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Uncle Sam's new island State,
lighthearted and booming,
hitches its star to the sixties

Hawaii, U. S. A.

By FREDERICK SIMPICH, JR.

Illustrations by National Geographic photographer THOMAS NEBBIA

WE CITIZENS of the State of Hawaii sometimes become annoyed with our friends from the other 49. Tens of thousands of them a year come to visit us, but too many of them refuse to take us seriously. For instance:

A friend of mine flew out from Arizona for a visit. From the airport he taxied to a luxury hotel on Waikiki Beach. When I found him, he was already immovably dug in: a reclining beach chair under him, sunglasses and shorts his only attire, long blue combers before him, pretty girls in bathing suits surrounding him, a shaded terrace behind him whence he could, by raising a finger, summon food or drink.

"Wouldn't you like to tour the other islands," I asked without much hope, "and see what Hawaii is really like?"

"Thanks," he said. "I'll stay here."

I tried to tell him of the beauties of our mountains, the variety of our racial cultures, the vigor of our industry. But to compress into a sentence or so the enthusiasms of 25 years' residence in Hawaii proved too much.

So I left him to enjoy the languor of his hotel, so removed from the true life of the islands. Long since returned to Arizona, perhaps he will read this and learn what I wanted to say that day.

Volcanoes Keep New State Abuilding

Hawaii is a place where sugar cane fields have traffic lights, where the apeape plant throws leaves bigger than a man (page 39), and where the moon sometimes shines so bright we have rainbows at night. In these surprising islands, beach boys massage sun bathers with their feet, and woven feather hatbands costing several hundred dollars are the badge of the old-timer.

This is one State that grows bigger all the time, as active volcanoes vent their lavas toward the sea. Here escalators carry signs warning children, traditionally barefoot, against catching their toes. In Hawaii, Sears, Roebuck & Co. sells orchids, and lunch counters advertise Japanese sukiyaki as prominently as hot dogs and pancakes.

Removed from the west coast by 2,250

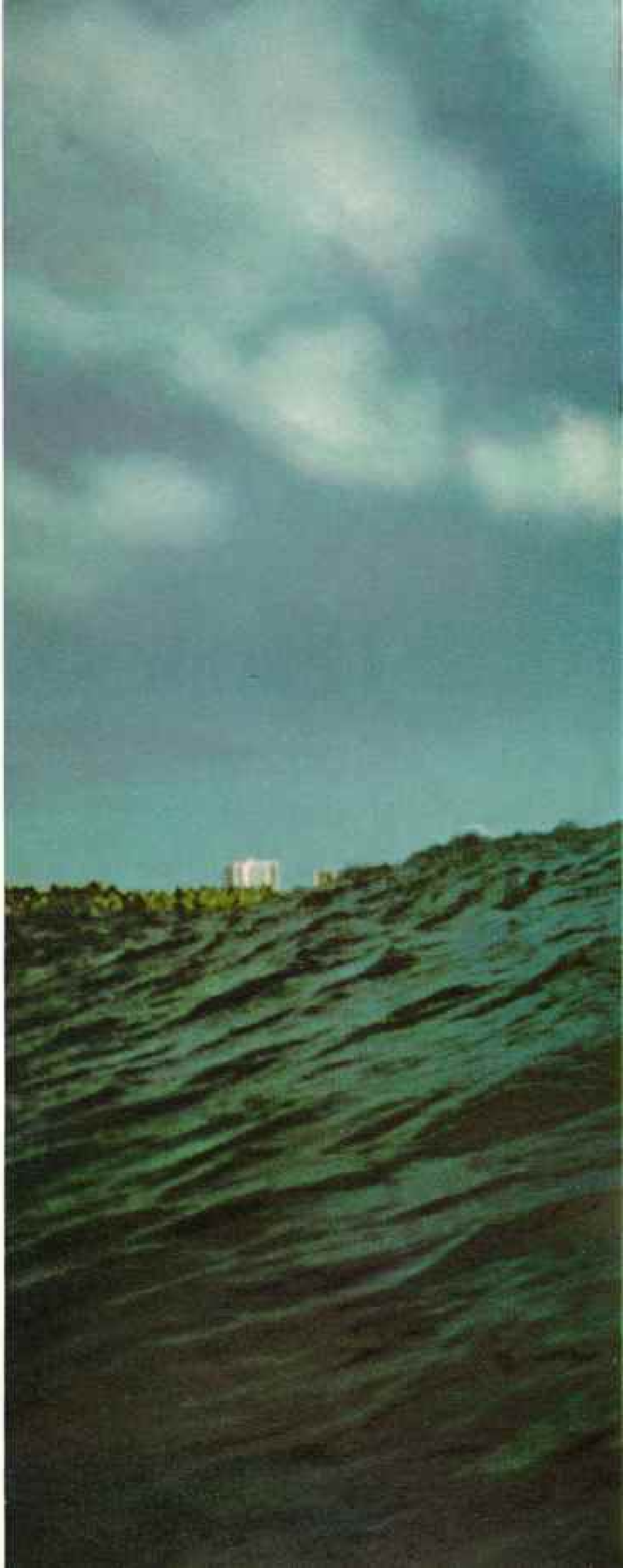
miles of water, seven inhabited islands of Hawaii span some 400 miles of the Pacific. From northwest to southeast they carry the music of their Polynesian names: Niihau, Kauai, Oahu, Molokai, Lanai, Maui, and Hawaii (see the 10-color Atlas Map distributed to members with this issue).

These are not so much islands as the tips of tremendous mid-ocean mountains, thrust up by volcanic eruptions. Hawaii, capped by Mauna Loa and Mauna Kea two and a half miles high, is not only the largest of the chain, the "Big Island"; it is the tallest mountain mass on earth, rising from the ocean bottom for a total ascent greater than Mount Everest's (diagram, page 34).

Britain's voyaging Captain Cook, searching for the fabled Northwest Passage, blundered on the Hawaiian group in 1778. He reported of his first encounter with the natives: "Several small pigs were purchased for a sixpenny nail."

Today pork costs a dollar a pound in Honolulu markets, and there are precious few Hawaiians left of pure Polynesian heritage. Hawaii holds 600,000 resident American citizens, 32 percent of Japanese extraction, 29 percent Caucasian, 11 percent Filipino, 6 percent Chinese, and the rest a blend of other bloods—including 2 percent pure Hawaiians.

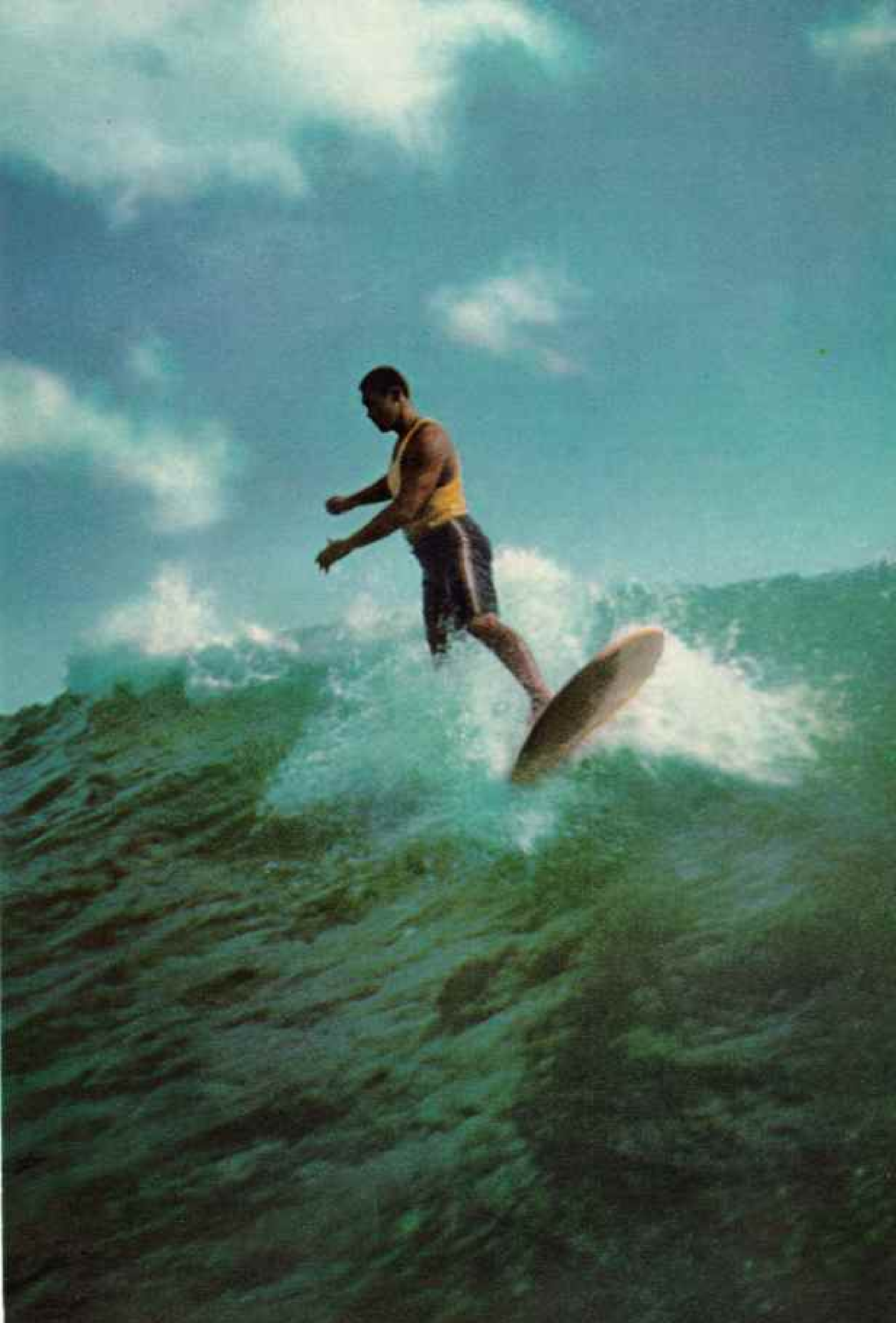
Twenty years after Cook's land-



Racing Toward Waikiki, a Surf Rider Teeters Between Sky and Sea

Sun-soaked beaches, lofty mountains, and balmy temperatures make the Nation's newest State a mid-Pacific paradise. Mark Twain called the archipelago "the loveliest fleet of islands that lies anchored in any ocean."

Braced for a turn, this surfer at Waikiki Beach exhibits championship form at 40 miles an hour.



ing a native ruler, Kamehameha, consolidated a kingdom in the islands that endured for a century.

Kamehameha towered 6 feet 6 inches and was a tremendously powerful man. Adept in warrior sports, he delighted in having javelins flung at him and plucking them from mid-air as he side-stepped them.

He had a canny trader's instinct behind a full-lipped, copper-colored face. Born in a Stone Age society of breechcloth and outrigger canoe, he lived to negotiate with the Western World. At his death he left among his vast properties a flagship of 175 tons and resplendent uniforms of Napoleonic cut.

The "Sandwich Islands," as Captain Cook named them for an English earl, soon became a trading crossroads of the Pacific. New inhabitants arrived in waves.

First there were sailors who jumped ship to savor the gentle life. Then came missionaries, to save souls and, without intending it, to prepare for ultimate statehood.

Other Americans, pioneering in planting seas of sugar cane, brought industry to the islands. The plantations soon demanded more labor than Hawaiians, felled by white men's diseases, could provide.

So Hawaii's sugar planters first turned to China for willing hands and strong backs. Later, recruiting agents scoured Japan, even tapped the Scandinavian countries and the Madeira Islands. The Philippines provided the final immigration in 1946, when weed-raddled pineapple and sugar fields, neglected during wartime, demanded restoration.*

Sugar cane now tosses its tassels over more than 200,000 acres. Hawaii's heavy yields, the marvel of the sugar world, reflect the latest in scientific advance (pages 12-13).

* See "Because It Rains on Hawaii," by Frederick Simpich, Jr., NATIONAL GEOGRAPHIC, November, 1949.

Dusk silhouettes Diamond Head and kindles the twinkling lights of Honolulu. Viewed

There was a time when the plantations moved cut cane from field to factory by private, narrow-gauge railroad. But the locomotive has long since given way to huge rubber-tired hauling units. I am still startled, during plantation visits, by traffic lights blinking above the waving stalks.

"Pines" Add a Prime Crop

If sugar is still king, the pineapple is queen (pages 10-11).

Jim Dole, who lived until 1958 to see his name become synonymous with pineapple, was among the last frontiersmen, the same breed as John Sutter in California and Dr. John McLoughlin in Oregon who helped build a territory. Coming to Hawaii in 1899, after it was annexed by the United States, Dole sensed opportunity in the fact that pineapples grew well on uplands too cool for sugar.

He began with a 64-acre homestead and, as he once said, with "two horses, a plow, a harrow, a wagon, and a 16-year-old Chinese, complete with pigtail." My father remembered him in the early 1900's as a "long, lanky figure, loping through the fields with a grin on his face and a copy of Hamlet in his pocket."

Pineapple was then little known to America. One of Dole's first ads read, "Pineapple—you eat it with a spoon, like a peach!"

Employing techniques developed for sugar—mechanized cultivation and research—Dole's venture skyrocketed to success. Perhaps his most daring move was to purchase the whole island of Lanai, six times the size of Manhattan, and to convert 15,000 acres of its pastureland to verdant "pines."

Today's fruit canneries—Dole's is one of the world's largest—are among Hawaii's biggest industries. In season some six million pines a day are washed and graded, peeled and cored, sliced or crushed, and canned.

from the rim of Punchbowl crater, resort hotels glitter along the Waikiki shore

PHOTOGRAPHS BY ROBERT MOSER (ABOVE) AND NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS NEBBIA © N. G. S.

Jets tighten Hawaii's ties with the mainland by slicing to some five hours the flying time between San Francisco and Honolulu International Airport (above). Ten airlines fly to the islands. Tripler Army Hospital sprawls beneath Moanalua Ridge.

Bright flower necklaces flash aloha to malihinis—newcomers—disembarking at Honolulu. Dockside lei sellers wear the colorful muumuu, a shapeless Mother Hubbard introduced by 19th-century missionaries. Orchids, carnations, and plumeria make up the garlands, which sell for as little as 50 cents or as much as $10.

Virtually all the export is canned, since ripe fruit ships badly. (The fresh pineapple sold in mainland stores is picked green.)

