inhabited Palestine 70 centuries ago. When drawings were completed in that area of the dig, where we had sliced through the ruins of one house built upon the tumbled remnants of another, we sent word to bring out the skull but to make as small a hole as possible in the side of the trench.

Peter Parr, in charge of digging in that area, appeared that evening with an astonishing object. It was a Neolithic skull all right, but the whole of the lower part was covered with plaster molded into human features. Eyes were inset with sections of shell. Central slits represented pupils. Cheeks were rounded and chubby, ears delicately molded, mouth prim. Only the nose was broken away.

Plastered Skulls a Surprise Link

Here was a missing link so unexpected that it had never been missed! No archeologist had even guessed at the existence of such a work of art, foreshadowing the great traditions of Mesopotamia, Egypt, and ancient Greece. We realized with a thrill of discovery that we were looking at the portrait of a man who lived and died more than 7,000 years ago.

One of these sculptured skulls would have been culmination enough for our two seasons' work, but more surprises were in store. Visible in the cavity from which Parr had removed the first skull lay two others. When these were removed, three more appeared (page 857). Behind them lay still another. We ended, a week after our efforts should have bowed to the advancing heat of a Jericho summer, with a family group of seven of these amazing portrait heads and an enormous hole in the side of our trench.

Jericho, whose ancient artists produced our seven portraits, owes its existence to that vitally important feature of the Jordan Valley—an unfailing supply of water. Elisha's Fountain ('Ain es Sultan) is honored by tradition as the very one into which the prophet cast his handful of salt, miraculously "healing" its waters (II Kings 2: 19-22). It flows to this day only a few yards from Old Testament Jericho's ruins (page 855). This gushing sweet water in the midst of the arid plain of the Jordan Valley has for untold centuries attracted wanderers to its side.

A Cradle of Human Culture

We had come to Elisha's Fountain and Jericho to learn what we could of man's cultural beginnings.

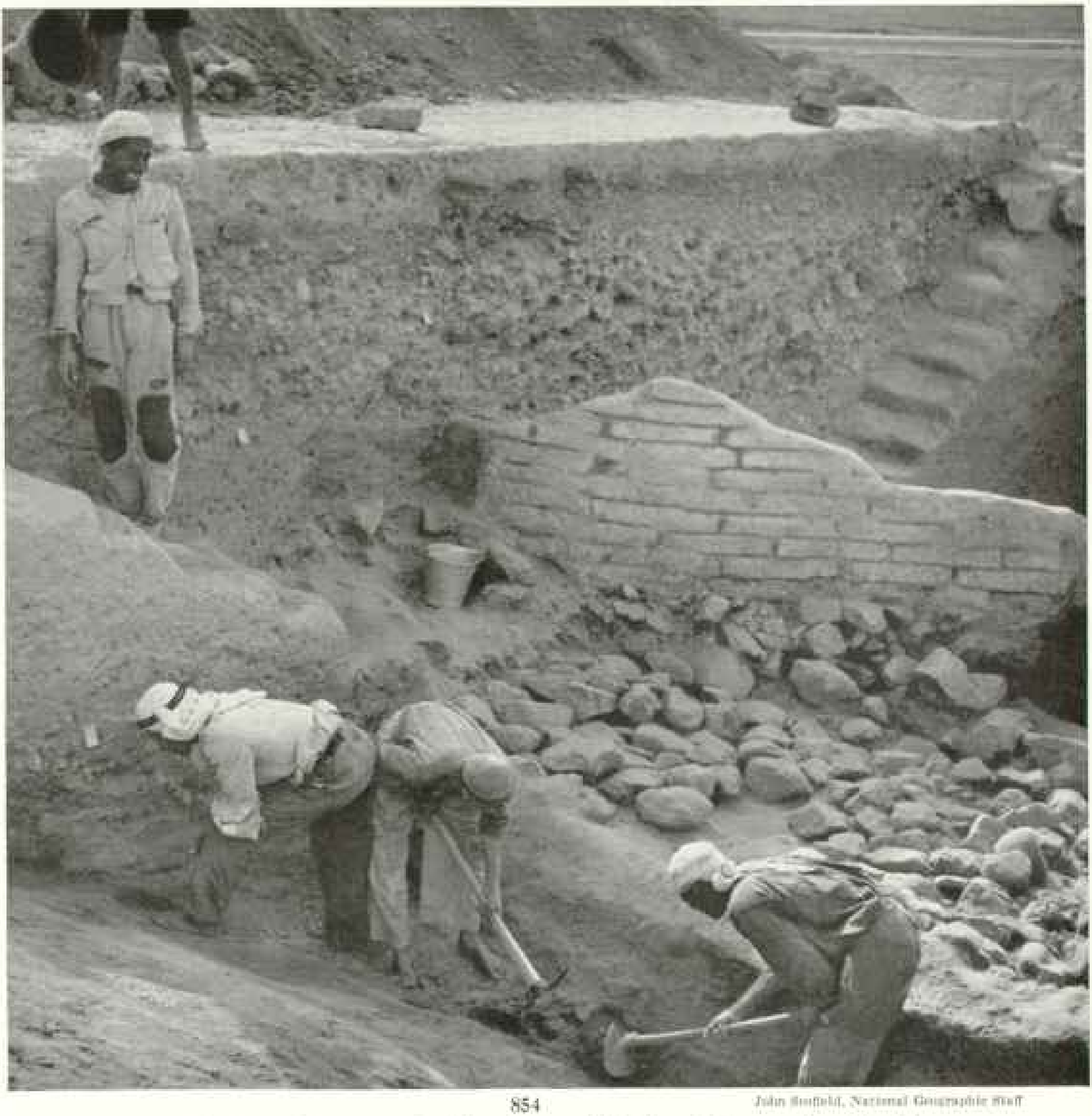
To Christians the world over, Jericho is familiar for the dramatic Old Testament description of its capture by the Israelites under Joshua. Its very name conjures up the familiar Biblical story: "So the people shouted when the priests blew with the trumpets: and it came to pass . . . that the wall fell down flat . . . And they utterly destroyed all that was in the city . . . with the edge of the sword" (Joshua 6: 20-21).

Our expedition hoped to illustrate the Bible's account with confirmation of the town's destruction by the Israelites. Literary evidence points to a date somewhere between 1400 and 1250 B. C. for the collapse of the wall before the Israelite assault.

Moreover, Jericho's ruins have thrown important light on man's first hesitant steps toward community effort. There was every possibility that Jericho might take honors as the oldest known town in the world.

Palestine, in which Jericho lies, is a land of contrasts. On one hand, Jerusalem and its ancient sister city of Samaria (Sebastye) perch high on rocky hills. In the Near East's brief

* The 1952 and 1953 Jericho excavations were sponsored jointly by the British School of Archaeology and the American School of Oriental Research, both with headquarters in Jerusalem. Dr. Kenyon, the expedition director, is Lecturer in Palestinian Archaeology at the University of London Institute of Archaeology. Dr. Tushingham, assistant director for both seasons, is an associate professor at Queen's University, Kingston, Ontario, Canada.



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Arab Workmen Uncover the Many-layered Walls of Bronze Age Jericho

Tumbled defenses provide a tantalizing jigsaw puzzle for Jericho archeologists. These loose boulders supported a wall about 2100 B. C. The standing wall of mud bricks was built two or three centuries later. Rough stairs were hewn recently for workers carrying debris to the dump heap.

springtime the land bursts into color as grain sprouts on terraces built on the hillsides, then lapses again into the blinding gray-white of dry, sun-drenched limestone. Every possible inch is cultivated, for Palestine is a hard country from which to wrest a livelihood.

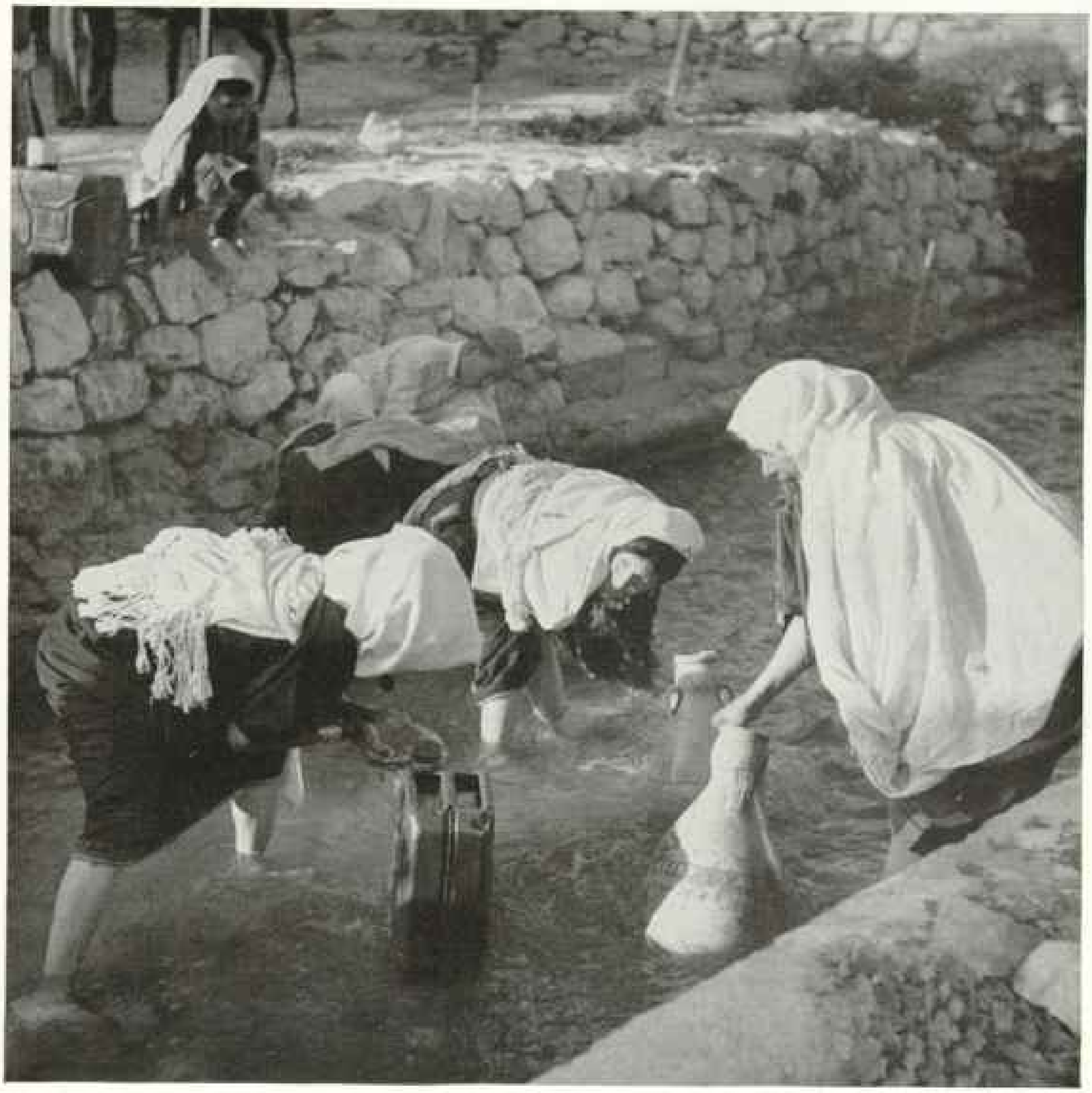
On the other hand, rolling grasslands spread out from 'Amman, capital of the Hashemite Kingdom of Jordan,* merging farther east into the hot wastes of the Syrian Desert. Between these twin highlands, in the great gash of the Jordan Valley, lies Jericho (map, p. 856).

The elevation of Jerusalem is 2,550 feet above sea level; of 'Amman, 2,600. From either place a road descends a few miles through steeply winding valleys, then plunges downhill past signs in Arabic and English marking sea level, until it reaches Jericho, 840 feet below sea level, the lowest-lying town on the earth's surface.

As the road descends, gray hills with their terraced fields and scattering of olive trees are left behind. Here are glaring slopes too waterless to be cultivated, fit only for flocks of goats and sheep that subsist on vegetation which comes up after the winter rains.

Suddenly there appears the flat plain of

* See "Hashemite Jordan, Arab Heartland," by John Scofield, NATIONAL GEOGRAPHIC MAGAZINE, December, 1952.



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Refugee Women Use Elisha's Fountain as Laundry and Social Club

Ankle-deep in swift water, Arab housewives exchange gossip as they fill graceful pottery jars and an ugly but utilitarian jerrican (pages 862, 863). One (right) uses teeth to hold her skirt out of the stream. Their village lies a few hundred feet away in the shadow of Jericho's hoary mound.

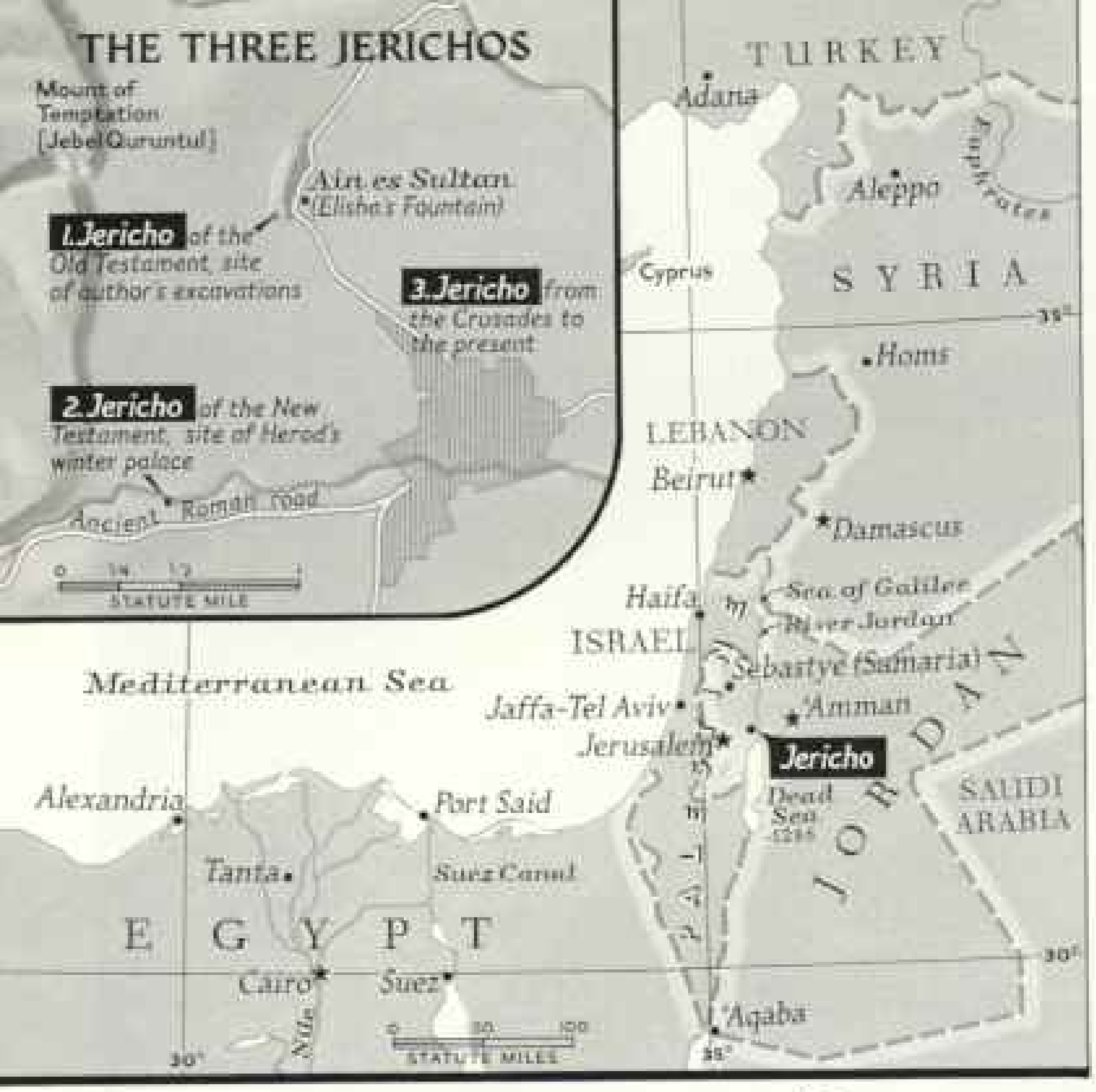
Jericho, the bottom of a great rift through which the River Jordan coils to lose itself in the Dead Sea. The center of the plain is a fantastic badlands where the river has twisted its channel between slimy white mounds. The landscape is glaring white in the sunshine and inexpressibly barren.

In the midst of this bleak plain Jericho stands out in startling fertility. Deep-green fields of grain surround gardens, palm trees, and banana groves. This lush oasis fans out from an oval, mud-colored hill a mile northwest of the modern town (page 860). Archeologists years ago discovered that the hill is actually a mound composed of layer upon layer of ruins deposited as successive towns rose, prospered, and fell beside the pleasant waters of Elisha's Fountain. These waters, carefully diverted to rich gardens, nurture modern Jericho exactly as they did the ancient Jerichos.

West of present-day Jericho, near a stream, archeologists have uncovered some of New Testament Jericho, where Herod had his winter palace.*

Ours was not the first expedition to attack Old Testament Jericho's long-buried secrets. German archeologists were there before World

* See "The Ghosts of Jericho," by James L. Kelso, NATIONAL GEOGRAPHIC MAGAZINE, December, 1951.



Earth's Lowest Town Was a Crossroads in Bible Times

Jericho, where ancient trade routes met, was the gateway to the Promised Land. Its destruction by Joshua's Israelites opened the way to the heart of Palestine.

An important center in New Testament times, Jericho was the scene of many incidents in the life of Christ. Tradition identifies Jebel Quruntul as the place of His temptation in the Wilderness. The winter palace of Herod stood near by.

A venerable Roman road over which courageous visitors may still drive up to Jerusalem is perhaps the one traveled by Jesus. The traditional place of His baptism is a spot on the River Jordan, a few miles away.

Situated 840 feet below Mediterranean level, modern Jericho is the world's lowest-lying town.

Drawn by Victor J. Kelley

War I, and Prof. John Garstang led British expeditions between 1930 and 1936. These revealed much of the site's history and first told something of its incredible antiquity.

Seventy Centuries of History

Jericho's first families probably occupied the gentle slope above Elisha's Fountain even before 5000 B. C. By 1600 B. C. the walls stood at a height of 70 feet above the spring, crowning an impressive mound. For 4,000 years Jericho was a great fortified town, rising slowly from the plain as it rebuilt itself time after time on the remnants of its own past. When buildings and walls fell or were destroyed, the ruins were leveled and new structures built on them.

Into the rubbish that grew beneath the city went telltale evidence for today's archeologists: broken pots, rude implements, and bits of lost or discarded ornament.

Digging up the past is a round-the-clock job. Archeologists usually set up headquarters as near to their dig as possible. We live in an old millhouse beside Elisha's Fountain, a few yards from the eastern slope of the mound. Streams flow on either side of us; to them comes a constant procession of women from the near-by refugee camp.

Here, at 7 a. m., 50 laborers assemble daily to collect tools and climb up the *tell* (an Arab word for a mound marking an ancient site) which towers above our headquarters.

On the tell the laborers split into groups. Each has a man to break the soil, using a pick if the deposit is deep or a trowel if more delicate work is required. Another fills baskets. Laughing Arab boys, carrying baskets of earth to the refuse dump, climb stairs left in the sides of the trench (page 854). An expedition staff member in charge of each small group records everything found as the layers of soil are sliced away.

Palestinian expeditions are a far cry from the romantic, treasure-hunting concept of archeology. As often as not, a dig looks more like the start of a major construction project than a search for earth's buried secrets.

Our first task was to establish the dates of old Jericho's many defenses. Their main outlines had been revealed by previous excavations. Now, to learn the *when* of these successive walls, a deep trench was dug from top to bottom through one side of the mound. Walls and city levels stood revealed on its vertical face in varying colors and textures. By carefully tracing the different layers in the soil, it was possible to determine which city was responsible for each wall.