No less impressive than the number of pines canned is the roster of generals and admirals headquartered in Hawaii—52 at latest count.

About one-fifth of the islands' population depends directly on military payrolls for its livelihood. But gunsmiths at Pearl Harbor shipyard, radar technicians at satellite tracking stations, submariners and carrier pilots training off Waikiki are more than a boon to Hawaiian purse strings. The community, having gone through one Pearl Harbor, gains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reassurance from the presence of these combat-ready forces.

Their presence also does much to generate tourist travel to the islands. And tourists, or "visitors" as islanders prefer to call them, are soon to become Hawaii's biggest business. They numbered more than 240,000 last year. Increasing by 20 percent a year since the war, tourism is expected to flourish even faster with statehood—and with jet travel, provided so far by three of the ten airlines that fly to Hawaii. Jets bring Honolulu within five hours of the west coast.

Samuel F. Pryor, Pan American vice president, looks to the future. Envisioning 2,000-mile-an-hour aircraft in the next decade, he says, "You'll leave New York and be here in Hawaii, because of the five-hour time difference, two and a half hours before you left."

Where Shahs and Stenographers Play

Honolulu is the Hawaiian port of call for transpacific airliners and cruise ships, and its curving beach at Waikiki is the tiara for the tourist trade (pages 22-23.)* New arrivals are so eager for its sun, sand, and surf that some beach hotels provide special dressing rooms so one can change and "hit the beach" without taking time to unpack.

I recall lazing there one day. To my left lounged the Shah of Iran, amid enough beach umbrellas and courtiers for King Solomon himself. To my right, a lone girl unpacked her matting and ointments.

A mainland teacher or stenographer determined to get her money's worth of tan, I thought. Near her, two servicemen lobbed a beach ball; the girl would not be alone long.

Waikiki's hotels and shops, restaurants and cabarets cater to all tastes. The Hotel Kaimana gives travelers from Japan a taste of home with mat floors and sliding paper doors. Beach shops display silks from Hong Kong beside locally made sportswear. But even cosmopolitan Honolulu was given pause when a Chinese restaurant advertised Italian pizza pie.

Though airliners approaching Honolulu dispense sun-tan lotion rather than history books, some visitors do go looking for evidences of the native culture.

Iolani Palace, now the State capitol, was once the home of Hawaiian kings. In the room where the House of Representatives meets, red-upholstered thrones are displayed (page 14). Towering above are feathered kahilis, standards of Hawaiian royalty adapted from status symbols of the native chiefs.

Perhaps the most photographed object in all Honolulu, save the towering peak of Diamond Head, is the heroic statue of Kamehameha in the Civic Center. Garbed in the helmet and cloak of the Hawaiian warrior, his figure is so draped with flower leis on ceremonial occasions that only the head emerges (page 18).

Oahu's view No. 1 is from the 1,200-foot-high Nuuanu Pali, a mountain pass behind the city (page 28). Here, in conquering the island, Kamehameha trapped its defenders and, as the popular song goes, "Pushed 'em over the Pali" to their death.

My wife remembers her grandmother telling of being lowered over this cliff in a basket, the only ladylike way to descend. The transit took an hour. Now the cliff is pierced by multilane automobile tunnels, and her granddaughter drives them in minutes.

Busy Honolulu Still Honors Boat Day

Bustling Honolulu, living out of doors perhaps more than any other State capital, has always had a form of year-round daylight saving. Office doors open at eight and close at four, though wage earners in this mid-Pacific city of 330,000 now find their free time spent more in traffic jams and crowded supermarkets than in the pounding surf.

Honolulu today is as American as strawberry shortcake. Her policemen hand out tickets as impassively as any on the mainland. Her movie theaters make their money from popcorn. The kennels where we board our dogs send them Christmas cards each year.

Where Honolulu differs from other State capitals, it differs not only because of its climate, but, of course, because of its distance from the main body of the States.

(*Continued on page 15*)

* See "Honolulu, Mid-Ocean Capital," by Frederick Simpich, Jr., National Geographic, May, 1954.

Pineapple Fields in Martial Ranks Parade the Flaming Coast of Kauai

Roads 130 feet apart accommodate trucks with 65-foot booms that spray, fertilize, water, and harvest the fruit (next page). Wavy terraces control soil erosion. Iron stains the earth red; paradoxically, the element exists here in a form the pineapple cannot use. Growers must douse the plants with an iron solution.

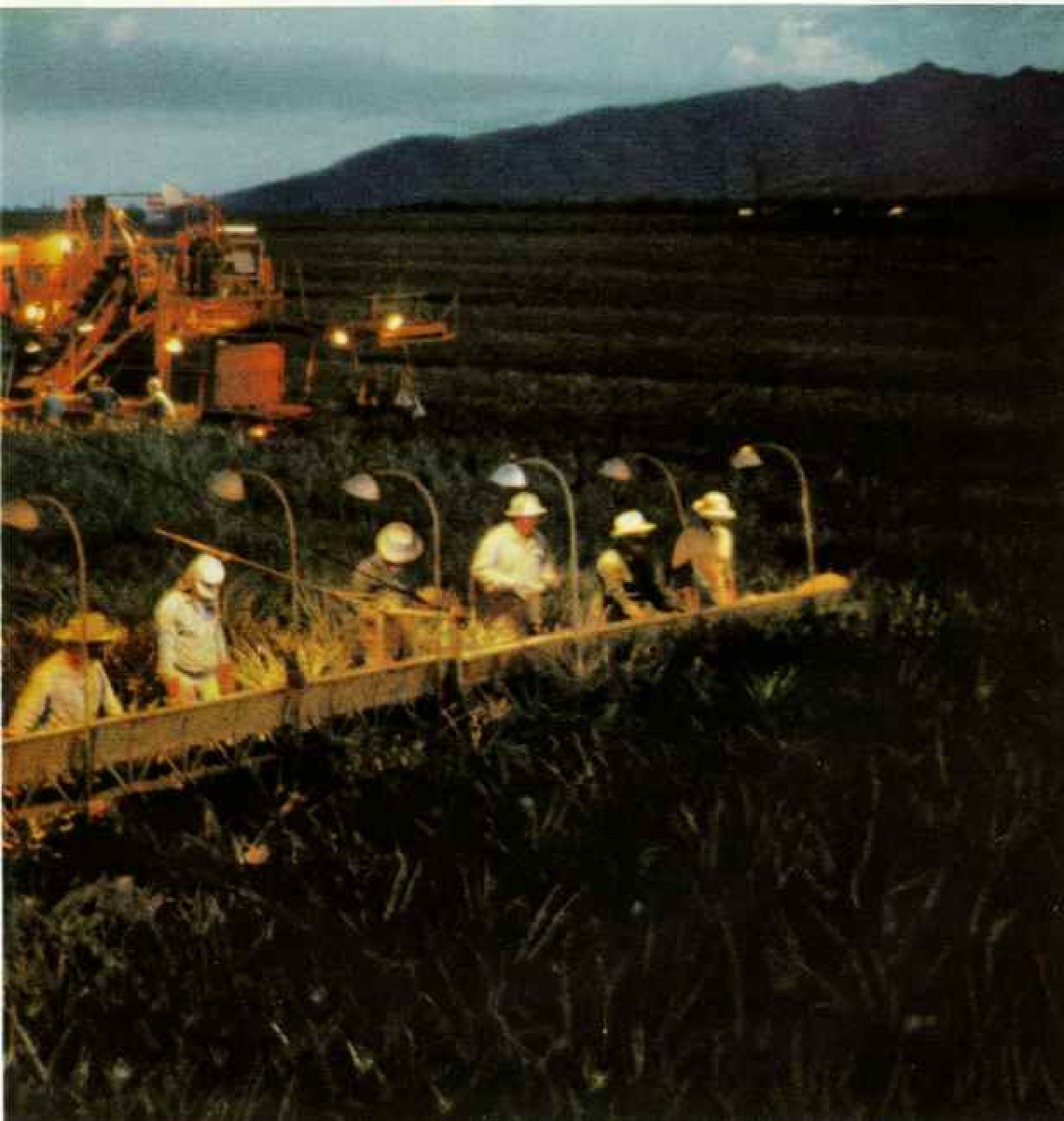
Where Pineapple Is Queen . . .

HAWAII leads the world in growing and canning pineapples. Spiny crowned and pine-cone shaped, the pineapple is not a single fruit, but a cluster of many small ones. Each "eye" develops from a pale blue flower that blooms but a single day.

Usually seedless, pineapples grow from shoots taken from a mother plant. After plowing, machines carpet the fields with tar paper to raise soil temperature, save moisture, and check weeds. On each acre some 17,000 shoots are hand planted through holes punched in the paper. The fields bear fruit in about 20 months. Value of the crop exceeds $120,000,000 a year.

Boom harvesters, like these at the Hawaiian Pineapple Company's Wahiawa plantation on Oahu, speed collection of the fruit. In season, pickers march day and night between the rows, deftly snapping off the ripe "pines" and tossing them onto an endless belt. Goggles shield pickers' eyes from the spiky leaves.

HIGH SPEED EKTACHROME (BELOW) BY NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS NEBBIA; KODACHROMES BY WALTER MEAYERS EDWARDS, NATIONAL GEOGRAPHIC STAFF (OPPOSITE; LEFT) AND THOMAS NEBBIA © N. G. S.



HIGH SPEED KATAHDINS (YELLOW) BY WALTER MEAYERS EDWARDS,
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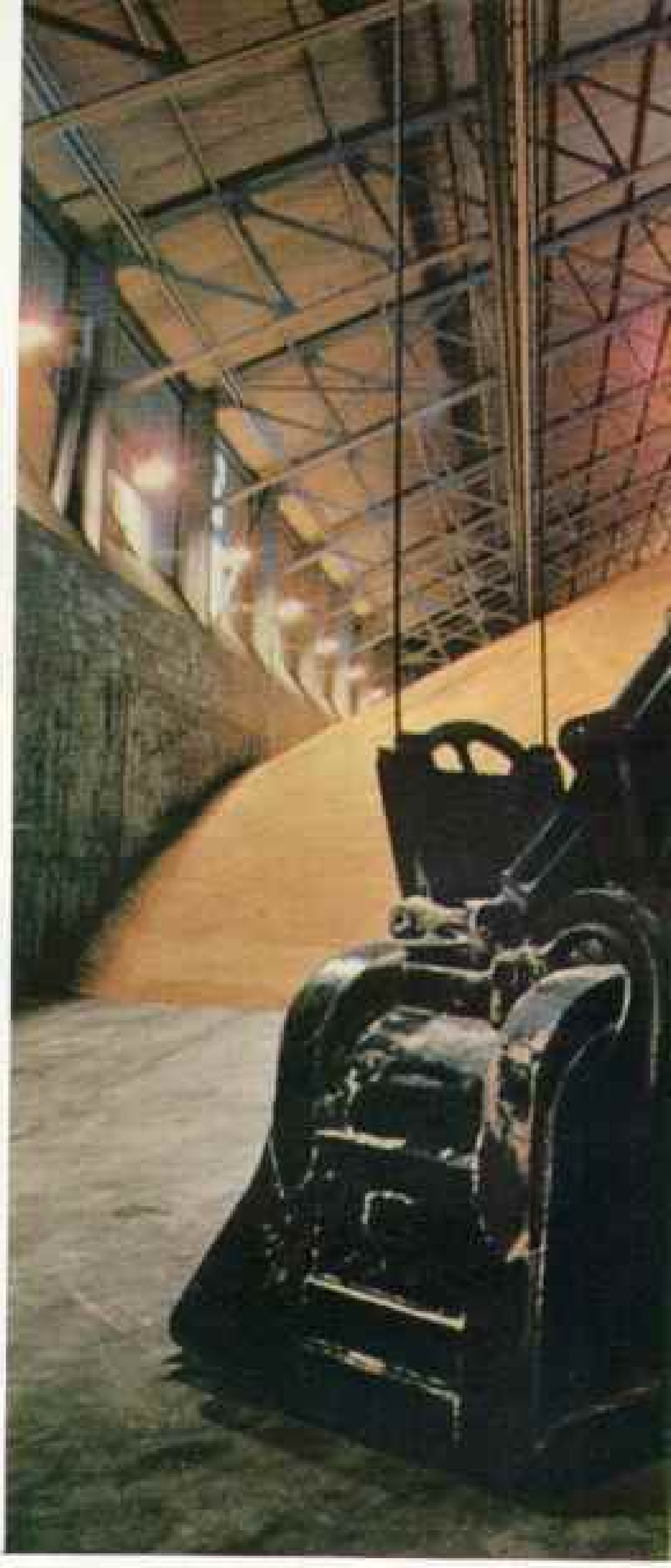
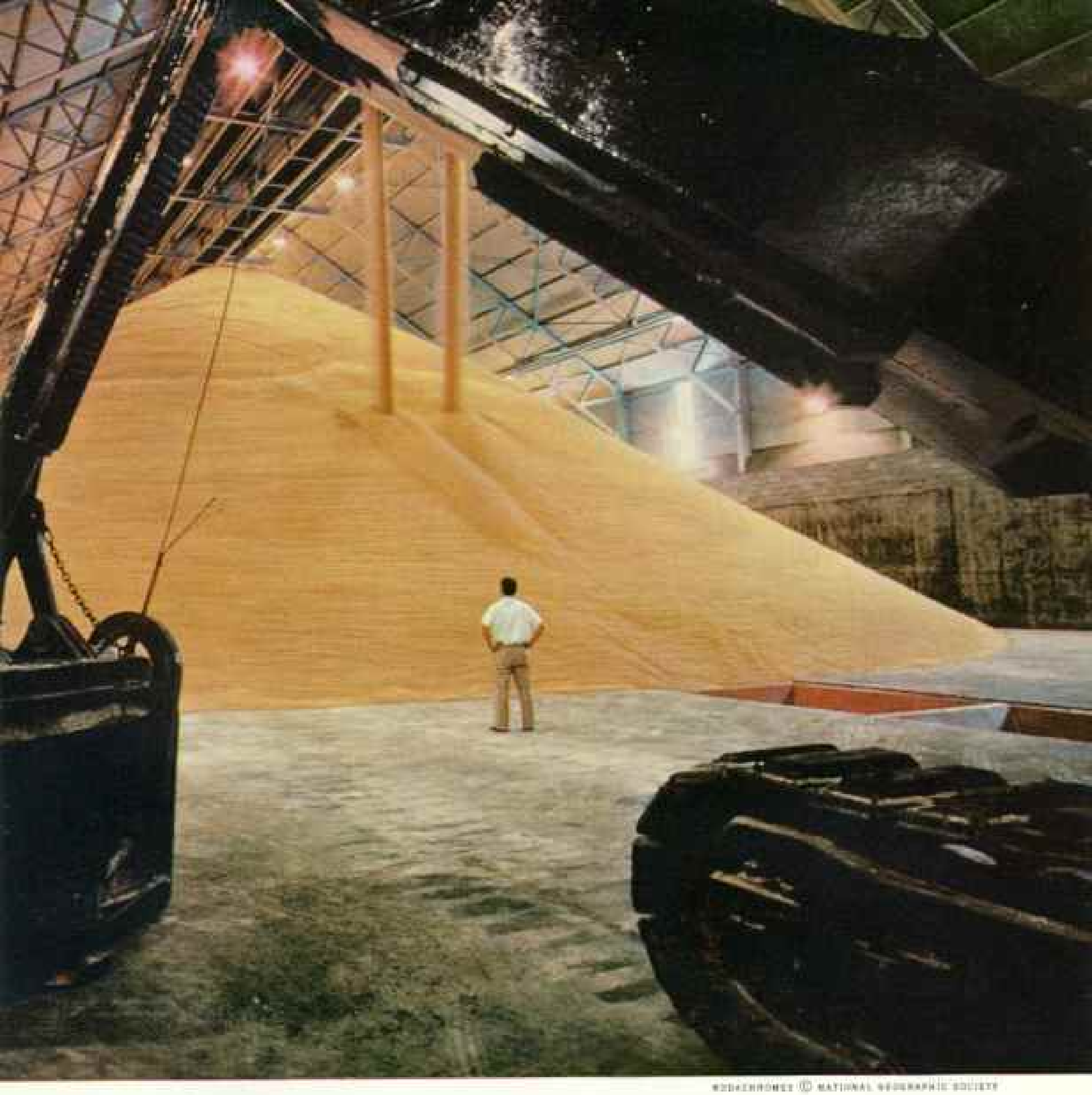