One of the greatest advances of Near East archeology is the ever developing "pottery chronology." Like everything else in man's culture, pottery has undergone a slow, steady evolution since its invention some 65 or 70 centuries ago. A trained archeologist can determine, with considerable accuracy, the date of a level by examining the broken bits he

(Text continued on page 865)

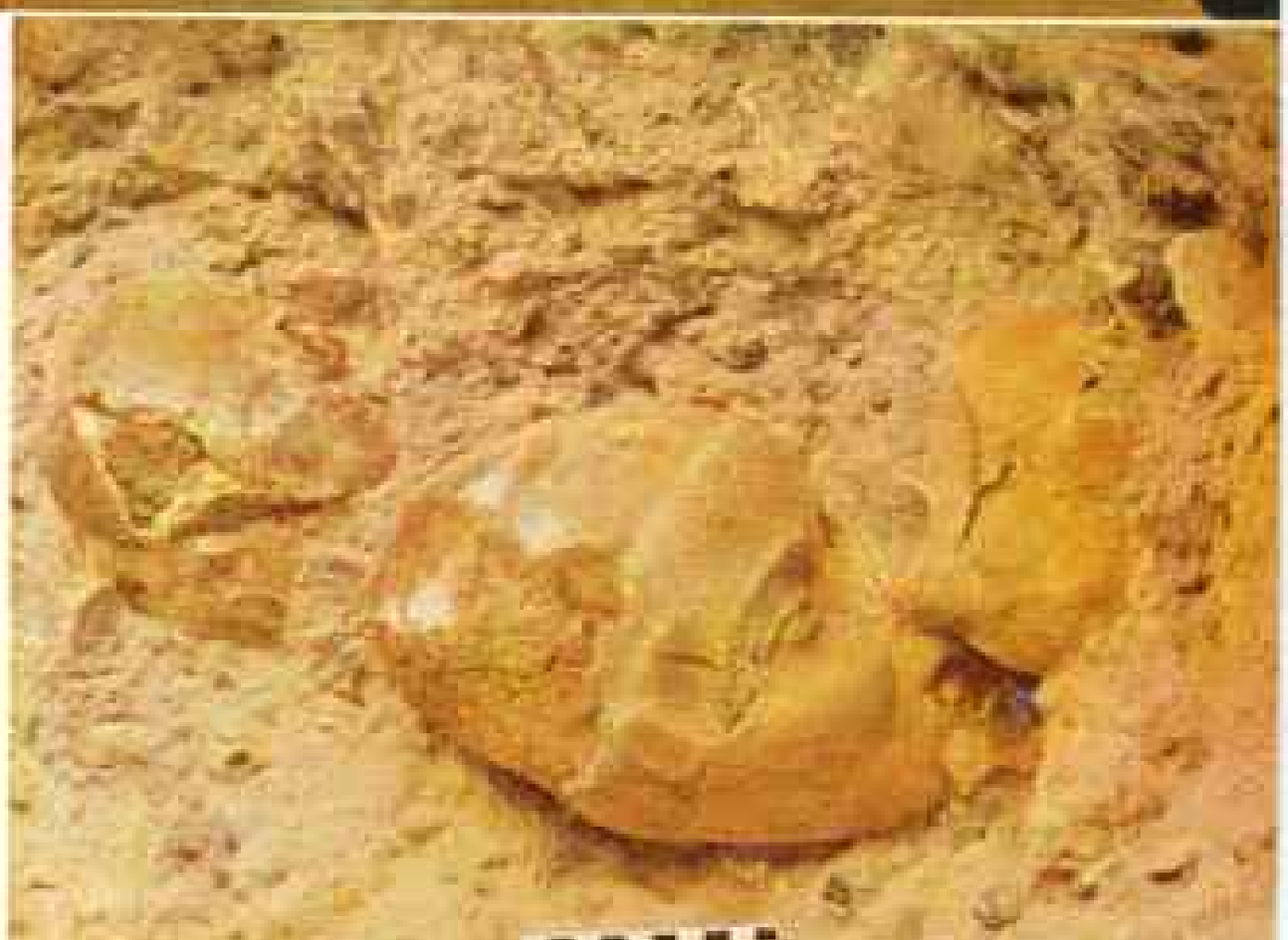
Jericho's Plastered Skulls Depict Men Dead 7,000 Years

At least 35 centuries old when Joshua conquered Jericho, these sculptured heads were found beneath a Neolithic ruin in the oldest known walled town.

In London University's Institute of Archaeology, Dr. Kathleen M. Kenyon (right) and technician Cecil Western compare Jericho heads with pictures of skulls discovered previously.

This head is best preserved of seven found in Jericho. Two others lie partly revealed.

Kodachrome by National Geographic Photographer David S. Boyer and Ektachrome by Nancy Lord



↑ A Plaster Floor Buried 7,000 Years Gets a Scrubbing

Wilkin Fisher (left), 16-year-old son of an American archeologist, helps Arab workmen wash a floor uncovered in Neolithic Jericho. Burnished plaster is so well preserved that it needs only a wet rag to restore its luster.

Scientists discovered the portrait heads of page 857 beneath the floor of a building near by.

← Jericho's crowded cemetery gives archeologists almost as much information as the ancient town itself.

Here Diana Kirkbride, a Briton, emerges from a Middle Bronze Age tomb in which the expedition found a rich collection of possessions used by Palestinians about 5,500 years ago.

Jericho Tombs Preserve Meat Prepared 35 Centuries Ago

Like primitive men the world over, Jordan Valley people buried with their dead examples of all the things they used in life: tools, ornaments, and weapons. Even their food is known, thanks to a dry climate that saved intact the contents of tombs.

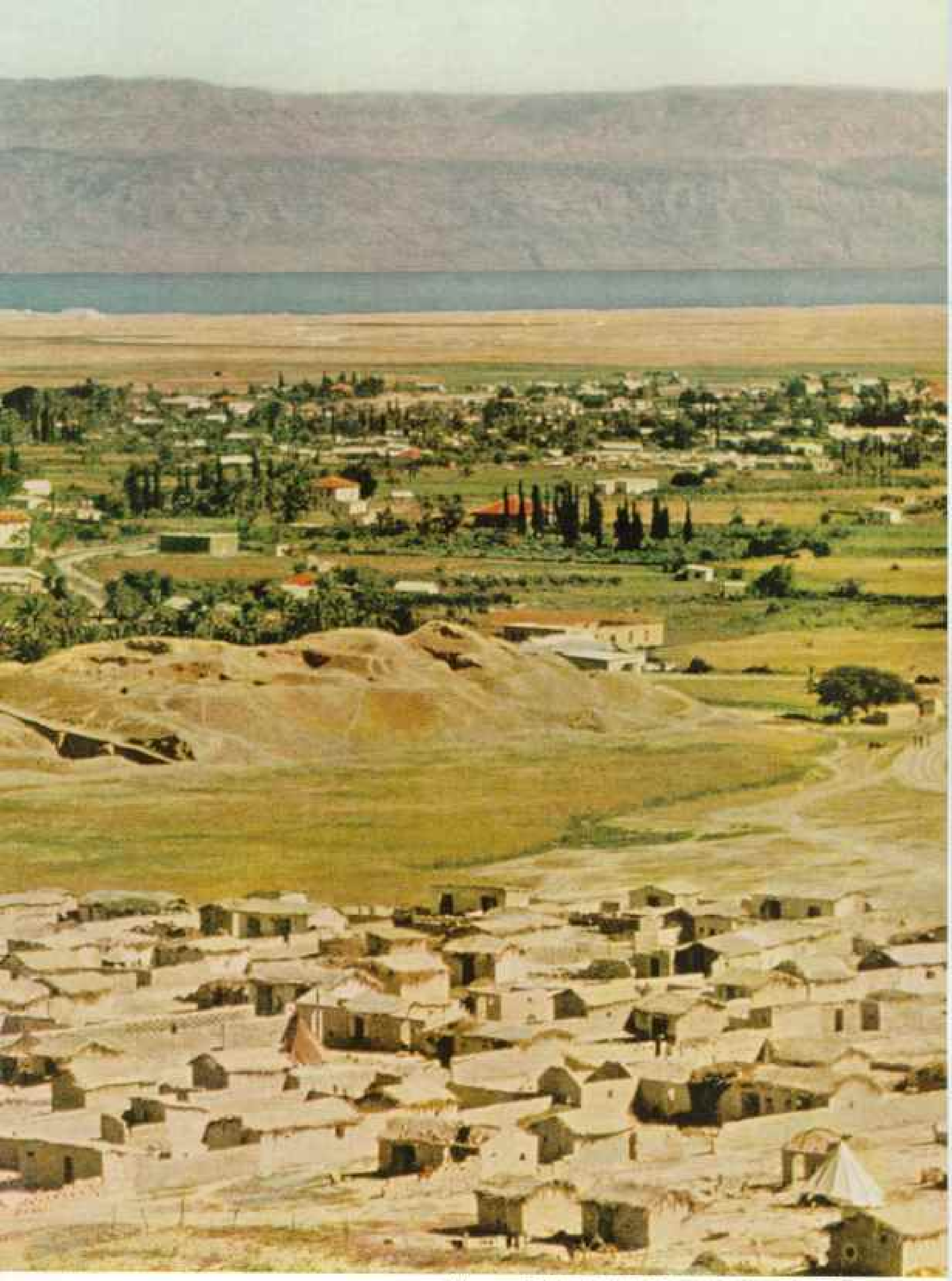
Here Albinia Gell, an Englishwoman, holds a bowl containing meat buried with a Middle Bronze Age man about 1600 B. C. This "roast" contains no bones; it may have been a slab of liver.

Submitted to analysis, the bones of Jericho animals are expected to show how far Neolithic man's domesticated livestock had progressed toward the modern standard.

↓ Archeologist Neil Richardson of Syracuse, New York, cleans a Neolithic pot unearthed in the Jericho mound. Only the base remained; it had to be strengthened with liquid plastic before it could be removed.

Old Jericho's Tumbled Ruins Lie Between Parched Mud Village and Green Oasis

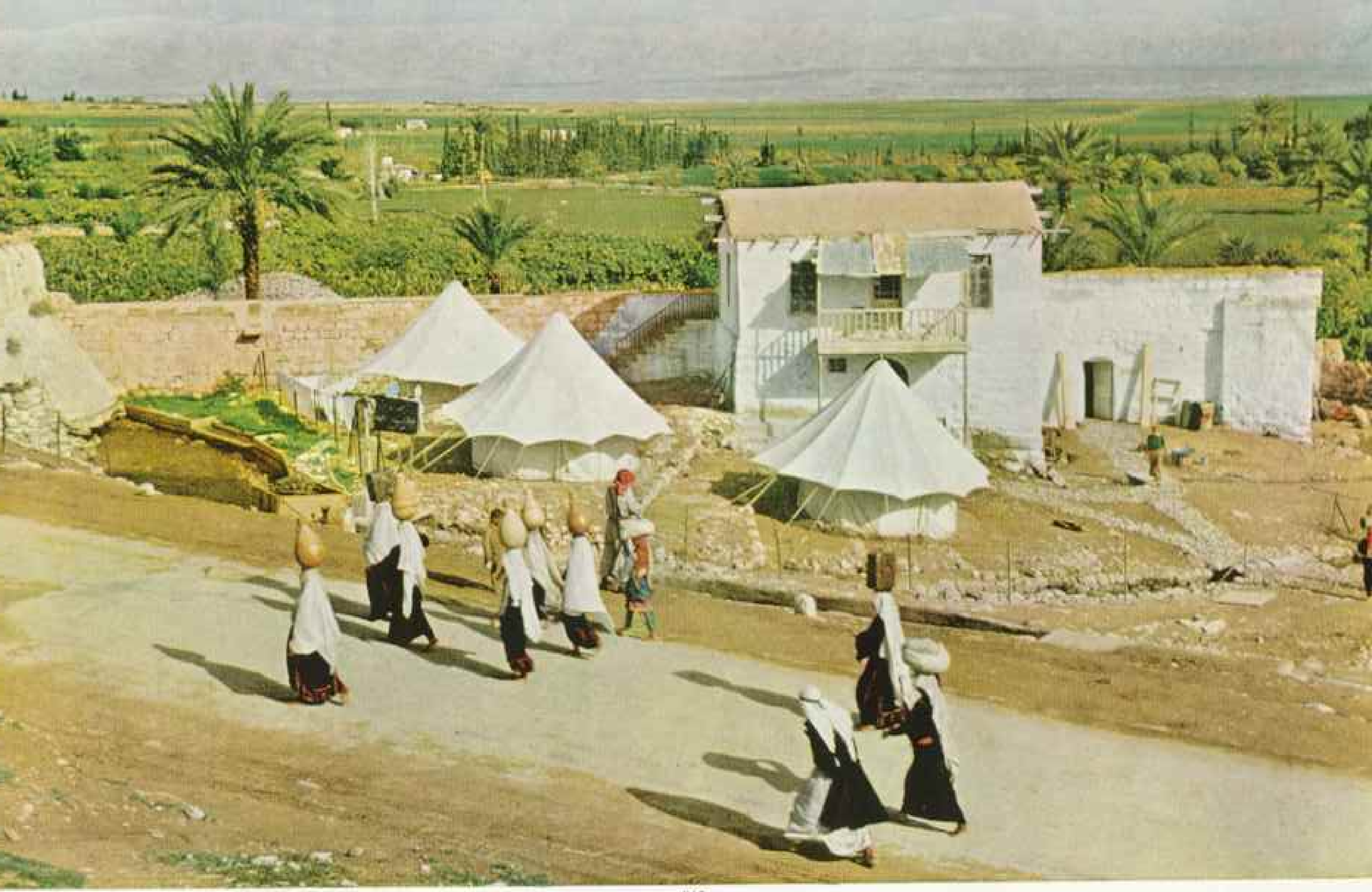
Arab refugees from Israel live in adobe houses beside the mound that rose as one town after another grew upon the debris of its predecessors. Modern Jericho (beyond) is a farming center in Hashemite Jordan.

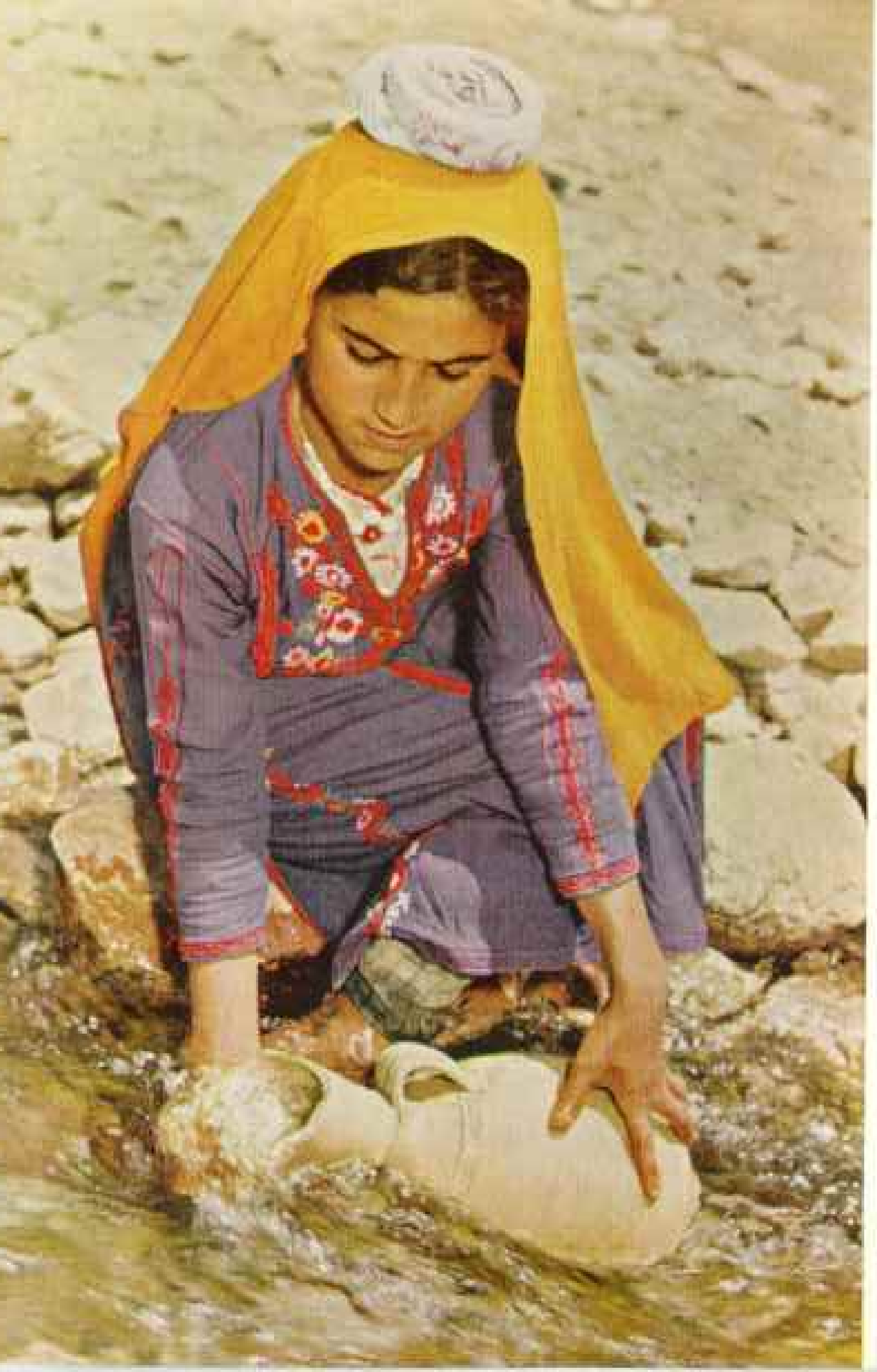


861 Kodachrome by National Geographic Photographer David S. Boyer

Moses, Standing on the Distant Mountains, Glimpsed the Promised Land and Died

Later Joshua, besieging the city, commanded the priests to blow their trumpets and the people to shout; the walls fell (Joshua 6). The Dead Sea, earth's lowest surface feature, shines 1,286 feet below ocean level.





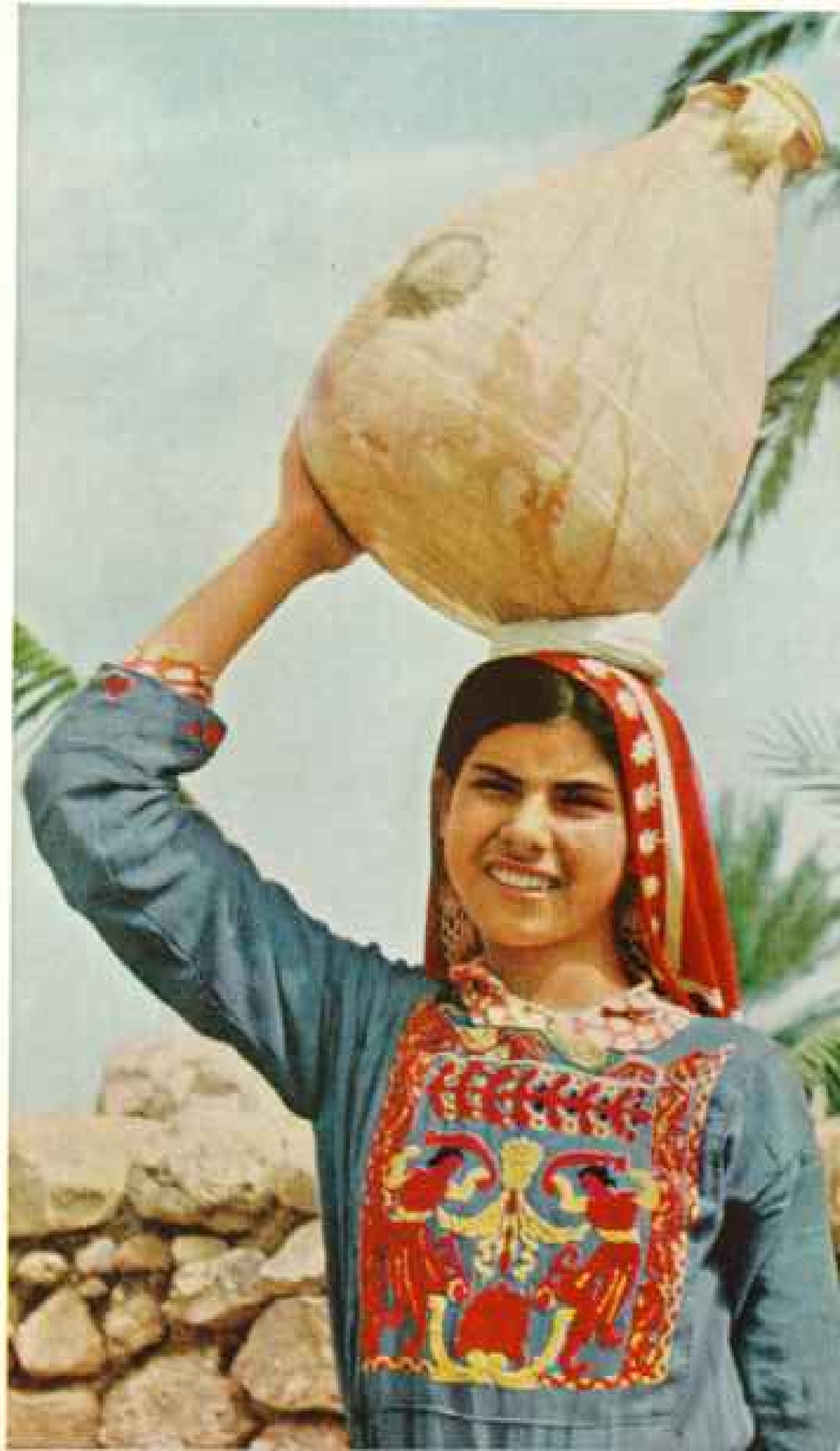
Water Carriers Still Trudge to Elisha's Fountain as in Bible Days