. . . Sugar Cane Is King



KODACHROMES © NATIONAL GEOGRAPHIC SOCIETY

Twin streams of sugar build a sweet sand pile in this Honolulu bulk storage plant of the Oahu Transport Company, Ltd. Refiners convert the raw product to snowy crystals for cooking, candy, and the family table. Cane ranks as Hawaii's first crop. Each year the islands produce a million tons of raw sugar worth $150,000,000. Only a twentieth is refined and used in Hawaii; the rest goes to the mainland.

A member of the grass family, sugar cane needs rich soil, warm weather, and abundant water—all available in Hawaii. Early Polynesians hedged their huts with the bamboolike stalks; cane growing first boomed a century ago to meet Union demands during the Civil War. Today cane fields corrugate Oahu (opposite) and other islands. Furrows serve as canals for irrigation water gushing from flumes, seen here as white lines. To produce a single pound of refined sugar requires a ton of water.

Huge machines dig furrows and plant stalks of seed cane. The plants mature in 18 to 22 months. Dry tangles of leaves shed by the ripening stalks must be burned away (upper left), leaving the ripe cane—87 percent liquid—unharmed.

Mills wash the cane, shred the stalks, and crush out the juice. Twelve hours of boiling and evaporating produce the raw sugar. Leftover cane is called bagasse.

Cane and pineapples do not compete for space. The thirsty cane grows best on the moist lowlands, while pineapples can survive long spells of dry weather in semiarid upland fields. Less than ten percent of mountainous Hawaii's land will raise a crop; the islands' tillable acreage is smaller than the tiny Grand Duchy of Luxembourg.

KODACHROME BY ROBERT MUGGE © NATIONAL GEOGRAPHIC SOCIETY

Relics of royalty recall the Hawaiian monarchy, overthrown in 1893. The Bishop Museum in Honolulu displays the crowns of the last king, Kalakaua, and his queen, Kapiolani; the royal scepter; and a cape fashioned from the feathers of the *oo* and *iiwi* birds.

Iolani Palace in Honolulu serves today as the State capitol. The House of Representatives meets in this chamber. Thrones are replicas; the Bishop Museum preserves the originals. Gov. William F. Quinn (left) makes his office in a onetime royal bedroom.

It is this distance that makes "boat day" important. In the time of sail, a lookout known as Diamond Head Charlie was posted on that landmark and galloped his horse into town upon sighting a ship. When radio cost Charlie his job, there was still good reason to shut up shop and go down to see the boat come in.

Then, too, there are special boat days. More than one housewife now living in Honolulu caught the first glimpse of her husband-to-be from the rail of the "teachers' boat." Each year it brings a new crop of teachers for the public schools, to be greeted by a band of bachelor "inspectors." The "school boat" is the sailing in early September that carries youngsters off to mainland colleges.

While the arrival and departure of as many as 234 transpacific aircraft a week have deprived boat day of its past significance, Honolulu still turns out in force for the comings and goings of the graceful Matson luxury liners (page 22). The white-coated Royal Hawaiian band plays buoyantly at dockside, hula dancers undulate amid paper streamers thrown from ship to shore, and many a tear is shed.

Castle Trail Climbs Through History

Visitors who enjoy walking may leave the surf-embroidered beaches and hike up the Castle Trail. It provides an easy ascent of the Koolau Range, a backbone of Oahu.

Recently my wife and I set out upon this trail with our children, Mike and Louli, and our family dog, an amiable boxer named Moki. Starting near sea level amid groves of eucalyptus and Java plum, we followed a series of switchbacks, climbing through guava and lantana, pandanus and wild taro, from which the old Hawaiians made their poi.

Atop what natives call "Pig God" ridge, the trees gave way to hardy koa and kukui, whose oily nuts were once burned for light.

Barefoot balloter votes on Kauai Island in Hawaii's first election after statehood

HIGH SPEED EKTACHROME AND KODACHROME (OPPOSITE) BY NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS NEBBIA © N. G. S.

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"Lady, lady, turn around. . . ." Rope twirlers chant the count at Oahu's Ewa Beach Elementary School. Glass walls and open-air corridors of the modern building take advantage of Hawaii's bright, pleasant weather. Flag flies at half-mast following Secretary Dulles's death.

Spelling test demands tongue-biting concentration from an Ewa Beach second-grader. Her pony-tailed classmate answers with ease.

Climbing, we came to a forest of ohia, a Hawaiian hardwood, and sandalwood, in the early 1800's the islands' chief export. We paused again to show Mike other plants important to the Hawaiians. The hibiscus was their hedge, we told him. The olona was the fiber from which they wove their nets, the awa root provided their narcotic, and to pick the lehua blossom at the start of a journey was to invite rain.

Suddenly the silence was pierced by furious barking. Running up the trail, we found our boxer set upon by four savage dogs.

I doubt that we could have saved Moki, hard put amid the swirling, snarling melee, if two men armed with rifles had not come running down the trail and helped to break it up. They were hunting the wild pigs that course these mountains, and the dogs were theirs, specially trained to corner boar.

As we started off, Moki followed, disconsolate. We never knew which hurt more—his wounds, or the indignity of being taken for a pig.

There are other byways the visitor can travel to learn why Hawaii is Hawaii. Follow the coast road northwest along the white sands of Makaha, where the sea crashes in from western reaches of the Pacific. Waves occasionally run 30 feet high, luring surfboarders from such far beaches as Santa Monica and Sydney's Bondi.

Farther along toward Oahu's westernmost point, Kaena, the road becomes worse, and the swimming, fishing, and shell collecting improve. To spend the night on this wind-swept headland is to experience a side of Hawaiian life rarely enjoyed by tourists. At night the bikinis and surfboards depart, and the beaches come alive with campers. Surf fishermen set

ANSCOCHROME (OPPOSITE, BELOW) AND KODACHROMES © N.G.S.

Wreathed in leis, a graduate of the University of Hawaii celebrates commencement day. Some 7,500 students attend this land-grant school in Honolulu's Manoa Valley. They represent seven major racial groups: Japanese, Chinese, Filipino, Korean, Caucasian, Polynesian, and a mixture called Cosmopolitan.

An international college and cultural center at the University of Hawaii has been proposed in Congress to strengthen U. S.-Asian understanding.

40-foot Leis Smother Helmeted King Kamehameha I

Islanders celebrate June 11 as Kamehameha Day, honoring the noble who united Hawaii's jealously guarded tribal kingdoms under one scepter a century and a half ago. A four-day festival follows, featuring parades, pageants, and aquacades; the bronze statue in Honolulu's Civic Center wears fresh garlands of scented blossoms day and night.

Swaying to the music of ukulele and drum, grass-skirted students perform a Tahitian dance for their "King" and "Queen" at Hilo High School. The occasion: Lei Day, May 1, when every citizen from governor to beach boy dons a flower necklace, and every school stages a pageant.

PHOTOGRAPHS BY NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS NEBBIA (ABOVE) AND WALTER MEAYERS EDWARDS, NATIONAL GEOGRAPHIC STAFF © N.G.S.

their rods in the sands, the lines far out. They tie cowbells to the reels to signal a strike and sit silently for hours by the eerie light of gas lanterns. In near-by pools torch fishermen slosh, peering through glass-bottom boxes for mullet or papio by the flickering rays of kerosene flares.

Traces of Hawaii's Past Survive

Caught up in world events, the islands have permitted much of the true Hawaiian culture to disappear. But evidences of it remain. In the Bishop Museum you can see the fabulous feather cloaks of warrior chiefs and fishhooks fashioned from human bones.

There is a trace of early Hawaii, too, at Kawaiahao Church. Built of coral blocks by missionaries, it reflects in its stern lines the architecture of New England seaports. This past Christmas we took Mike and Louli there to hear 80 voices render "Hookani A'e"—a chorus from "The Messiah" in Hawaiian.

From whitewashed walls hung bronze plaques, reminders of the mission families that brought Calvinism to these islands.

The magnificent music caught us up. But as might be expected in carefree Hawaii, two events occurred to lighten the occasion. The Hawaiian minister, his white robe and surplice contrasting with the mahogany of his face, left the pulpit at one point to sing "Holy Night" as a solo, accompanying himself on the guitar. Then I looked down to see that Mike, in the manner of Hawaiian boys, had taken off his shoes and socks.

Last resort of the Hawaiians, as a race, is Niihau, the island to the extreme northwest.

Niihau is owned by a single family, the Robinsons. Of Scottish descent, they arrived in Hawaii from New Zealand in 1863 and, like so many of us, succumbed to the charms of the islands. They bought Niihau, and, working with the Hawaiians there, they planted trees, built schools and churches, paddocks and homes.

They were determined to help the Hawaiians preserve their gentle life on Niihau. That determination continues to this day, and virtually no one goes to Niihau unless he has business there.

I set out for the island one morning not long ago with Aylmer Robinson, manager of the place and great-grandson of the family founder. We sailed from Kauai before dawn in a diesel-powered sampan, and on the way we were treated to a rare and beautiful sight. A full moon was mirrored in the smooth sea; a bank of clouds lay pillowed over the mountains behind us. And as the moonlight played on the clouds and mist, it formed a glowing lunar rainbow.

We landed on Niihau through a high surf in a longboat manned by Hawaiians—much, I am sure, as Robinson's ancestors landed nearly a hundred years ago.

For the day we were there, I felt a stranger in my own land. All conversation was in the musical cadences of Hawaiian. Except for a few spouses of other bloods, there are only Hawaiians among the 250 people living on the secluded island.

We visited the scene of Niihau's most dramatic event in modern times—the spot where a Japanese pilot crashed his crippled plane after the attack on Pearl Harbor.

Held under guard by the populace for five days, the pilot broke free before troops arrived, and cowed the bewildered Niihauans with the machine guns from his plane. He lost his "invasion" when a shepherd, one Benehakaka Kanahele, though wounded three times by pistol bullets, overpowered him and, lifting him by the neck and one leg, smashed his head against a stone wall!

On the return to Kauai with Robinson, I noticed two big boxes with screened vents in the sampan.

"Homing pigeons," Robinson said. "When no boats are running, we communicate with the island that way. Whenever we take the sampan over, we exchange birds."

But change comes even to remote Niihau. Since I was there, two-way radio has replaced pigeons for interisland messages.

Kauai, the Unconquered

That Kauai is the oldest of the islands is attested by its fertility. Abundant rainfall over centuries has converted lava flows to rich soil; erosion has carried this soil from volcanic slopes to enrich the lowlands.

Kamehameha never conquered Kauai, though old-timers will show you the beach where the bones of "his warriors" are still turned up on occasion. The island later joined the kingdom, but its people retain a sense of rugged independence to this day.

Its beaches are the best, Kauai says—else why would the producers of many a movie with a tropic background choose it for their location? Certainly Haena Beach, a *South Pacific* set, is everyman's Bali Ha'i.

But my own favorite view in all the islands is reached through Kauai's mountain quarter of Kokee, above Waimea Canyon. Hiking in this far-from-tropic setting, I have waded through waist-high grasses and strolled along mountain streams thronged with trout so well fed they won't respond to a fly.

A road threads pastures and winds past weather-beaten homes, each with a smoke-charred chimney to remind me that nights in these mountains are cold. Then it leads to the brink of a precipice. Here I can peer through mists down the Napali cliffs to the valleys and beaches of the north shore, 4,000 feet below.

There, in the verdant valleys of Kalalau and Milolii, Hawaiians lived in stubborn isolation until long after Western man settled and cultivated the gentle slopes to the south. From my lookout I can still see the Polynesian system of irrigation terraces.

Eric Knudsen, beloved on Kauai as a rancher and teller of tales, knew these gorges well. He recalled as a boy the occasional emergence from the valleys of the mysterious, secluded "Napali men" (page 44). He described them as tremendous in size, the color of morocco leather, with long hair falling over fierce faces, and bare feet callused into pads by scrambling over rocks.

Among the entries by land to these valleys is a Hawaiian trail blazed along the cliffs in centuries past. The Napali men guarded their isolation well. At one point a removable fiber ladder linked the precarious trail.

Moat of Air Guarded Kauai Valleys

Farther along there is a three-foot gap, with nothing below but 1,000 feet of air. Here a Polynesian Leonidas used to be stationed with a long stick. Any enemy that tried to leap the gap was deflected in mid-air to fall into the void.

Kauai is older than its neighbors lying southeast of Honolulu. The other islands show their youth in fewer scars of erosion.

First of these is Molokai, a ranch with an island around it. The whole west end of Molokai, some 45,000 acres, is owned by one fam-

Tropical snow blankets the cinder cones atop Mauna Kea on the island of Hawaii. Skiers, who reach the slopes on horseback, can schuss these trails almost every day during winter.

Flower-decked, ukulele-strumming snowman delights his creators on lofty Haleakala Crater in the Maui section of Hawaii National Park. The park also embraces the Kilauea-Mauna Loa domes on Hawaii.

ily, the missionary-descended Cookes, who bought it in 1908. They soon found that pineapple, less demanding of water than cane, would flourish there. Today two firms, Del Monte and Libby, lease and farm 13,000 acres of this rich, red, powdery soil.

C. M. Cooke, founder of the ranch, predicted that someday, with water, Molokai would become the "breadbasket" for Honolulu. That time draws near. Honolulu, 40 miles across Kaiwi Channel, is growing so fast that truck crops are being forced off Oahu.

"We have three possibilities for water," Harrison Cooke, ranch president, told me. "First is to tunnel into the mountains. The government is doing that now with benefit to homesteaders.

"Second, the Department of the Interior is experimenting with converting sea water to fresh. If they ever succeed in doing it economically, all this dry plain below the pineapple fields will become farmland.

"In the meantime," he continued, "we are trying saline agriculture—using brackish water to irrigate everything from asparagus to papaya. We are already making commercial shipments of alfalfa to Honolulu."

A lonely arm of land thrusting from the rugged cliffs on the windward coast has brought this island its greatest renown. Here stands the famous settlement of Kalaupapa, where Hawaiians stricken by leprosy, or Hansen's disease, once were put ashore and isolated.

In 1864 a Belgian priest, Father Damien, came to Hawaii as a missionary. Shocked by conditions at Kalaupapa, he made it his life's work to care for the outcasts. This dedicated man ultimately contracted the disease himself and died from it.

Leprosy in Hawaii has now been contained, and only advanced cases are isolated. Yet more than 200 patients remain in the settlement, most of them by their own choice.

On neighboring Lanai, 2,300 people live, breathe, and sleep pineapple. It is the island's only product. Dole is sole owner.

(Continued on page 26)

Waikiki Wonderland

PERHAPS the world's most famous beach, Waikiki lures bathers the year round with warm seas and palm-fringed sands. When surf runs high, the venturesome climb aboard 55-pound Fiberglas slabs shaped like ironing boards and race in on the crests of giant combers. The S.S. *Lurline*, steaming toward San Francisco, may provide the backdrop. Surfing too risky? Then take a seat in a 30-foot outrigger canoe, dip a paddle, and ride a mountain of rolling water. For pure relaxation, step aboard a twin-hulled catamaran and cruise under billowing sail toward Diamond Head. Or bask on the beach and let the tropic sun toast the skin a golden tan, with time out now and again to sip tangy nectar served in a hollowed pineapple. And Waikiki entertains by night as well. Almost every floor show features sarong-clad maidens doing the graceful hula.

KODACHROMES BY THOMAS HEBBIA AND ROBERT WENKAM (LEFT) © N. G. S.

Guests at a hukilau, a Hawaiian fishing party, pluck mullet, moi, and weke from the waters off Laie, on the windward coast of Oahu. A leaf-fringed seine nets the catch. The woman wears a flowing muumuu; her companions sport hand-woven palm-frond hats.

Hungry diners watch with mouths watering as chefs uncover two succulent pigs at a luau. Wrapped in leaves and buried amid hot rocks, the pigs have roasted for four hours.

Bronzed beauty strides ashore on Oahu.

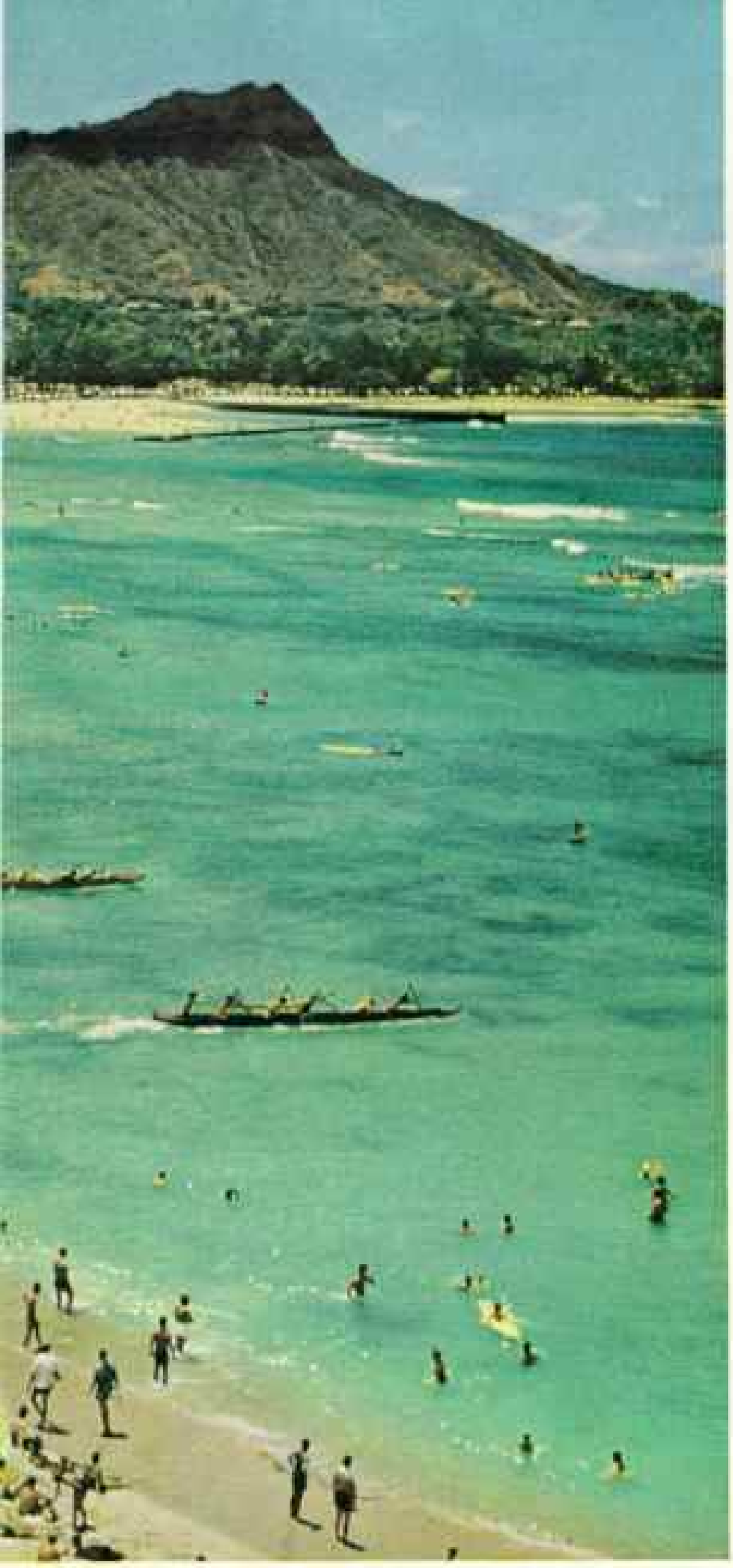
KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

Excitement grips holiday crowds on Waikiki's crescent as Fourth of July canoe races get underway. Waterfront property, once duck ponds and taro patches, now sells for $50 a square foot. View from the Royal Hawaiian Hotel looks toward Diamond Head.

Here I have watched workmen planting slips through sheets of mulch paper, in soil that has been fumigated against nematodes. The rows hold 17,000 plants per acre, cultivated with the meticulous care of a grandmother tending roses. The pines demand iron at one season, nitrogen at another, weed killers at one moment, overhead irrigation the next; all are supplied mechanically.

Harvesting is partially mechanized, too, with special loaders extending long booms across the rows. Lines of men, gloved and goggled against the spearlike leaves, follow these machines through the waist-high plants, picking the ripened fruits judiciously and placing them on the boom (page 10). A conveyer belt whisks them away. Green fruits are left for another day.

Walking through the fields with youthful Herbert C. Cornuelle, Dole's president, I asked if there was some chance of mechanizing this laborious picking operation still fur-



ther. "Nothing," he said, "is going to replace the human eye in deciding when a fruit is ripe, or the human hand in reaching into those prickly leaves to break it off."

Fruit from Lanai moves to Honolulu by barge through the tiny port of Kaumalapau. When I first came here, most plantations in the islands had their own shipping points, and lightering cargoes through heavy seas required master seamanship. Kaumalapau is one of the last of such ports, but even here longboats have given way to cranes.

The airplane is the way to travel from island to island now. Even livestock and the kitchen stove move by air. To get the feel of this new commerce, I rode a Hawaiian Airlines' freighter one early morning on its rounds.

On the floodlit apron of Honolulu airport I watched as lift trucks loaded fresh-baked bread onto the plane. There was a last-minute scamper to put aboard Maui's morning papers. At dawn we were off.

Alone in the cargo-crowded cabin as we flew down the chain, I could see Lanai and outriding Kaboolawe crouching in the early light. The latter, used by the military as a bombing range, supports only wildlife.

Turbulence jostled us as we crossed the Maui coast and flew above the sugar-rich central plain toward our landing at Kahului. Through ages of volcanic building, this plain has become the most fertile in the 50th State. It holds the largest sugar plantation in the islands. The two fac-

Green seas explode as body surfers, spurning boards, belly-ride a comber. One swimmer, a split second too slow, risks being caught in the curl and carried under for a "trip to the bone yard."

Golfer blasts out of a trap at the Pali Golf Course below Oahu's Koolau Range. Cross Island Highway roller-coasts along the ridge.

Violent gusts whip Nuuanu Pali Lookout, near where Kamehameha's army pushed defenders to their death. Pali Golf Course lies at right.

tories of the Hawaiian Commercial & Sugar Company extract 140,000 tons of sugar a year, about two percent of U. S. needs (page 42).

We passed over plantation villages, marked by the tall black stacks of sugar mills. From such villages most of the people of this 50th State spring. If they have not experienced plantation life themselves, their fathers or grandfathers did, and their social customs, political views, and personal ambitions reflect the experience.

At wind-swept Kahului Airport we unloaded our bread and papers, and a ground crew wrestled a washing machine from the fuselage, along with machinery parts, a baby carriage, and someone's garden tools.

Raft Voyage Threads Mountain Tunnel

Plantation children on Maui, as on other islands, still learn to swim in irrigation ditches, rather than in the sea near by. Some of these ditches, bearing water to the cane fields from far away, tunnel for miles beneath whole mountains. Not long ago, to experience a boyhood adventure of rural Hawaii for myself, I joined *Honolulu Advertiser* columnist Bob Krauss on a raft voyage on one of them.

We started at a fern-festooned tunnel mouth, walking by flashlight perhaps half a mile into the mountain. Climbing down dank wooden stairs, we came upon a chamber where water from the surface cascaded into a dark, churning basin.

Looking at the box of lumber we were to ride, 16 feet long and floated by inner tubes, Krauss complained laughingly, "Not much of a boat—no name, no whistle."

For two hours and six miles we drifted through the blackness of aged lava, an entire mountain over our heads. The only sound beyond our voices was the ripple of rapids at points where the tunnel grade steepened.

Krauss spoke up, "This would be a great time for an earthquake."

Suddenly, in the light of the gasoline lamp we carried, a sign appeared hanging from the roof of the tunnel. I chuckled. In land-short Hawaii, ownership even at 2,000 feet below the surface is important. The sign read, "Boundary Bishop Estate, Territory of Hawaii." Nobody had been down there to change it since statehood.

At this point Krauss observed, "Somebody's missing a great tourist bet. You could make this into the world's longest tunnel of love."

A road follows the entire perimeter of Maui, providing easy access to much of the island's history. Sparkling La Perouse Bay is named for the first French explorer to reach the islands, who refused to make claims of sovereignty. On similar visits Vancouver persuaded Kamehameha to cede Hawaii Island to England, but that country never accepted.

Abandoned pillboxes and rusted iron tetrahedrons on a tree-lined beach are all that remain of "Little Tarawa" and the World War II training here of Marines.

Lahaina, an early white settlement in Hawaii, was later headquarters for a whaling fleet that ranged the Pacific in the mid-1800's. At times hundreds of whalers wintered here, their behavior sometimes outraging missionaries converting pagan Maui to Christianity.

Here the island's capital stood among coconut groves and primitive stone walls that guarded the royal chickens. Tiny Lahaina today drowses around a great banyan tree. Lahainaluna, a school founded by the missionaries in 1831, flourishes now as a part of the State educational system.

Far on the other side of the island, from the palisades beyond Hana, you can see the great mountains of Hawaii, across 30 miles of open ocean churned white with scud. I crossed it once in a 38-foot fishing cruiser. It may not be rougher than the English Channel, but having suffered through both trips, I can testify that this made me sicker.

Island Builds Itself From Within

Hawaii grows bigger with every eruption of its last active volcanic mountains, Kilauea and 13,680-foot Mauna Loa. The latter has been silent over the past decade, but Kilauea has loosed two recent blasts, one from an old crater and one from its slopes. It was near there, early this year, that I saw a town die.

Heralded by earthquakes, Kilauea volcano, which late in 1959 put on the most spectacular display in Hawaiian memory,* broke out anew. This time the eruption spurted along a rift line among sugar cane fields near the village of Kapoho. In a matter of days, spuming fountains of lava destroyed some five million dollars' worth of land, crops, and structures—schools, a church, and homes (pages 36-37). Later, another village was engulfed.

*See, in the National Geographic, the author's eyewitness account, "Fountain of Fire in Hawaii," March, 1960; and "Volcanic Fires of the 50th State," by Paul A. Zahl, June, 1959.

Arizona's Rusty Hulk Hallows the Memory of Pearl Harbor's Dead

Minutes after the attack began on December 7, 1941, a Japanese dive bomber scored a direct hit on the U.S.S. *Arizona*. The mighty battleship blew up and sank in 50 feet of water. There she rests today, oil still seeping from her tanks, a memorial to the thousand men entombed within her shattered hull.

The Navy treats *Arizona* as if she were still a commissioned vessel. An honor guard daily raises and lowers a flag from a platform over her exposed superstructure.

Here services mark Memorial Day aboard the *Arizona*. Navy nurses (below) salute wreaths honoring those lost in the Pearl Harbor attack.