From Jericho's ancient mound, on which the photographer stood to make the picture, excavators daily watch streams of refugee women moving to Elisha's Fountain (left). This spring, which yields a thousand gallons a minute, is by tradition the one into which the prophet Elisha cast a handful of salt, miraculously "healing" the water (II Kings 2: 19-22).

The old millhouse is used as headquarters for the archeological expedition. Tents serve as men's dormitories.

Arab Women Toil at the Spring

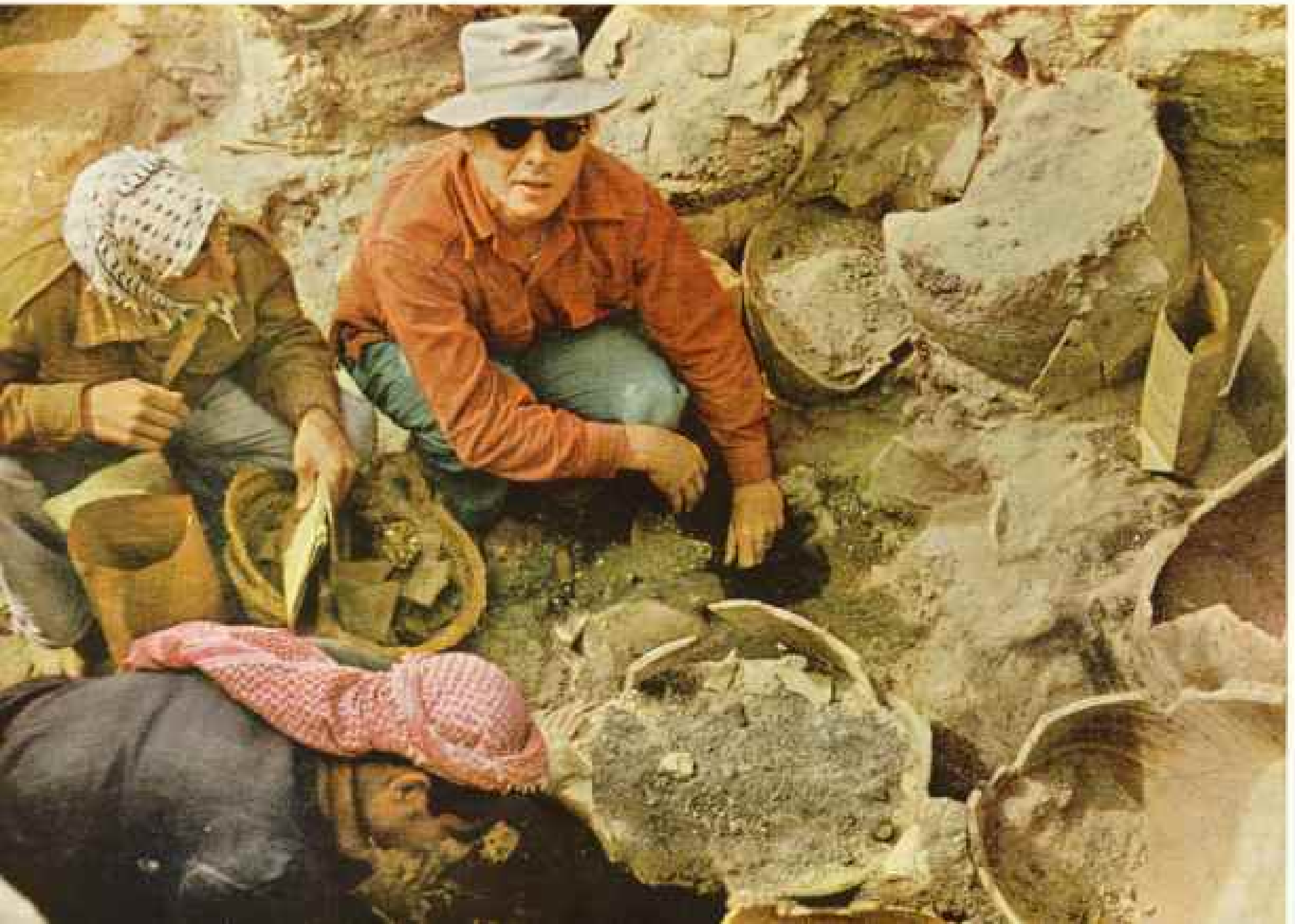
Pottery jars used by these refugees have not changed materially from those found in Jericho ruins. Women wear the embroidered costumes of Palestine, where each Arab village has its recognizable style. Less colorful Western dress is making rapid gains among these folk, particularly the men.



Grain Stored About 1560 B. C. Comes to Light A. D. 1953

Invaders sacked Old Testament Jericho during the closing years of the Middle Bronze Age (1900-1550 B. C.). This was a time of Egyptian domination over Palestine, generations before the town's destruction by Joshua's Israelites. When fire swept the site, flame-blackened walls collapsed on this granary and smashed food-filled jars. Heat carbonized the grain, accounting for its preservation.

Above: Arab workmen lay bare broken storage jars for removal to the expedition's field laboratory. Below: Jim Warren of Paducah, Kentucky, supervises the collection of pottery fragments.



finds in it. At Jericho each layer is stripped off separately; the pottery is set aside as an aid in dating the layer from which it comes. The results tell a fascinating story as our trowels and spades bring Bronze Age Jericho to light (pages 859, 864, 867).

Six months of hard work have gone so far into our investigation of the Bronze Age defenses of Jericho. As we removed one wall after another and realized that we were examining only a small segment of the circuit enclosing Jericho's nine acres, we came to realize the scope of effort expended by these ancient Palestinians in keeping their defenses in repair.

Repeatedly we saw places where a wall had been built 5,000 years ago, only to fall, be patched, then rebuilt, then strengthened in front and behind, and finally, when repairs proved fruitless, be replaced by another broader wall on top of its ruins. Not only in our day has security lain in preparedness!

The Early Bronze Age in Palestine lasted from about 3100 to 2100 B. C. This was the dawn of the "historical" period in Bible lands. During all this time Jericho was thickly populated and strongly defended. The ancient city lay at the gateway to Palestine from the east. Every invader crossing the Jordan came face to face with it, as did the Israelites.

Jericho's Walls Tumbled Many Times

During the thousand years of the Early Bronze Age the city suffered many vicissitudes. Jericho's walls were repaired or completely rebuilt no fewer than 16 times! The earliest wall was undoubtedly destroyed by an earthquake; we found it lying flat, fallen forward on its face. Later walls probably suffered the same fate. Others may have been destroyed by enemies, as the latest of the 17 certainly was.

The destruction of this last wall marks a great catastrophe for Bronze Age Jericho, as indeed it must have for the whole of Palestine. Its predecessor had collapsed, possibly because of an earthquake. While it was still in ruins there was clearly an urgent threat, for the last wall was hurriedly built of rough and broken materials. Before it was finished, disaster overtook Jericho.

The wall as we found it was destroyed so completely that the very stones of its foundations were split and blackened by fire. Brickwork was burnt bright red, and ashes of the conflagration, in striking shades of red, white, and pastel blue, were piled against the remains.

Without doubt this destruction marks the invasion of Palestine by a wave of nomads from the desert, which brought the great Early Bronze Age civilization to an end. The invaders, probably the Amorites, brought with them to Jericho an entirely different way of life. They cared nothing for the city architecture which had grown up in the thousand years of the Early Bronze Age; their houses were simple and flimsy. Their pottery was unlike that of the older inhabitants; their burial customs were austere. For 200 years progress in Palestine was halted.

During the next period, too—the Middle Bronze Age—Jericho's defenses tell us much about the people who built the old city. This was the time of Abraham and of Joseph—by our calendar, from about 1900 to 1550 B. C.

Chariot Warfare Changed Defenses

About 1730 B. C. Asiatic invaders imposed their rule on Egypt and its territories, including Palestine. These Hyksos warriors are credited with having introduced chariot warfare.

Jericho's Middle Bronze defenses are distinguished by the introduction of a completely new system, in which the city wall was protected by a sloping ramp. It seems logical to associate each new system of defense with some new method of attack. This steep ramp would have been an excellent defense against chariot warfare by preventing the chariots from galloping up to the base of the wall before the defenders could mass.

The "newest" Middle Bronze Age city uncovered by our picks dates from about 1600 B. C. After this there is a tantalizing gap in our evidence. The invasion of the Israelites under Joshua must have taken place somewhere between about 1400 and 1250 B. C. Scholars cannot agree on the exact date; evidence from Jericho might solve the problem.