Flag and flowers on Memorial Day mark a hero's grave in the National Memorial Cemetery of the Pacific. Cupped in the Punchbowl, a volcanic crater in the heart of Honolulu, the cemetery provides a last resting place for 13,000 victims of World War II and Korea. War correspondent Ernie Pyle lies here. Many markers recall the valor of Japanese-Americans who served in Europe with the 442d Regimental Combat Team, one of the Army's most decorated units.

When I flew over the scene with crop duster Bill Stearns, our light plane was buffeted by the hot updrafts of the volcano's breath. Along a mile of coast, red-hot lavas crunched into the sea, building new land as they rolled; steam rose 5,000 feet.

We turned in over the flow and below saw a score of bulldozers, looking like beetles from so high, scraping up soil to form protective dikes. Fine cinder, borne downwind from the fountain, peppered our wings and blackened the roads and fields not yet overrun by lava.

Scarecrow Guards Forgotten Fields

Later when I visited Kapoho afoot, I found it smothered in ash as if by a blizzard of black snow. In one abandoned garden a scarecrow stood knee-deep in the stuff, its coat flapping an idle warning to birds that would never feed here again.

On the deserted main street I came upon a Civil Defense fireman, sheltered under the eaves of a deserted building near his parked fire truck. He exemplified the futility of man against the lava fountain I could hear roaring close by. He was reading a comic book.

Triangular Hawaii is larger than all the other islands combined. Its five mountains rise like massive mounds from the sea, their flanks overlapping one another to form an intricate series of plateaus.

Sugar flourishes along the northeastern coast, where time and an annual rainfall of 100 inches have crumbled the lava into soil. Elsewhere, on drier parts of the island, impervious lavas lie flow upon flow, inert and unproductive under the tropic sun.

Verdant Hilo, principal port of the island and, with 26,000 people, second largest city of the new State, is also its flower basket. It has rained 19 inches in a day here. With all this water, and in surroundings of tropical jungle, Hilo grows orchids and anthurium, tree ferns and hibiscus in such profusion the city itself seems a garden.

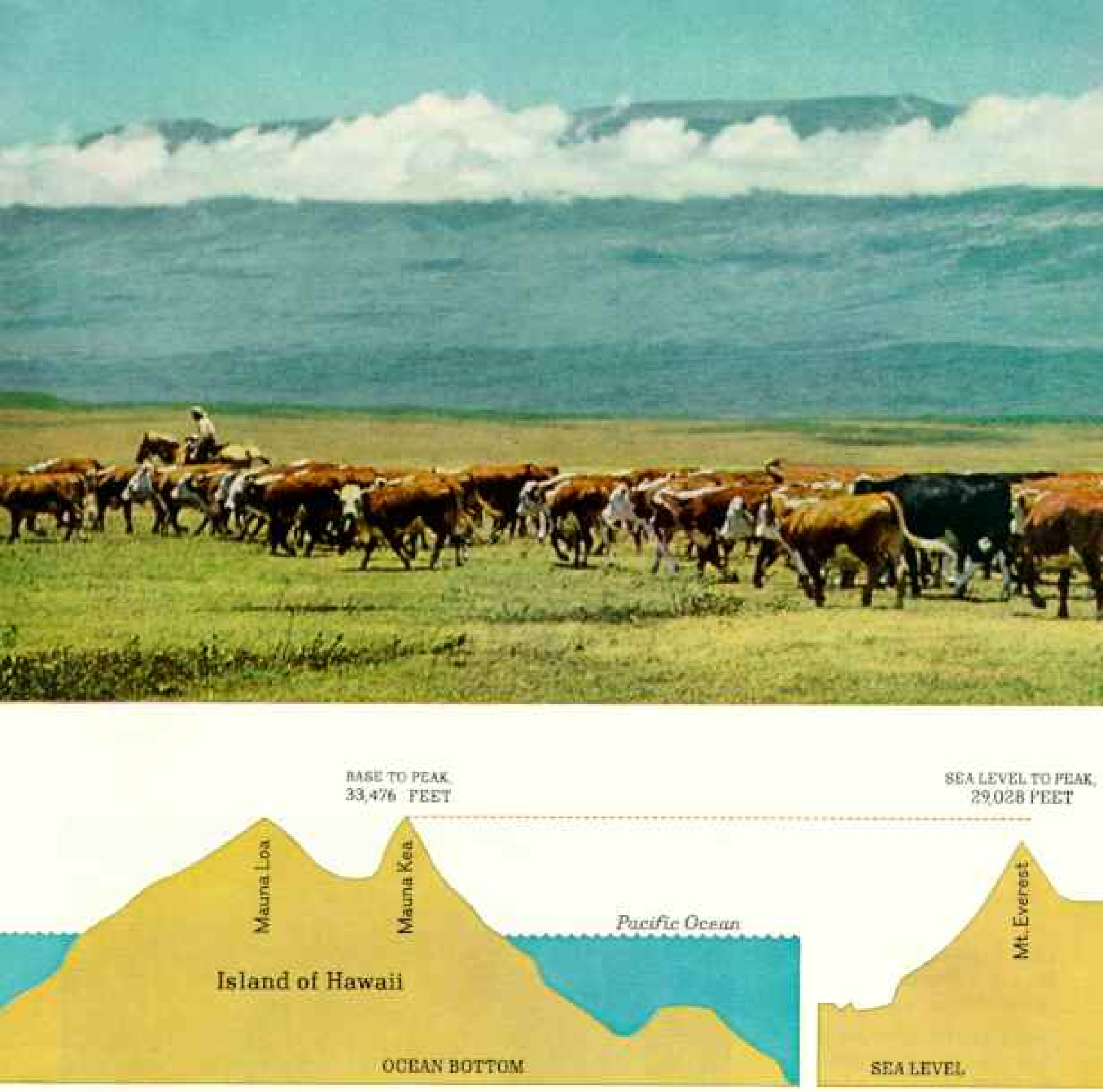
Where Honolulu has the bustle of a mainland city, Hilo retains the charming simplicity of an overgrown plantation town. Shops

Cliff Riders Duck Behind a Waterfall in the Pololu Valley

Heavy rainfall drenches the rugged northeastern coast of the island of Hawaii. Sugar planters pierce mountains to tap runoff for thirsty cane fields. The Kohala Ditch Trail, shown here, parallels one such tunnel.

A nine-hour ride on mule-back carried photographer Edwards over the hazardous path to Kapoloa Falls.

Bronze plaque at Kealakekua Bay marks the spot where Hawaiian warriors killed Capt. James Cook, the English navigator who chanced on the islands in 1778. Water covers the plate at high tide.



close early, and people gather at the soda fountain to pick up the latest gossip. And while Hilo teems with tourists, its residents live an unsophisticated life, preferring to fish for lobster along the near-by shoreline rather than frequent its night clubs.

One-man Crusade Saves the Nene

Herbert Shipman, head of a ranching and landowning clan, has a deep regard for tradition. Every land lease he writes stipulates that no breadfruit trees are to be harmed, in deference to the old Hawaiian belief that breadfruit must be spared as a source of food. Any Hawaiian artifacts found on Shipman land must be returned to him.

Excavating for his own home, he unearthed an old burial cave. Respecting native custom, he changed the building plans to avoid molesting the ancient bones. So his basement playroom has a boxlike intrusion that is in fact a mausoleum.

I first encountered a Hawaiian goose, the nene (pronounced nay-nay), when I visited my friend Shipman at his home. From him I learned that these gray-brown birds, somewhat smaller than turkeys, were close to extinction.

The birds I watched—11 specimens—were among the few survivors.

The nenes were native to the island, but as civilization encroached on them, they retreated to the dry uplands and rapidly dwindled in numbers.

REGACHROME BY WALTER MEAYERS EDWARDS, NATIONAL GEOGRAPHIC STAFF © N. G. S.

Cowboys ride herd on bellowing Herefords on Hawaii's quarter-million-acre Parker Ranch. Hawaiian horsemen call themselves paniolos, after the Spaniards, or *españoles*, who taught the islanders how to ride and rope. Clouds halo Mauna Kea.

Hawaii's twin giants, 13,796-foot Mauna Kea and 13,680-foot Mauna Loa, rise 19,680 feet before they break the water.

Measured from base to peak, the two mountains exceed Mount Everest's height from sea level to summit. Drawing exaggerates the vertical scale.

Shipman protected the remainder, less than half a dozen birds in all, and nurtured them through several generations. A flock has been established in England from stock supplied by Shipman, and distribution of the nene has been made to several other countries. There are now more than 100 in captivity, and Shipman is confident the species will survive. Hawaiians, devoted to this hard-pressed native of the islands, have made the nene the State's official bird.

On Shipman land near Hilo one of Hawaii's newer agricultural products, the macadamia tree, is being planted on a plantation scale. Originally introduced to Hawaii from Australia as an ornamental, the tree bears a nut that is bland and crunchy. Its round kernel is the size of a nickel and costs about that much on gourmet counters. Cost notwithstanding, it has become a popular appetizer; plantings of hundreds of acres provide nuts that are sold throughout the mainland.

At Hilo the trees grow from weathered, crumbled lava. "This is really hydroponics on a big scale," orchard manager John Cross told me. "There is little nutrient in the lava, so we add chemical food. Rain carries it down to the roots."

Second Honolulu: Population, Zero

Reflecting the limitations of the Hawaiian language, the names Kaapahu, Pohakuloa, and Kukui are found on five of the inhabited islands. So limited was the Polynesian tongue that missionaries, in reducing it to writing, used only seven consonants—H, K, L, M, N, P, and W.

At best, Hawaiian place names are uncertain renderings of a strangely melodious language that baffled early settlers. Captain Cook spelled Hawaii, Owhyhee; Niihau, Oneeheow; and Maui, Mowee.

On Hawaii there is a second Honolulu. Challenged by the name on a map, I drove a rutted road to see the place.

(*Continued on page 41*)

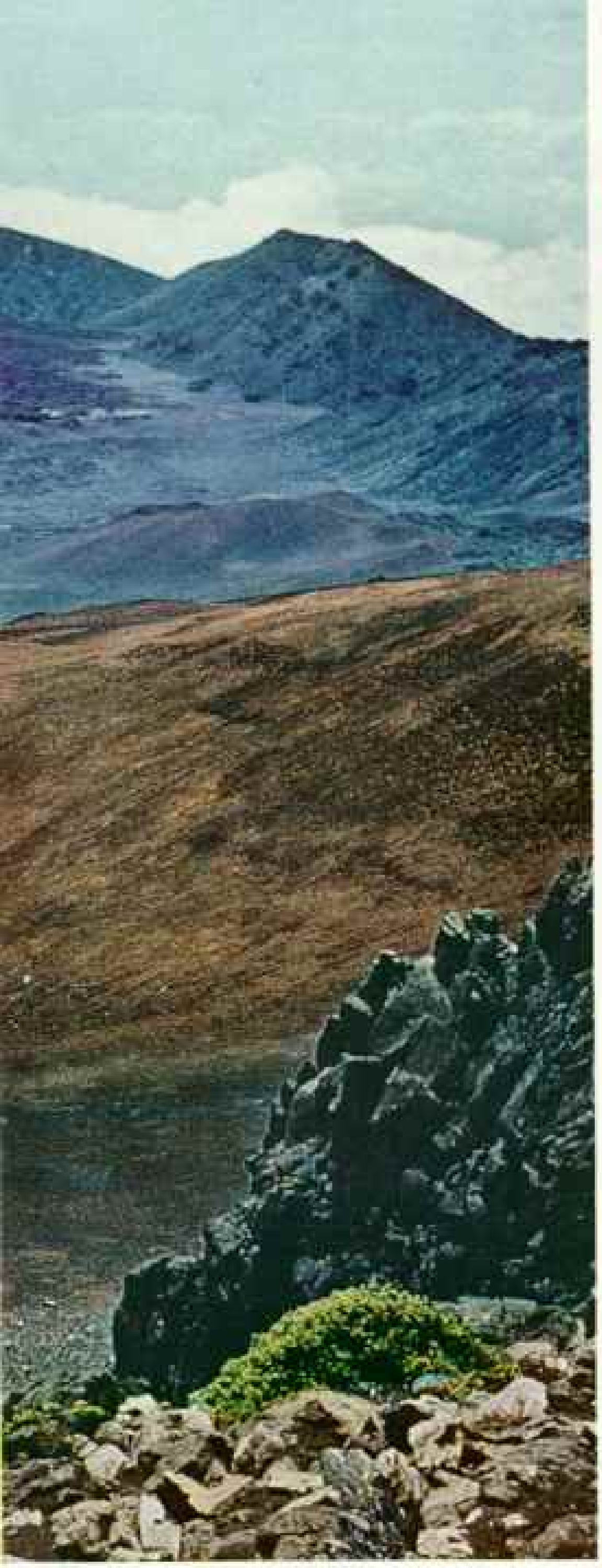
Fiery Geyser Spouts From Kilauea's Flank; Lava Engulfs Homes and Sets the Sea Aboil

Kilauea volcano, awakening last November after a four-year nap, burst from a fresh vent on Hawaii's eastern slope in January. A roaring fountain leaped 1,700 feet high, showering the surrounding cane fields with scorching pumice (above). Rivers of lava drowned the village of Kapoho; residents fled unharmed. Clouds of steam soared 5,000 feet as the blistering torrent spilled into the sea.

Dead cones pock the floor of Haleakala Crater, a slumbering volcano on Maui. Measuring 20 miles around its rocky rim, the half-mile-deep bowl could almost hold Manhattan Island. Erosion probably formed the basin in eons past; subsequent eruptions studded the floor with ghostly cinder mounds. The 10,000-foot volcano's last outburst occurred two centuries ago.

Haleakala, meaning "house of the sun," takes its name from a legendary exploit of the Polynesian demigod Maui. To give his mother enough hours of daylight to do her work, Maui climbed to the top of the volcano, snared the sun, and forced it to travel more slowly.

This view, from an observation post near the end of the highest paved road in the islands, overlooks a lunar landscape. Puu o Maui, largest of the cinder cones, rises some 900 feet at center. Clouds fringe Hanakauhi peak on the far rim. The crater lies within Hawaii National Park.



EDACHROMES BY WALTER MERRITT EDWARDS,
NATIONAL GEOGRAPHIC STAFF © N.G.S.

Umbrella-shaped leaves of the ape-ape plant (*Gunnera petaloidea*) dwarf a hiker in Puohokamoa Gulch, on Haleakala's windward slope. One giant leaf, the photographer reports, measured nearly two yards across. The leaves sway atop tall stems that snake across the ground before ascending. Wind pollinates the conical clusters of tiny brownish flowers.

The obscure track passed under arching mango trees and was all but lost in encroaching guava and lantana. Ramming the car as I would a tank through this underbrush, I finally broke out into a clearing overlooking the sea and surrounded by coconut palms, sure evidence that natives once lived here. And that was all there was of Honolulu.

Southern Hawaii is dotted with such reminders of native life. Fences built of lava rock mark forgotten pig sties. More recent missionary days are recalled by tiny churches, built for congregations of 10 or 15 souls, that raise their New England steeples along the deserted coastline.

The miracles of transpacific navigation performed by early Hawaiians with their calabash sextants are being dwarfed now by a space communications and control station recently erected on the southernmost point of Hawaii, Ka Lae. This wind-swept cape has been suggested as the site for a massive radio-telescope comparable to the one at Jodrell Bank in England. Thus, as our earth revolves, one of these electronic eyes would always be available to track astronauts and scan any point in space.

Near by, casual Kona district is more interested in the price of coffee or the latest marlin catch than in moon shots. For the cherry-red coffee beans grown on 5,500 acres of its slopes have a subtle flavor popular in blends. And on Kona's Kailua Bay centers much of the sport fishing in the 50th State, its lure the giant blue and striped marlin lurking in gentle Pacific swells.

Paniolos Ride the Parker Ranch

On the 3,000-foot-high plateau below Mauna Kea, the Parker Ranch runs 33,000 cattle on more than 250,000 acres, making it second in size in the United States only to the King Ranch in Texas (page 35).

Paniolos, as Hawaiian cowboys are called, are a breed apart. Priding themselves on their horsemanship, they live a most untropic life in the cold mists, find their sport in hunting wild goats and boar that roam the rugged mountains, and take part of their pay in raw beef to be cooked, unhung, by campfire. When they come into ranch headquarters at Waimea, they carry themselves with an air that turns the mind back to trappers and mountain men of the early West.

I rode over part of the neighboring Shipman Ranch with one of these stalwart paniolos. Henry Haa, a pure Hawaiian, is as versatile a horseman as the Big Island provides. He can rope a wild turkey as easily as a calf. As we rode along the seashore, I noticed him watching the surf-filled pools.

"What are you looking for?" I asked.

"Mullet," he said.

Shortly he reined in, dismounted, and quickly freed a throw net tied to his saddle. Crouching low, he quietly sneaked up on the rocks that embraced a pool. For minutes he bent motionless there, the bulk of the net over his shoulder with its loose folds in his hands.

Cowhand Nets a Silvery Catch

Then, in one graceful movement, his body sprang straight as he cast the net out from him. It soared and fell upon the water in a perfect circle. He jumped from the rocks and sloshed after it, pulling in its edges even before I could dismount.

Beaming, he brought his catch up to me, a score of shining mullet, each a pound or more, still writhing in the folds of the net.

From the green rangeland of Waimea, a road leads in 15 minutes down to the sea where, amid the parched rock and dust of tiny Kawaihae town, the Army Engineers have just completed a multimillion-dollar port. Its first cargoes were molasses from the northern plantations, which, their own little ports long ago closed, have had to make the long truck haul to Hilo.

The seas along Kawaihae run diamond clear. Walking the lava cliffs that rise from the bay, I've watched 50-pound ulua disporting themselves over the white sand in as many feet of water. Here and there along the bay are beaches of powdery sand, so remote that the only access is by boat.

An ancient Hawaiian trail leads past petroglyphs carved into the lava, human and animal figures predating the white man's coming. Here, too, hide forgotten burial caves, where parched bones wrapped in robes of tapa cloth, made from mulberry bark, have been found as they were put to rest.

Yet I am able to leave these pagan scenes and be back in Honolulu in an hour of flying by interisland air freighter.

Sand and relics from Hawaii's past seem a

Beauty and the breeze: her wind-swept perch overlooks Kauai's lacy Opaikaa Falls

Smoke From Burning Sugar Cane Signals Harvesttime on a Maui Plantation

Puunene Mill of the Hawaiian Commercial & Sugar Company, Ltd., crushes cane from the islands' largest plantation, which covers more than 50,000 acres. Each day men burn off and harvest

KODACHROME BY WALTER MEAYERS EDWARDS, NATIONAL GEOGRAPHIC STAFF © N. G. S.

just enough to feed the mill. Irrigation ditches trace wavy lines across the fields. Wells and runoff from the mountains provide roughly 370,000,000 gallons of water a day—almost enough to supply metropolitan London. Homes at lower left house company employees. The communities of Wailuku and New Kahului (right) lie at the foot of Maui's western mountains.

far cry, too, from such industrial complexes as Standard Oil's new $60,000,000 refinery beyond Pearl Harbor at Barbers Point.

The oil to be refined here will come from distant sources, for Hawaii's abundance stops with rain, sunshine, and fertile soil. Its mineral resources, save for low-grade bauxite which may become important, are of no economic significance.

Nonetheless, this mineral-short State is stirring on the industrial front. Canadian interests have joined with local capital to build a steel mill that is converting scrap to reinforcing rods. Two $12,000,000 cement plants are being engineered, one by industrialist Henry Kaiser, who is now venturing many millions in resort development in this, his adopted home.

Rotating Restaurant to Cap Skyscraper

The sugar people, in partnership with Crown Zellerbach Corporation, are winding up years of research with operation of a pilot plant to make paper from bagasse, the residue of sugar cane. A full-scale mill is under consideration.

Building goes on everywhere. A new $28,000,000 shopping center midway between downtown Honolulu and Waikiki overlooks the sea. When completed, it will include a skyscraper capped by a rotating restaurant designed to give diners a 360-degree view of Honolulu.

But the biggest growth is in the tourist industry. In addition to Kaiser's lavish Hawaiian Village center, Sheraton has just bought the four Matson hotels and announced plans for more. A local entrepreneur, Roy Kelley, has built his fifth hotel. Hilton International eyes a beach-front site for its operations. Even the slower tempo of the outer islands is responding, with Hanalei on Kauai, Lahaina on Maui, and Kona on Hawaii all scheduled for new development.

In this rapid pace, Hawaiians of Oriental ancestry are not left behind. Soft-spoken Hung Wo Ching, who went to Cornell University for a doctorate and then made a fortune before he was 40, recently took over control of Aloha Airlines. Already he has brought turboprop service to interisland routes.

On the political scene, two of the three successful candidates for Congress have Oriental origins. One is young Dan Inouye, who fills Hawaii's lone seat in the House of Representatives. He won his Distinguished Service Cross—and lost an arm—while fighting with the Nisei of the famed 442d Regimental Combat Team in the Po River campaign.

"Though their casualties were tragic, the conduct of men like Dan in World War II brought our people of Asian blood to cultural and social maturity," the Territory's last Delegate to Congress, John A. Burns, once told me. "They had proved their loyal citizenship, and in doing so gained the self-confidence necessary to assume a place of responsibility in the community.

"Without their sacrifice, we might never have gotten statehood," Mr. Burns said, "though many others, of course, have contributed to putting the 50th star in the flag."

The Delegate should know, because in the Halls of Congress he himself is given a good deal of credit for bringing statehood to pass.

Hawaii: America's Door to the East

When I came to Hawaii 25 years ago, it seemed the end of the line, commercially and politically. All eyes were turned toward the mainland.

Two wars later, all this has changed. Fiji and Sydney, Hong Kong and Tokyo are familiar now. Their aspirations not only for trade but for understanding from America are a vital and real thing to those of us who live here.

The islands' brilliant young Governor, William F. Quinn (page 14), views our role in the Union this way: "We are a solvent enterprise with an expanding future. More than that, Hawaiian statehood gives tangible evidence to awakening millions in Asia and Africa that the United States is no colonial power, but means what it says about equality of races and the democratic process."

Napali's Towering Cliffs Wall a Shangri-La Valley Accessible Only by Sea

Ramparts of layered lava soar 3,000 rocky feet almost straight up along Kauai's northwest coast. Junglelike glens tucked amid the ridges offer an unspoiled world for the adventurous. Behind these cliffs lie the secluded valleys of the Napali men, who mysteriously abandoned their settlements at the turn of the century. White sand beaches often disappear when winter's stormy swells pound the shore.

KODACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS NEBBIA © N. G. S.

Watery Hawaii: Fiftieth State Spans 1,600 Miles of Ocean

THE 71 FACES on the opposite page add up to one of the trademarks of Hawaii. Gathered for a happy occasion—graduation day at the university in Honolulu—these citizens of the newest of the United States typify the world-wide mixture of peoples and cultures analyzed in the preceding article.

The wonders of this far-flung State are charted on the new five-section Atlas Map of **Hawaii** sent to National Geographic members with this issue of their magazine.* The map, carrying 18 explanatory notes and hundreds of place names in melodious Hawaiian, will guide you to beauties and rarities of nature—whether you travel in imagination or by jet aircraft and outrigger canoe, whether you turn *mauka*, toward the mountains, or *makai*, toward the sea.

The combined land surface of the Hawaiian Islands amounts to only 6,439 square miles, which makes it the fourth smallest State in the Union (after Rhode Island, Delaware, and Connecticut). Yet these islands, flung across the Tropic of Cancer in the middle of the North Pacific, form a chain 1,600 miles long—equal to the distance from New York to Cheyenne, Wyoming, and spanning more meridians than Texas.

What most people mean when they refer to Hawaii are the eight largest islands, shown in detail on the central portion of the new map. A long inset across the top displays 25 islands of the new State, a glamorous mid-ocean strand of beads.

Northwest of the main islands, from Niihoa to Pearl and Hermes Reef, stretches the Hawaiian Islands National Wildlife Refuge. Here one finds probably the only visitors that commute between the 50th State and the 49th: Pacific golden plovers, bristle-thighed curlews, and wandering tattlers, that use Hawaii as a wintering ground or a way station on flights from Alaska, 2,500 miles away.

On Necker and Nihoa Islands are remains of terraces and low stone platforms built by long-vanished Polynesians. Master sailors, they may have abandoned their isles for bigger ones to the southeast. Westernmost islands on the map are Kure and Midway, where Japan's bid to follow up its Pearl Harbor attack was turned back by U. S. naval and air power. Navy-controlled Midway, shown enlarged in an inset, includes an unsinkable aircraft carrier, Sand Island.

On the detailed inset of Oahu, home of the State capital city of Honolulu, you can see some of the odd-shaped markings—rather like bunches of bananas—that indicate coral reefs. Cleared from the entrance to historic Pearl Harbor, they still threaten sailors in some of Oahu's other bays and lagoons.

In Kaneohe Bay, on the northeastern coast, the new State's largest cluster of reefs provides a fabulous field of research for the University of Hawaii's Marine Laboratory. Eternally building, the tiny polyps do their patient bit to change the island's shoreline. Meanwhile, on the island of Hawaii, volcanoes are at work helping to change the 50th State in their own way, with massive overlays of lava.

One simple general rule will add to the enjoyment of this new map. In pronouncing place names, give each vowel its full value. A *kamaaina*, or old island hand, may mark you down as a *malihini*, or newcomer, but he won't get *huhu*, or huffy, about it. Especially now that the oldest kamaaina lives in the newest malihini to the Union.

* This new map forms Plate 15 in The Society's Atlas Series and is the 18th uniform-sized Atlas Map issued since the series began in January, 1958.

To bind their maps, more than 230,000 members have ordered the convenient Atlas Folio, at $4.85. Single maps of the series, at 50¢ each—or a packet of the 14 maps issued in 1958 and 1959, at $3.50—may be ordered from the National Geographic Society, Dept. 45, Washington 6, D. C. A combination of map packet and Folio is available at $9.95.

EXPLORING TOMORROW

WITH THE SPACE AGENCY

By ALLAN C. FISHER, JR.
Assistant Editor

Illustrations by National Geographic photographer DEAN CONGER

FOR MILLENNIUMS men have centered their hopes and dreams on a fruitful but relatively small island known as earth. Now, armed with an accumulation of knowledge, they look out with mounting confidence upon that strangest of oceans, space. No longer do the sunlit isles on earth's horizon—the moon and planets—seem unattainable. This is year three of the Space Age, and a vast new environment, the solar system, lies open to mankind's assault.

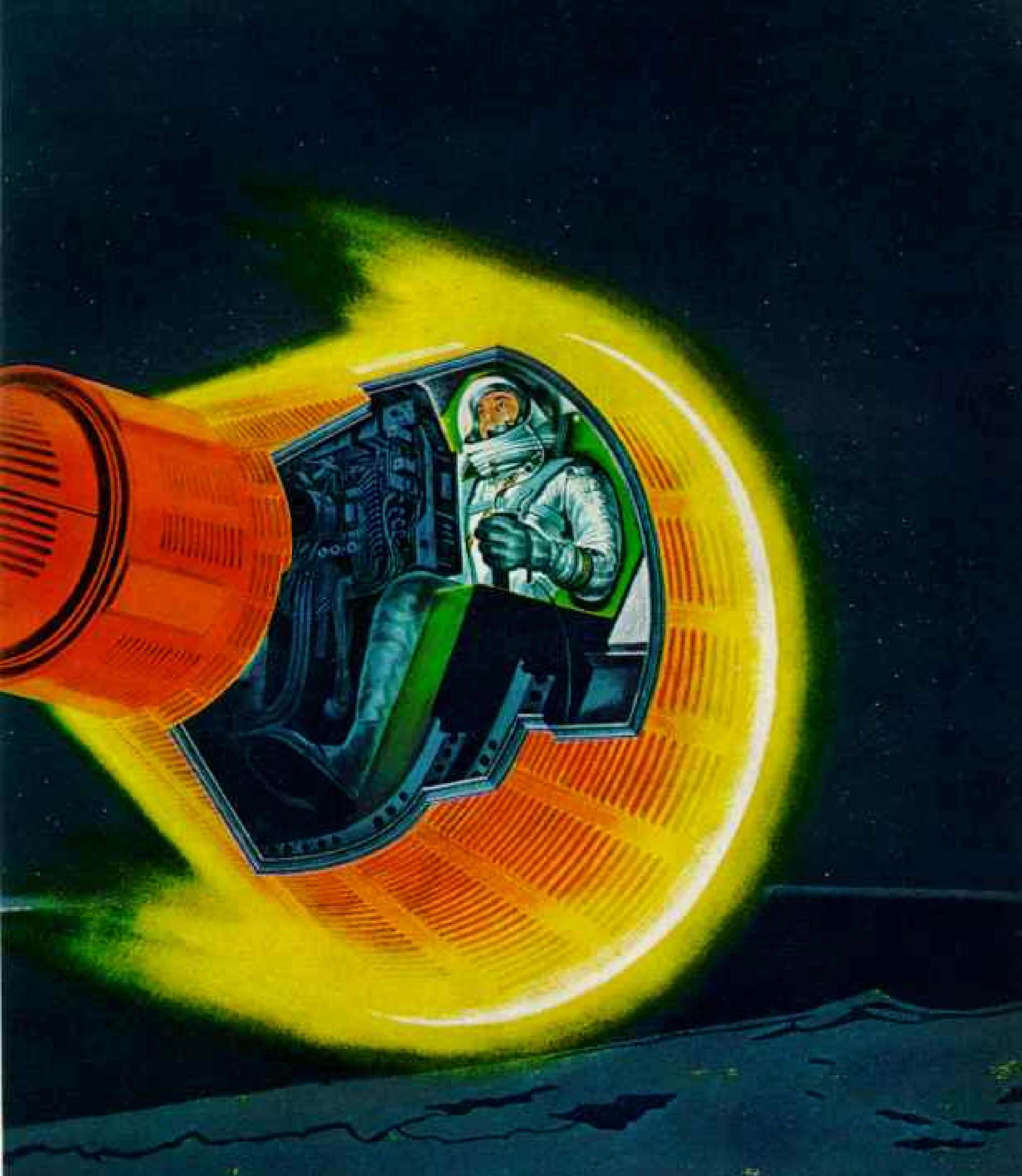
An agency not yet two years old, the National Aeronautics and Space Administration, leads United States forces in the developing assault. Boldly assessing the long-range future, NASA contemplates Columbian voyages to new worlds and a systematic program of fathoming and charting to the very ends of the solar sea.