Wherever we dug, Late Bronze Age levels had disappeared. This is due partly to abandonment of the town for long periods, when the topmost levels tended to wash away during successive rainy seasons. We know from the Bible that Jericho lay unoccupied for several hundred years after Joshua's conquest. Partly, too, soil had been stripped from the mound for brickmaking and gardens until all the later areas were removed. Perhaps before the end of the dig we shall discover an answer to our questions about Jericho's most famous destruction.

Cemetery Is Fruitful Hunting Ground

Strangely enough, with the exception of our seven skulls few sensational finds have come to light in the Jericho mound itself. These ancient Palestinians left little behind them but shattered walls, discarded tools and utensils, and the masses of broken pottery by which we can estimate the age of their settlements.

Fortunately for archeology, however, primitive man venerated his dead. Ancient ceme-

John Bedfill, National Geographic Staff

Bible's "City of Palm Trees" (Deuteronomy 34: 3) Still Reaps a Rich Harvest

Modern Jericho is noted for its dates, flavorful bananas, and pomegranates (foreground), which look like rose-red oranges. Shriveled pomegranates were discovered in one Middle Bronze Age tomb.

teries are fruitful fields. Jericho's lies beneath the mud houses and tents of a large refugee camp north of the mound. These newest Jericho residents, who fled from homes in what is now Israel, settled like their predecessors of several thousand years ago near the hospitable waters of Elisha's Fountain.

As so many others have done, the people of ancient Jericho buried with their dead all the things necessary in afterlife; their tombs, unlike their ruined cities, give us well-preserved examples of the objects Jericho men and women cherished and used.

These tombs beneath the refugee village provided another exciting milestone of Palestinian archeology. "Rich" burials of the Middle Bronze Age had often been found in Palestine, but Jericho's tombs showed us how poor the others really were. This was the period of greatest prosperity for the ancient city by Elisha's Fountain; gifts of food and household goods, laid away with the dead, awaited our spades and trowels.

In one tomb was a minute box about an inch high, carved to resemble a pomegranate; in the tomb were real pomegranates like those grown today in Jericho's lush gardens. Desiccated and shrunken, they were nonetheless recognizable. Half a dozen little wooden bowls had handles carved as rams' heads. Broken fragments of stools and tables gave indication of the furniture used in ancient Jericho.

Brain Survives 3,500 Years

In a Middle Bronze Age tomb we were amazed to find a skull containing an intact brain. It was shriveled to walnut size, but despite its 3,500 years every convolution was visible. Then we found other perishable materials: wood, fruit, textiles, even meat (page 859). In the extreme heat of Jericho the carefully sealed tombs preserved things which have rarely survived elsewhere except in Egypt.

Visitors often have a mental picture of the archeologist happily grabbing precious things out of a tomb and running to show them to his fellows. Actually, finds often remain untouched for weeks while preservatives are applied, photographs taken, plans drawn, and every object registered, so that a complete record is in hand of the tomb's exact appearance. Perhaps one of these tombs can some-

John Scofield, National Geographic Staff

Battered Pots and Dishes Are Calendars of Near Eastern Archeology

Scientists judge the age of long-forgotten towns and cemeteries from the style and workmanship of pottery. Expedition member Dorothy Marshall, of Scotland, here numbers homewares taken from a Jericho tomb.

day be reconstructed in the 'Amman museum exactly as we found it.

One of these Middle Bronze Age tombs stands out in our memories. The blocking of the door into the chamber was removed just as the day's work ended. Immediately inside we found the principal burial lying on a wooden bier. It was draped with a finely woven rush mat which overlapped a 5-foot wooden table, the largest we have yet found. On the table was a wooden platter holding joints of mutton to which flesh still adhered. Baskets held combs and toilet requisites.

Wood and textiles were in excellent condition when the tomb was opened. As soon as the outer air reached them, they began to ooze. Obviously they would be ruined soon unless we took steps to preserve them.

We started at once. For the wood objects paraffin wax is best. Outside in the shaft a Primus stove roared away, heating small jars of wax. These were passed through the narrow entrance to one of us who, squatting uncomfortably in the chamber, cleaned the wood with a camel's-hair brush. The hot liquid was then poured on the objects, into which it sank with a sizzling sound.

Baskets, textiles, and bones we treated with plastic preparations. Great care was necessary so that the weight of the liquid itself did not cause the powdery material to collapse.

By 2 in the morning, working in the light provided by a little gasoline generator, we had protected everything against the ravages of 20th-century atmosphere.

Skull Artists Were Town Dwellers

More important than the tomb discoveries, and overshadowing even the problem of Joshua's conquest, is the light Jericho has cast on man's striving toward community effort. Here is where our skulls fit into the picture. The men who decorated them were not only artists; they were town dwellers. We were able to prove beyond reasonable doubt that Jericho is the oldest town known to science.*

Only when men discovered that wild grains could be cultivated and made to produce more richly, and that certain animals could be kept

* The reputation of Damascus as the oldest city in the world was achieved mainly on the basis of references to it in the Bible in the period of the patriarchs. But to date there have been no archeological excavations at Damascus which have demonstrated its priority in age to Jericho.

Arab Schoolboys Get a Down-to-earth Lesson in Jericho's Past

As archeologists dug into the mound of the Old Testament town, their spades turned up exciting new evidence about man's past.

Houses, fortifications, shrines, art objects, and household wares reveal how far the ancients had progressed toward civilization. Bones remain to tell about early domestication of animals. Even food, preserved in the intense heat of the Jordan Valley, survives to fill in our knowledge of Jericho man's diet (page 866).

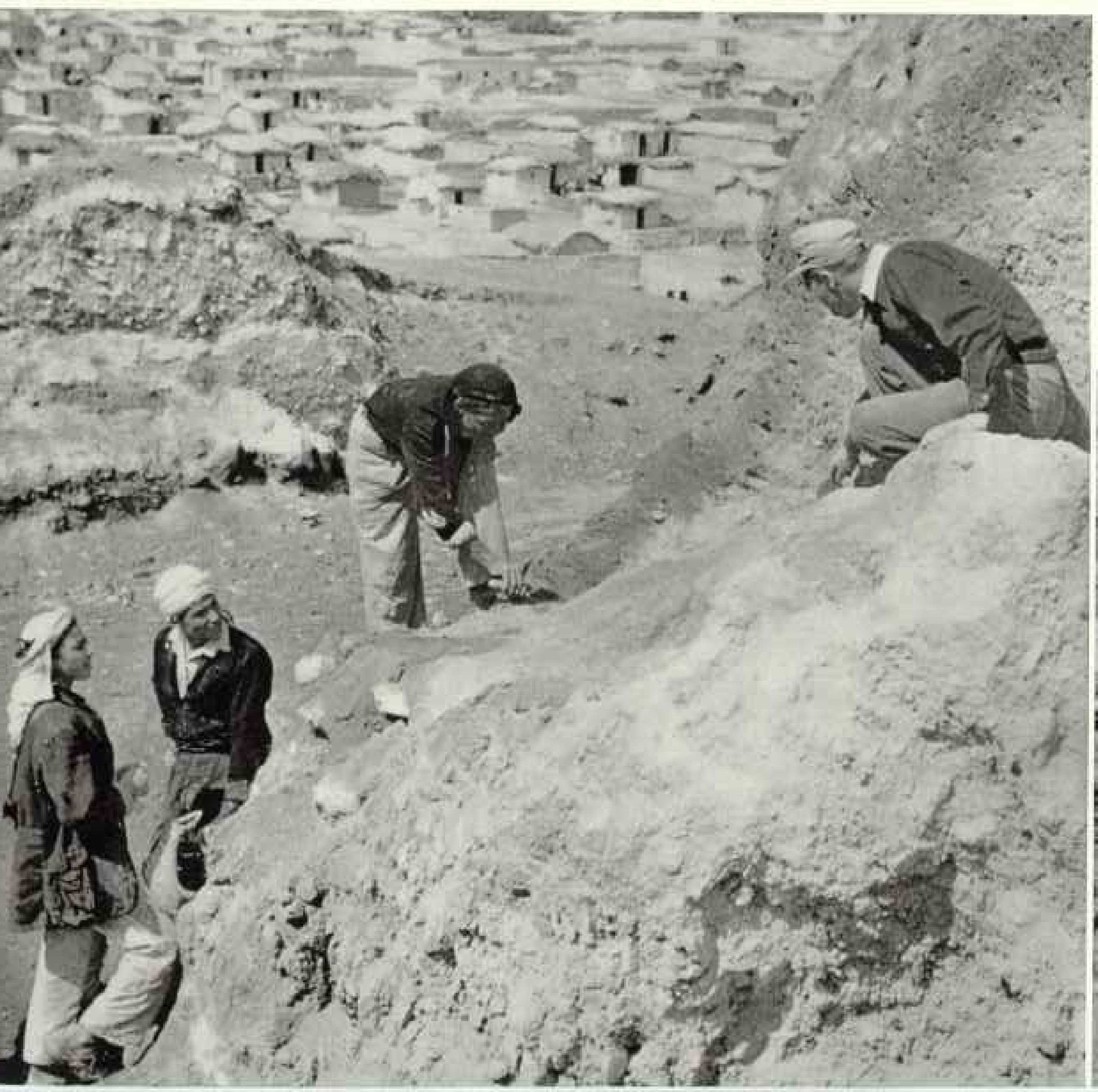
These boys from 'Amman, Jordan's desert-edge capital, get a first-hand look at Palestine's oldest known town. Dr. A. Douglas Tushingham, the expedition's assistant director, stands on an excavated wall and describes discoveries of the 1953 season.

Layers visible in the sides of the trench reveal how generations of Jericho men built on their predecessors' leveled structures. In some places this "layer cake" of history reached a depth of 70 feet.

Biblical Ruins Appear Meaningless Mounds of Earth to the Uninitiated

↖ It takes a practiced eye to tell crumbling sun-dried bricks from plain mud. Dr. Tushingham traces Early Bronze Age walls; an Arab workman helps. Adobe bricks like those found in the old town built the newest Jericho, the refugee village in background.