NASA Sponsors Nationwide Research

Sputnik I, launched October 4, 1957, ushered in the Space Age. NASA, though a late entry in the field, has responded to the challenge of Soviet successes by organizing one of the broadest research and development programs ever undertaken in any country.

Already, NASA has scored some brilliant firsts of its own—for example with *Tiros I*, the television-equipped weather satellite, and with *Pioneer V*, the space probe that has radioed scientific information back to earth across millions of miles.

(*Continued on page 52*)



Fired by the torch of air friction, a Project Mercury satellite streaks meteorlike down the predawn sky 300,000 feet over Florida. A special material on the thick, bulbous nose absorbs most of the savage heat and streams away as burning vapor, protecting the rearward-facing astronaut (shown in cutaway view). Soon parachutes will stream from the capsule's tail and ease the astronaut into the Atlantic, ending his orbital flight. To insure accuracy, artist Calle consulted eight scientists from the space agency, Navy, and Weather Bureau. Cartographer Wellman Chamberlin plotted the stars and perspective, assuming the date June 11, 1961.

Tumbling Pilot Flies a Space Mission in a Wind Tunnel

When an astronaut hurtles back into the sea of air, his capsule may pitch and careen like a boat in a gale. Scientists plan small jets, operated by the passenger or by an automatic device, to stabilize the satellite (page 61).

This bizarre chair, a jet-powered whirligig, simulates extreme control problems. The National Aeronautics and Space Administration experiments with it at Lewis Research Center, Cleveland, Ohio.

Strapped in MASTIF (Multiple Axis Space Test Inertia Facility), a test pilot (opposite) braces himself for a wild ride. Gas jets attached to the tubular supports spin his contour chair on three axes—roll, pitch, and yaw. Engineers initiate the dizzy movement by remote control. The pilot counters the motion with the small control stick in his right hand.

Beginning a run, the chair pitches forward (right). Moments later the rider whirls heels over head (lower). Lights attached to the framework trace his erratic tumbling.

The space agency brings to its tasks impressive resources: seven research installations, scattered about the Nation and valued at $500,000,000; more than 16,000 employees, including many distinguished and intensely dedicated scientists; and, for the 1961 fiscal year, a budget of some $900,000,000. As contractors, NASA has enlisted hundreds of industrial firms and many universities.

Space Program Benefits the World

Recently I took a three-months' tour of NASA's growing empire. I talked frankly and at length with scores of researchers and top administrators, witnessed many bizarre experiments, and gained an intimate insight into plans and problems.

This searching examination convinced me that our future position in the space race will be far stronger than NASA's critics predict. Mastery of space requires the blunting of many thorny problems. No country can send men to the moon and back, for example, until it develops new space craft materials that will withstand unprecedented heat and stress. It is in such basic, little-publicized areas, I believe, that NASA's most significant contributions are being made.

Dr. T. Keith Glennan, NASA chief, declares forcefully that, even today, our position compares favorably with that of the Soviets.

"We have a soundly based program, technically and scientifically," he told me. "That is what will be most useful to the world. Unless the Russians do something vastly different from what they have done to date, we have a better program.

"I do not say this in derogation," Dr. Glennan went on, "but the information that has been retrieved from the heavens leaves the balance in our favor. We must make the American public aware that the be-all and end-all of space exploration is not to match the Russians shot for shot."

Perhaps the word "scope" best characterizes NASA's program. It ranges from our first man-in-space effort—Project Mercury, with its seven celebrated astronauts—to advance planning on projects so "far out" they seem like science fiction. It is a program of contrasts; scientists work on radical new means of propulsion for interplanetary journeys while, next door, colleagues plan ultrastreamlined supersonic jet transports.

The space timetable for the next decade features some 250 major launchings, continuing a program that already boasts more satellites and probes than the Soviets have fired. In 1961 we will attempt to hit the moon, and the following year we will try to place instruments there in a "soft landing," so that they will radio back information. Also, in 1962 we will shoot rocket payloads close to Mars and Venus.

Modern Magellan Will Circle Moon

By 1964 the space agency hopes to send a rocket around the moon and back to earth. Later in the decade there are ambitious plans for duplicating that flight with a manned space craft and even for erecting a station in space.

When will we put a man on the moon? Not until after 1970, the experts say.

Project yourself into NASA's challenging future and imagine this scene:

A space craft hurtles through the void of night at 17,400 miles an hour, its blunt nose and dull metallic sides reflecting little light from the blazing stars. Hawaii, 125 miles below in the black ink of the Pacific, falls behind; five minutes ahead lies the United States mainland and the promise of dawn.

Tension . . . a cumbersome pressure suit

W. E. SAUSER

Allan C. Fisher, Jr., is the only member ever chosen twice by the Aviation Writers Association for its coveted magazine-or-book writing award, the James J. Strebig Memorial Trophy. The association gives this prize annually for the best writing on aviation or astronautics.

Assistant Editor Fisher won the first award for his article, "Aviation Medicine on the Threshold of Space," in the August, 1955, NATIONAL GEOGRAPHIC. "Cape Canaveral's 6,000-mile Shooting Gallery," in the October, 1959, issue, brought him the second honor.

Covering his prize-winning assignments, Mr. Fisher has scraped through a bellylanding in a jet, ridden whirling centrifuges, and made exclusive visits to remote missile tracking stations.

WIDE WORLD

Floating like thistledown, astronaut Leroy G. Cooper (left) and Dr. Edwin G. Vail, a physiologist, try to walk on the ceiling of a Convair C-131 transport during weightless flight. As their plane flies up and over in a roller-coaster arc, centrifugal force pushes them upward and gravity pulls them down. For 15 seconds the warring forces equalize each other, resulting in weightlessness. Similarly, astronauts will be weightless in orbit and, briefly, during rocket training flights (next page).

. . . cramped quarters . . . the eerie sensation of weightlessness . . . all these have taken their toll of the space craft's lone occupant. But, physically and mentally, this is an extraordinary man, and for years he has worn discipline like a shield. Determinedly he rejects fatigue and keeps his eyes on a clock as it ticks away critical seconds.

Suddenly three retro-rockets in the blunt nose erupt, braking speed. The craft shudders and wobbles, but automatic controls steady it. Minutes later it slashes like a fiery meteor through the atmosphere above Florida (page 49). Then parachutes open, and the strange projectile drifts down to the Atlantic. Rescue ships—and a rendezvous with fame—await the lonely voyager.

A fanciful return from a moon mission? No, nothing so remote. The account envisions climactic moments in a Mercury astro-

Time: 5 minutes
Speed: 1,600 mph
Altitude: 125 miles
Astronaut's weight: Zero

Small jets turn capsule so blunt heat shield faces forward, then tip capsule so periscope points down

Time: 2 minutes 5 seconds
Speed: 4,000 mph
Altitude: 45 miles
Astronaut's weight: Zero

Centrifugal force counteracts gravity; astronaut is weightless (see preceding page)

Five seconds after burnout escape device is jettisoned. Seconds later, capsule separates itself from rocket (see cutaway diagram, page 61)

Time: 2 minutes
Speed: 4,000 mph
Altitude: 40 miles
Astronaut's weight: 1,200 pounds

Rapid acceleration pushes astronaut against seat with crushing force, multiplying his weight

Should Redstone fail, small rocket blasts astronaut to safety

Redstone rocket launches capsule containing astronaut

Cape Canaveral

Time: Zero
Speed: Zero
Altitude: Zero
Astronaut's weight: 180 pounds

Fort Pierce

West Palm Beach

Fort Lauderdale

Miami

Miami Beach

PROJECT MERCURY

PREORBITAL TRAINING FLIGHT

Diagram by National Geographic Artist John Lothers

Kodachrome by Dean Conger

Late this year the United States hopes to launch a man into space. His epochal ride, diagrammed above, should last 16½ minutes—a brief training flight for global orbit missions in 1961. The seven Mercury astronauts, from left, are:

Retro-rockets, required for later global flights, test fire at maximum height

Time: 7 minutes
Speed: 3,000 mph
Altitude: 80 miles
Astronaut's weight: Zero

Spent retro-rockets are jettisoned

Time: 8 minutes
Speed: 4,000 mph
Altitude: 40 miles
Astronaut's weight: 2,000 pounds

Abrupt deceleration forces astronaut against seat again and multiplies his weight

Time: 9 minutes
Speed: 300 mph
Altitude: 12 miles
Astronaut's weight: 180 pounds

Braking chute eases descent

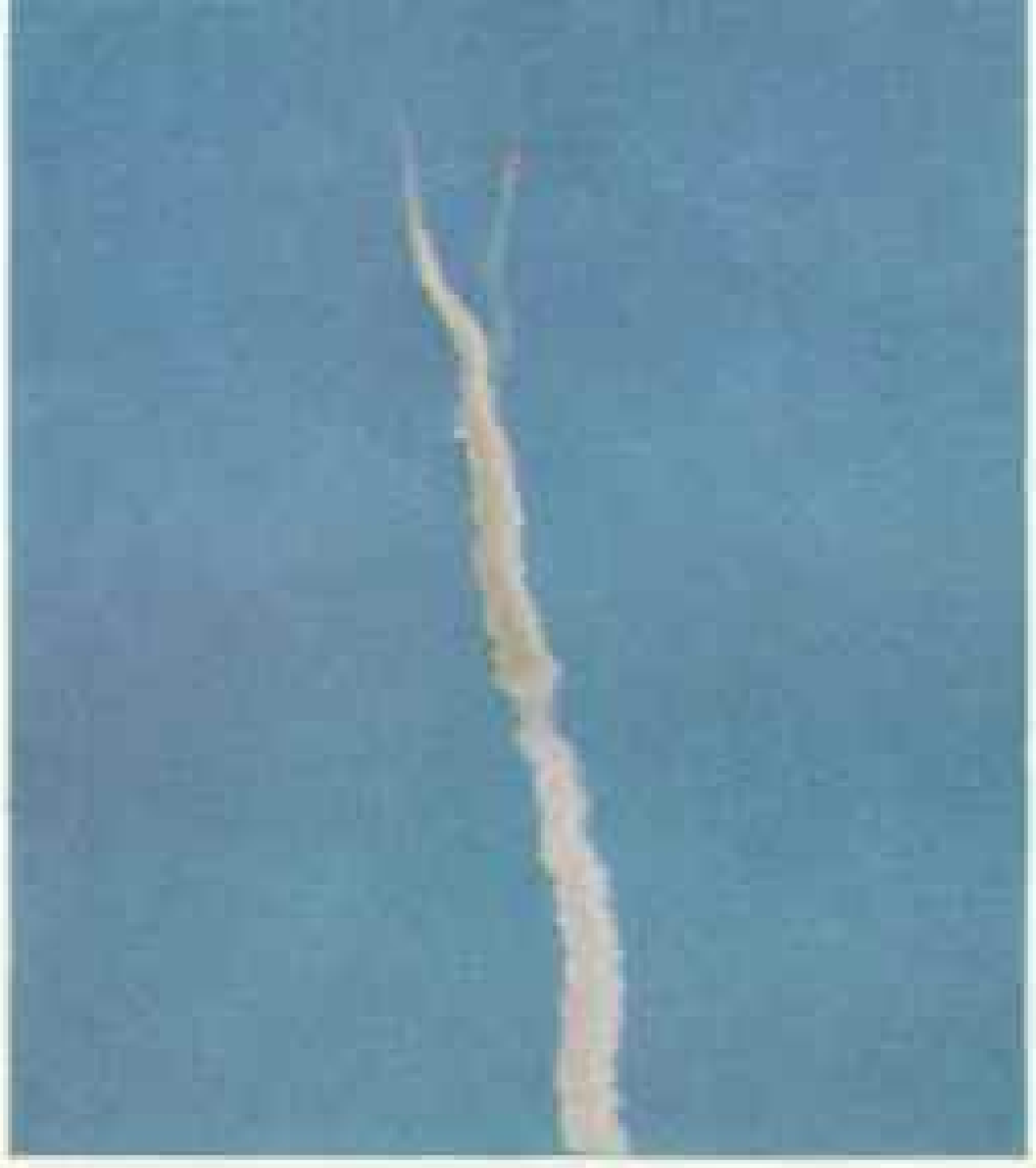
Time: 13 minutes
Speed: 25 mph
Altitude: 2 miles
Astronaut's weight: 180 pounds

Main chute opens

John H. Glenn, Jr., Lt. Col., USMC
Donald K. Slayton, Capt., USAF
Malcolm S. Carpenter, Lt., USN
Virgil I. Grissom, Capt., USAF
Walter M. Schirra, Jr., Lt. Comdr., USN
Alan B. Shepard, Jr., Lt. Comdr., USN
Leroy G. Cooper, Jr., Capt., USAF

Impact: 200 miles down range

Time: 16 1/2 minutes
Speed: Zero
Altitude: Zero



naut's globe-girdling flight. Next year an Atlas rocket will blast a man into orbit at five miles a second, and he will circle our planet three times in a mere 4½ hours.