↓ Accurate records are all-important to archeologists. This British team makes an elaborate survey so that detailed plans of uncovered buildings may be drawn. These will be science's only permanent record, for each layer must be destroyed to get at the one below.



in herds, could they settle in one spot and be assured of a food supply. From this time we can expect to find permanent dwellings and the development of arts and crafts, a most important one being the making of pottery. Archeologists have traced these developments back to two great river valley areas of the Near East—the Jordan, and the Tigris-Euphrates in Mesopotamia.

Our discoveries indicate that Jericho is the oldest town yet discovered in this key area of man's early development.

Neolithic Jericho Had No Pottery

The earliest level we have uncovered takes us back before the introduction of pottery, when food and water containers were laboriously worked out of stone or made of wood or skins. Yet already Jericho's buildings were elaborately constructed of hand-molded sun-dried bricks. Solid walls were covered with fine plaster.

Such buildings had been discovered by Professor Garstang near the spring, the obvious reason for these early agriculturalists to settle here. Our first big surprise was to discover houses of the same type half the length of the tell away, and on the side away from the spring. This meant that early Jericho was no mere village.

Another surprise was the discovery that Neolithic Jericho had been a walled town. Deep beneath the earliest of the Bronze Age walls we reached the top of a massive stone wall. Its base was only a couple of feet above bedrock. This belongs without doubt to the earliest Neolithic stage, before the introduction of pottery.

Even though lacking pottery, the inhabitants of Jericho were then a community, capable of organizing themselves for the great labor involved in erecting a wall. The stones —one of them nearly five feet across—had to be brought from adjacent mountains.

How early this was in years is guesswork; an estimate might be about 5000 B. C. Whatever the exact age, Jericho has a sound claim to the title of earliest known town in the world.

Stone Knives Still Sharp

In the debris of the houses we found many of the simple utensils and implements of Neolithic men and women and evidences of the food they ate. Tools were of flint or occasionally of beautiful translucent obsidian. Knives, sickle blades, awls, and chisels are today sharp enough to cut.

Utensils are of stone; no doubt there were others of wood and skin. We found stone querns, with which grain was ground, mortars and pestles for pounding grain and vegetables, and stone bowls of every size from small and finely worked cups to large basins of hard granite. These must have required infinite labor to hollow out with the tools available.

Food was stored in pits sunk in the ground and carefully lined with plaster. Animal bones we are carefully preserving, so that experts can identify the breeds and tell us how far domesticated herds had been developed from the wild types from which they had originated not so very long before.

We can even glimpse the thoughts of these men who were taking their first steps towards civilization. One of the alterations to an elaborately constructed house converted a passageway into a small room. At one end is a small niche recessed in the wall, with a rough stone forming a pedestal at its base. Not far away, in the debris of the building, we found an elaborately worked block of volcanic rock, clearly imported from a distance. This exactly fitted into the niche.

Here we surely have one of the earliest known cult objects, perhaps worshiped as a symbol of the spirit of fertility of the earth. Small clay and mud figurines of domestic animals which we found may have been dedicated to the same religious purpose.

Skull Found Beneath Floor

Even more striking is the skull of an elderly man carefully set upright beneath the floor of a room in the angle of the two walls. Either he was an enemy whom it was desired to keep under control or a venerated member of the community whose wisdom it was hoped to perpetuate in the house.

Eventually, by comparing these 7,000-year-old relics of Jericho's past with the utensils and customs of primitive peoples of our own time, we may be able to reconstruct a fairly complete picture of life in Neolithic Jericho.

As for the seven sculptured heads, it is still too early to grasp the full significance of these amazing objects. One cannot help but feel that they are portraits, which bring the men of the earliest Neolithic period astonishingly to life. But why were they made? Probably they are survivals of some form of ancestor worship, in which their descendants attempted to preserve the personality of tribal or family elders.

Every day new details appear. As a third season starts, we face still another problem: Have we come to the bottom of all the Jerichos? Are there still older settlements beneath the one where we found our seven portraits? In due course we hope to find traces of the very first men who settled beside Jericho's spring. Then we shall be very close indeed to the beginnings of civilization.

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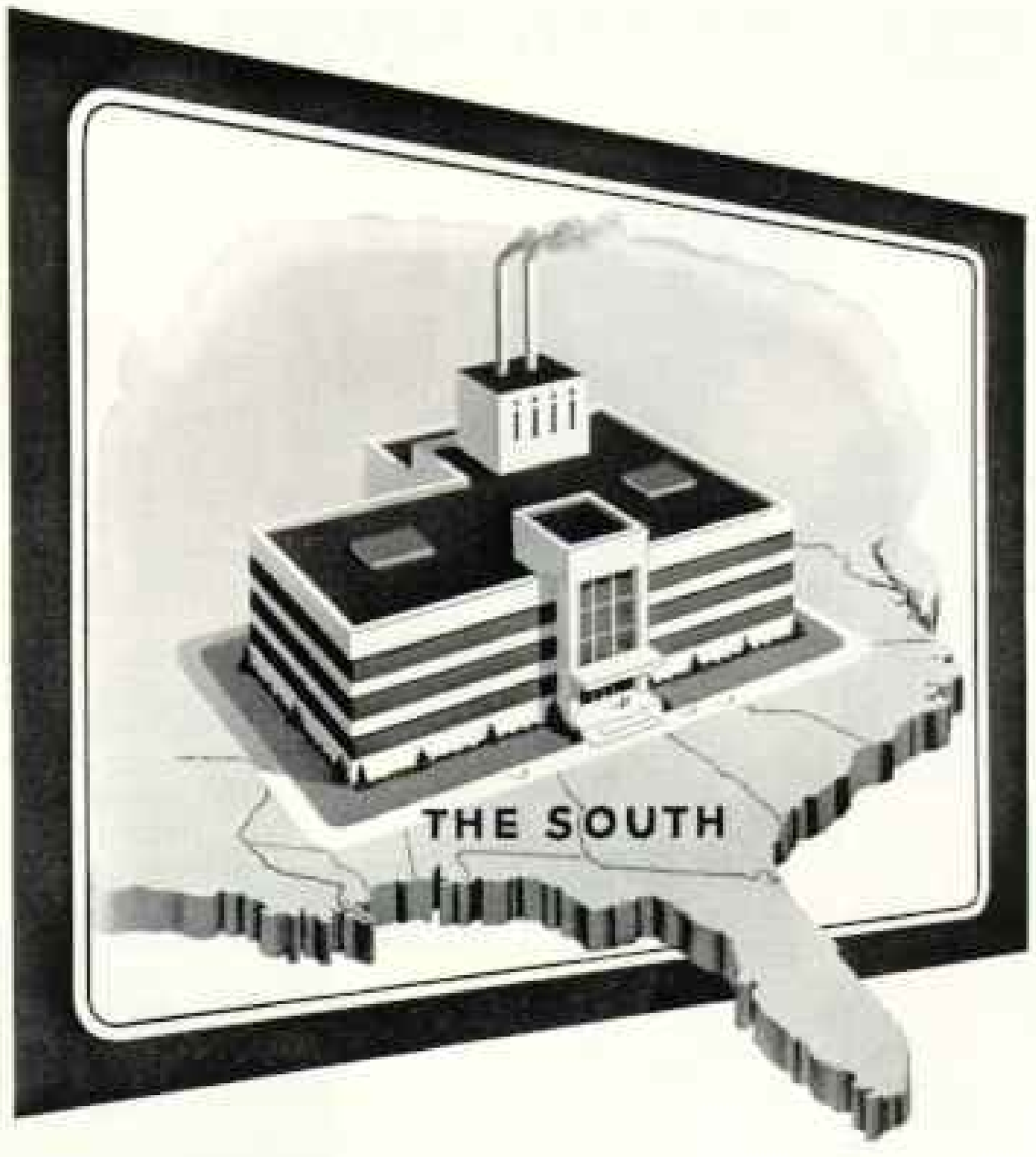

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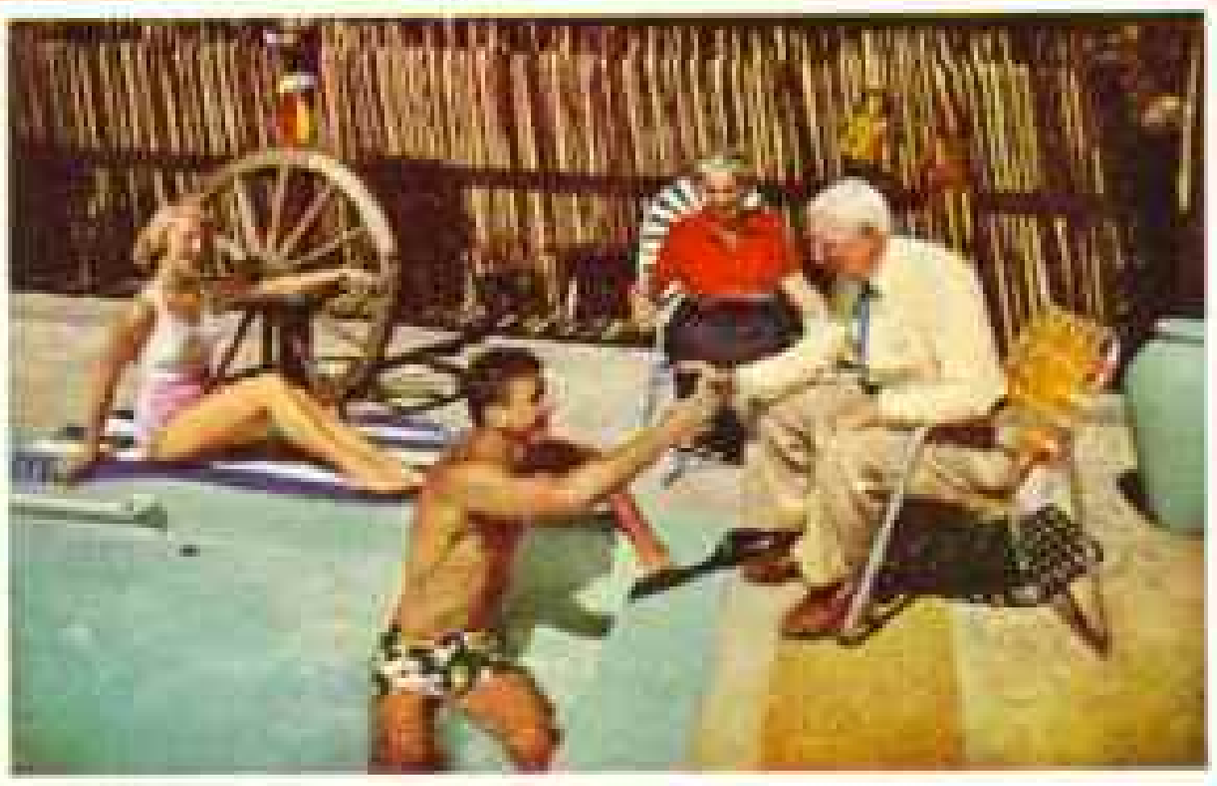

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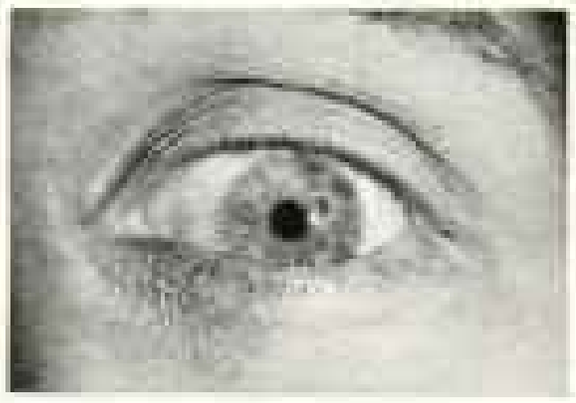

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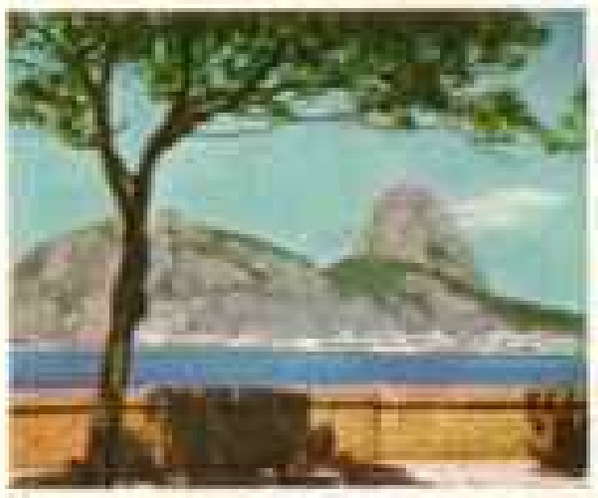

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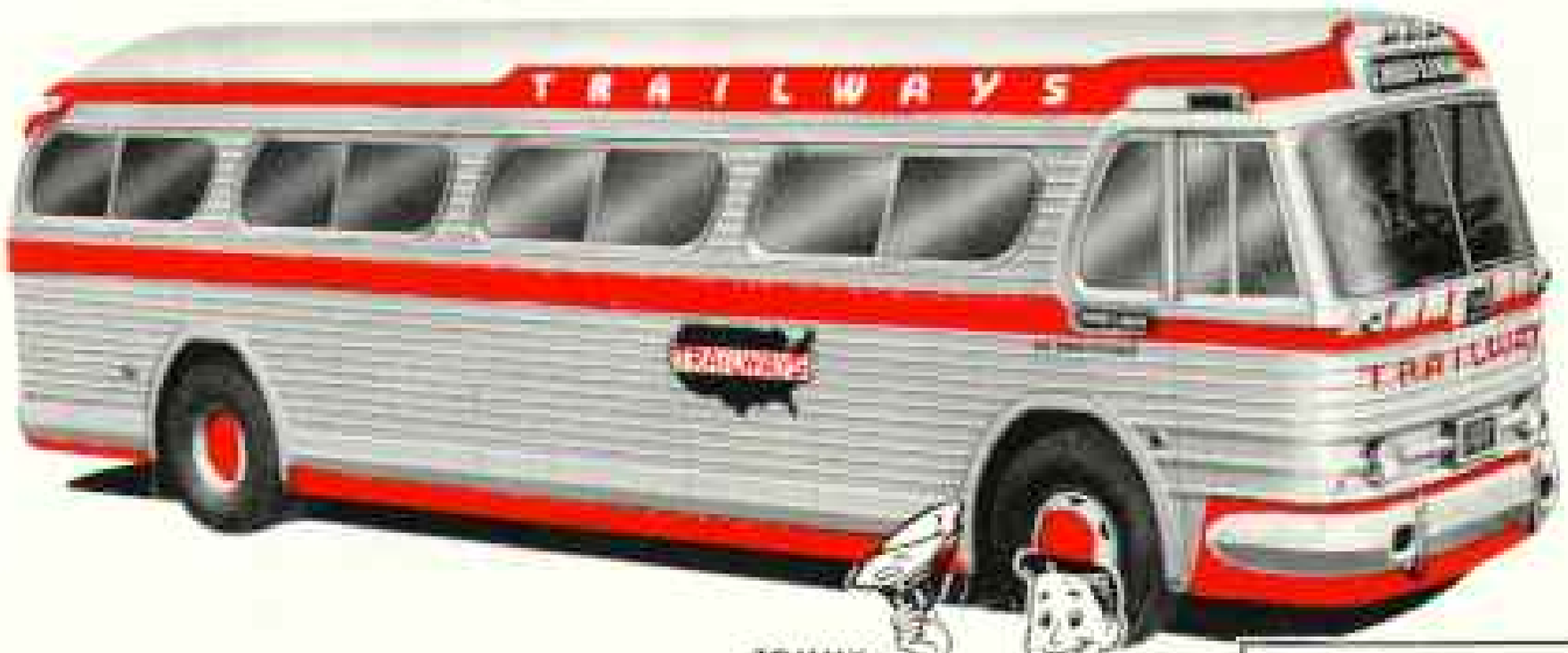

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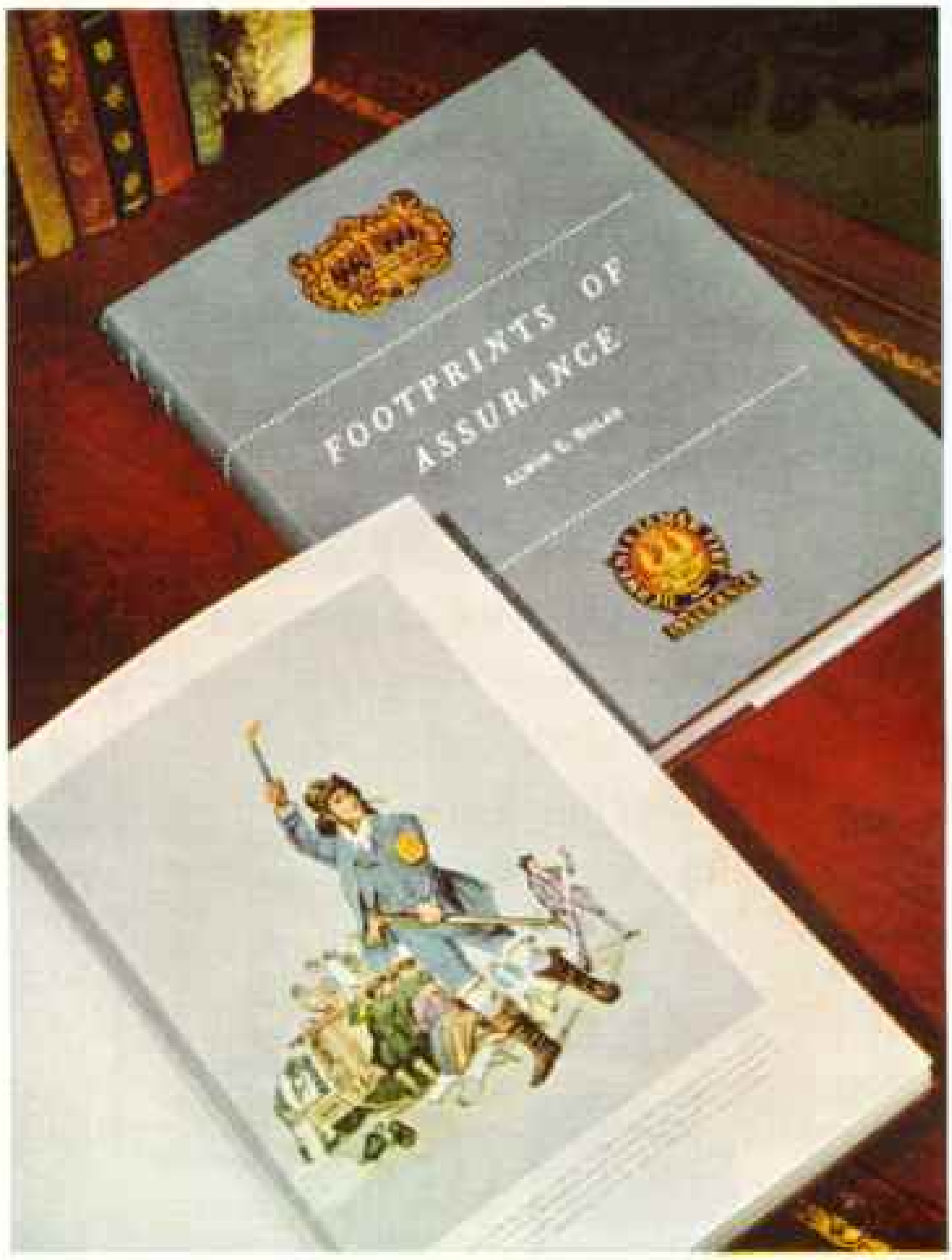

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A relaxed attitude toward life is important in the treatment of this disorder because rush, "drive" and emotional tension can cause an already elevated blood pressure to rise to even higher levels. This is why doctors advise a steady, easy pace during the day and eight or more hours of sleep every night.

In addition, patients should carefully follow their doctor's advice about diet and eating habits. Above all, weight should be constantly kept at the proper level, because high blood pressure and overweight often go hand in hand.

People who learn to take these precautions may live happily, usefully and actively with hypertension even to old age.

Of course, if blood pressure reaches and stays at an excessively high level . . . or if it is caused by an underlying disease . . . the situation becomes more serious. Even in these cases, there are often ways to lower pressure and relieve symptoms—such as drugs, surgery and special diets.

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