But sometime before the end of 1960 an astronaut will take the first tentative step into space.

One morning, probably before the first hint of dawn, he will climb into a one-ton conical capsule atop a Redstone rocket at Cape Canaveral, Florida. He will recline upon a contour couch, sweat out a long countdown, then endure an accelerative force nine times his weight as the missile blasts him a hundred miles high. Sixteen and a half minutes after take-off his capsule will parachute into the sea

Little Joe Rocket Hurls a Space-suited Monkey Into the Stratosphere

If the booster rocket launching an astronaut fails, the Mercury capsule blasts itself free of the booster and parachutes into the sea. Last January NASA scientists tested the escape procedure with a capsule carrying a specially trained, six-pound rhesus monkey, Miss Sam.

Raging streamers of fire lift Little Joe, a solid-propellant booster, from Wallops Island, Virginia (left). Metal tower atop the capsule supports an escape rocket. At 36,500 feet, the escape rocket ignites; in a single second it whisks the capsule 250 feet to the right of its booster (above). Parachutes eased Miss Sam down to the Atlantic for a quick recovery. Going up, the monkey endured an accelerative force 14 times her weight, but she emerged from the capsule frisky and unscathed.

Dressed for take-off in a custom-tailored space suit (right), Miss Sam smiles like a model in a toothpaste advertisement. Her scientist friends say she will marry Sam, a rhesus monkey who survived an earlier rocket voyage 100 miles high.

200 miles down the Atlantic Missile Range. Similar brief lob flights will follow, all designed to check out men and equipment.

NASA was only four days old when it set up a special unit, the Space Task Group, to plan epoch-making Project Mercury. Within weeks engineers designed the spectacularly ugly capsule, shaped like a television tube (page 60). Its blunt face bears a coating of resinous glass fiber that vaporizes under the savage blast of air friction and streams away, carrying with it most of the intense heat. This process, known as ablation, protects missile nose cones as they enter the atmosphere.

Similarly, it will protect the astronaut. Temperatures on the heat shield may reach 2,600°F. But the astronaut sits within a double-walled hull, insulated, airtight, and watertight. His cabin instruments will detect only a brief rise to 120°F., easily tolerated by a man in an air-conditioned space suit.

Unlike a nose cone, the capsule requires controls. After entering orbit, it must be turned end for end so that the heat shield faces forward, and it must be kept stable during descent. So engineers installed jets of hydrogen peroxide vapor to counter roll, pitch, and yaw. These jets operate automatically, but the astronaut can take control at any time (page 61).

NASA is trying to make orbital flight no riskier than tests of experimental aircraft.

EXTACHROMES BY RACE AND HIGH SPEED EXTACHROME (OPPOSITE, ABOVE) BY NATIONAL GEOGRAPHIC PHOTOGRAPHER DEAN CONGER © N.G.S.

One-ton Mercury Capsule Drops to the Salton Sea in a Parachute Test

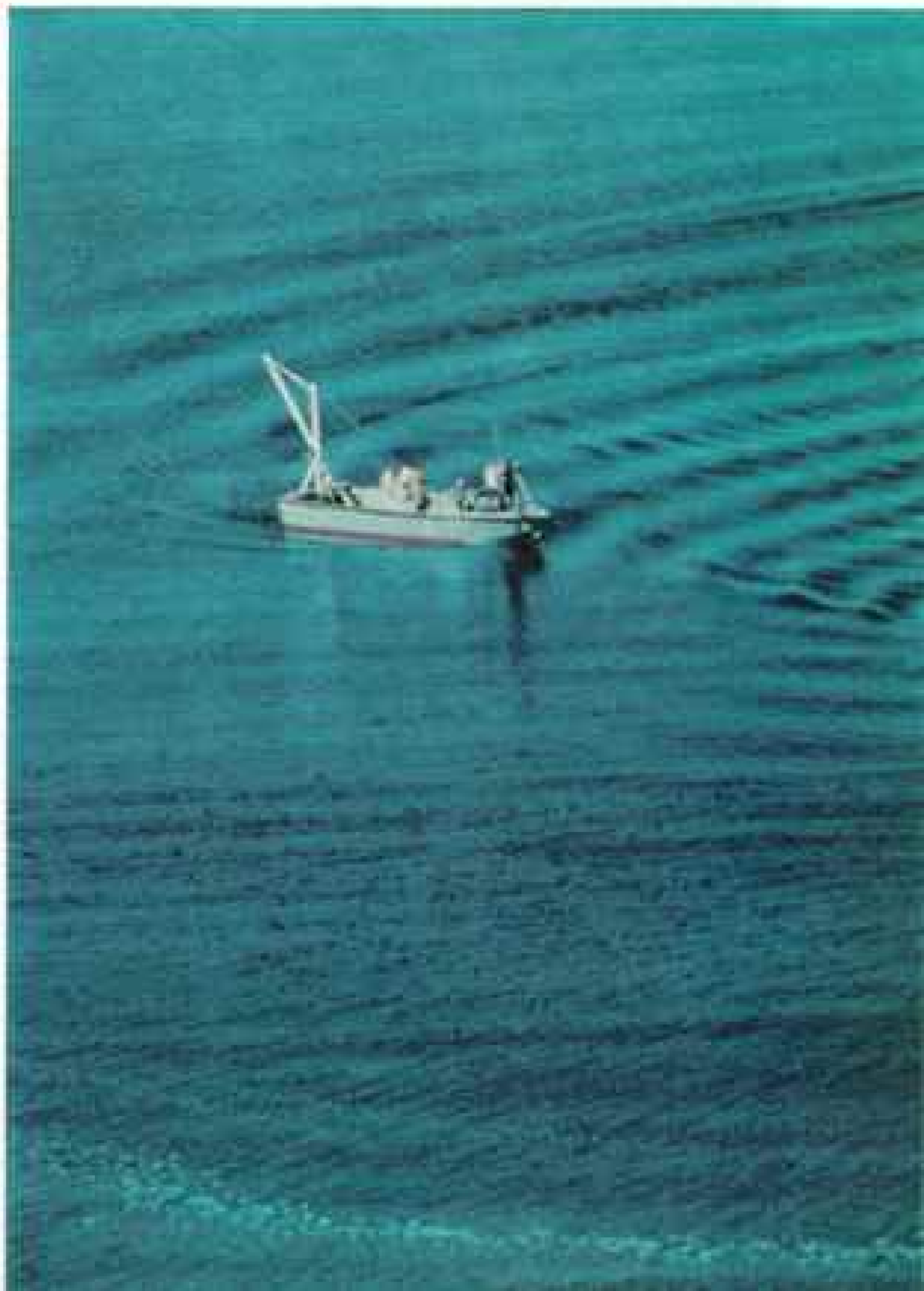
NASA and its contractors have conducted thousands of experiments to develop a safe design for our first man-carrying satellite.

Engineers staged this test of the capsule's recovery system near El Centro, California, home of the Air Force-Navy Joint Parachute Facility. The capsule, a full-scale mock-up, was released from a cargo plane at 30,000 feet. Just 88 seconds later—at 10,000 feet—the main chute opened.

Blossomed to its full 63 feet, the nylon canopy (above) lowers its burden to the land-locked Salton Sea. Traveling 30 feet per second at impact, the capsule's blunt nose craters the calm surface (upper right).

Airtight and watertight, it floats like a marker buoy (opposite) as a launch moves in for recovery.

Researchers have made more than 50 drop tests at El Centro from various altitudes. Photographer Bates Littlehales shot these views from a helicopter.



Instruments will monitor the Atlas constantly; at the first hint of malfunction, an escape rocket will blast the capsule free of its booster. Alternate systems provide a backup for each key mechanism in the satellite, and its oxygen-enriched atmosphere will last 48 hours.

Model capsules have been tested endlessly in wind tunnels, a sight I frequently encountered during my tour. Full-scale versions, some carrying monkeys, have been fired into space and retrieved after brief flight, and NASA is now setting up a global net of stations to track manned capsules.

My interest, however, centered not upon machines but upon the seven men who bear that strangest of all official titles, astronaut.

Talent Scouts Interviewed Astronauts

I knew they represented the pick of an unusual talent hunt. NASA issued rigid specifications for an astronaut; he must be a military test pilot with jet credentials and 1,500 hours or more flight time, a graduate of a test-pilot school, an engineer, under age 40, and no taller than five feet eleven. More than 100 volunteers responded; NASA interviewed 69 and picked 32 for a harrowing ordeal of physical and mental examination.

Judges finally selected these seven men: Capt. Leroy G. Cooper, Jr., Capt. Virgil I. Grissom, and Capt. Donald K. Slayton, Air Force; Lt. Malcolm S. Carpenter, Lt. Comdr. Walter M. Schirra, Jr., and Lt. Comdr. Alan B. Shepard, Jr., Navy; Lt. Col. John H. Glenn, Jr., Marine Corps (page 54).

The Space Task Group maintains its headquarters at Langley Research Center, a sprawling collection of laboratories and wind tunnels in a campuslike setting near Hampton, Virginia. There I talked to the astronauts in a series of meetings squeezed into their busy schedules.

Much that has been written gives them the aura of supermen—an impression they deplore. In their own minds they remain test pilots and engineers, now called to the most challenging job of their careers. They won't let fame spoil them. An intimate of theirs told me that if one seems to be basking too enjoyably in the spotlight, the others rake him with frank words and unmerciful gibes.

They wear civilian clothes, often carry briefcases, and—except for a tendency toward sports jackets—might be mistaken anywhere for earnest businessmen. Their mature years bolster this impression. Cooper, the youngest, is 33; Glenn, the oldest, will be 39 this month.

EKTACHROME (BELOW) AND HIGH SPEED EKTACHROMES BY NATIONAL GEOGRAPHIC PHOTOGRAPHER BATES LITTLEHALES © N.G.S.

Each is married and has at least one child. With the exception of Glenn, who commutes on weekends to his home in a suburb of Washington, D. C., all live near the Langley Center. Like many of us whose jobs are less spectacular, they often wish their work permitted more time at home. As Grissom put it, "The hard part is stalling the wife off on things to do around the house."

But there ends the resemblance to humdrum Average Man. Though they haven't the look of muscled athletes, each is a superb physical specimen. They keep in shape with swimming and diving, golf, tennis, and handball. Glenn, in the Marines' best Spartan tradition, does daily roadwork.

Each man also possesses an intellect far higher than average. This becomes obvious as you talk to them. They know their project in minute technical detail, and all are extremely articulate.

They believe—as do many NASA officials—that the Soviets may beat them into space. Mercury personnel work at a fast pace with the highest priority, but the competition got an earlier start. Apparently the U.S.S.R. has not set up a global tracking net, but the Soviets possess rockets powerful enough to hurl not one but two men into orbit.

"If you have enough power to kick up everything you want to—which the Russians have—you can do a lot of things," said Slayton. "Maybe they can afford to go without tracking ranges."

His statement reflected a general impression that the Soviets, who have rockets with twice the thrust of the Atlas, might launch a heavier, more versatile craft than the Mercury capsule.

A Giant Firecracker—Actually an Escape Rocket—Perches Atop the Mercury Capsule

McDonnell Aircraft Corporation, the capsule's manufacturer, built this full-scale model of sheet metal. Real satellites are made with an outer shell of heat-resistant cobalt and an inner shell of titanium. Insulation between the layers shields the rider against heat, cold, and noise.

The open entrance hatch yawns in the capsule's center. Retro-rockets, to be jettisoned after use, project from the blunt heat shield at bottom.

Infrared cells, scanning horizon, control equilibrium

Small braking chute

Movie camera photographs instrument panel

Pitch-control jets

Film packs detect cosmic ray penetration

Instrument panel

Spoiler turns capsule if yaw jets fail

Yaw-control jets

Main parachute

Periscope

Astronaut can maneuver capsule with control jets

Roll-control jets

Robert W. Nicholson

Redstone booster

Capsule

Escape device

Burnout plus 5 seconds: Escape device jettisoned, rockets blast capsule away from booster

Artist's cutaway reveals the Mercury satellite's gear-crammed interior. The spoiler, a metal half-moon (upper right), is an emergency device. To survive air friction, the capsule must turn its blunt heat shield forward before plunging to earth (page 54). If jet controls fail, the spoiler digs into the air blast, causing the capsule to flip over into the proper position.

After the main parachute opens, a perforated skirt of rubberized glass fiber four feet long pops out of the nose like a jack-in-the-box to cushion the capsule's impact in the Atlantic and act as a stabilizing keel (right). A tiny blimp, automatically released, supports the antenna for a radio beacon that guides rescuers to the waiting astronaut. Dye marker stains the waves.

The competitive spirit of the astronauts is such that they would like to be first, despite official disclaimers that we are in a space race. But everything takes a back seat to the immediate problem of getting a man into space.

"I suspect there is plenty of awareness at high levels of international competition," Shepard told me with a grin. "But here at Langley we're all so busy trying to get somebody into orbit that there's no time left to worry about the competition."

The astronauts are supremely confident that space exploration will benefit mankind in undreamed-of ways. Several times I pointed out that many people believe otherwise, and the thrusts always brought pungent replies. For example, Grissom said:

"You don't know what you'll get out of it until you try. Wernher von Braun once told a story along that line. In Paris one day, Benjamin Franklin watched the ascent of history's first gas-filled balloon. Someone asked him what good the balloon was. Franklin replied, 'What good is a baby?' "

"No one has to sell space flight to a person who believes in it," Carpenter declared, "but if that person hasn't faith, nothing you can say will sell him."

"Unknown" Intrigues Space Pioneers

A revealing comment by Walter Schirra typified the motivation felt by all the astronauts. I had told Schirra of a test-pilot acquaintance who, above all else, envied the astronauts their chance to be the first men to see the world from space. The pilot believed anything that happened later in their lives would be anticlimactic.

Schirra's reply seemed tinged with disgust. "There's so much coming behind this first program," he said. "We want to know if men can live and work in space. To go up just for a look, as if that represents all you can do, is a selfish thing. If we felt that way, we wouldn't be in the program."

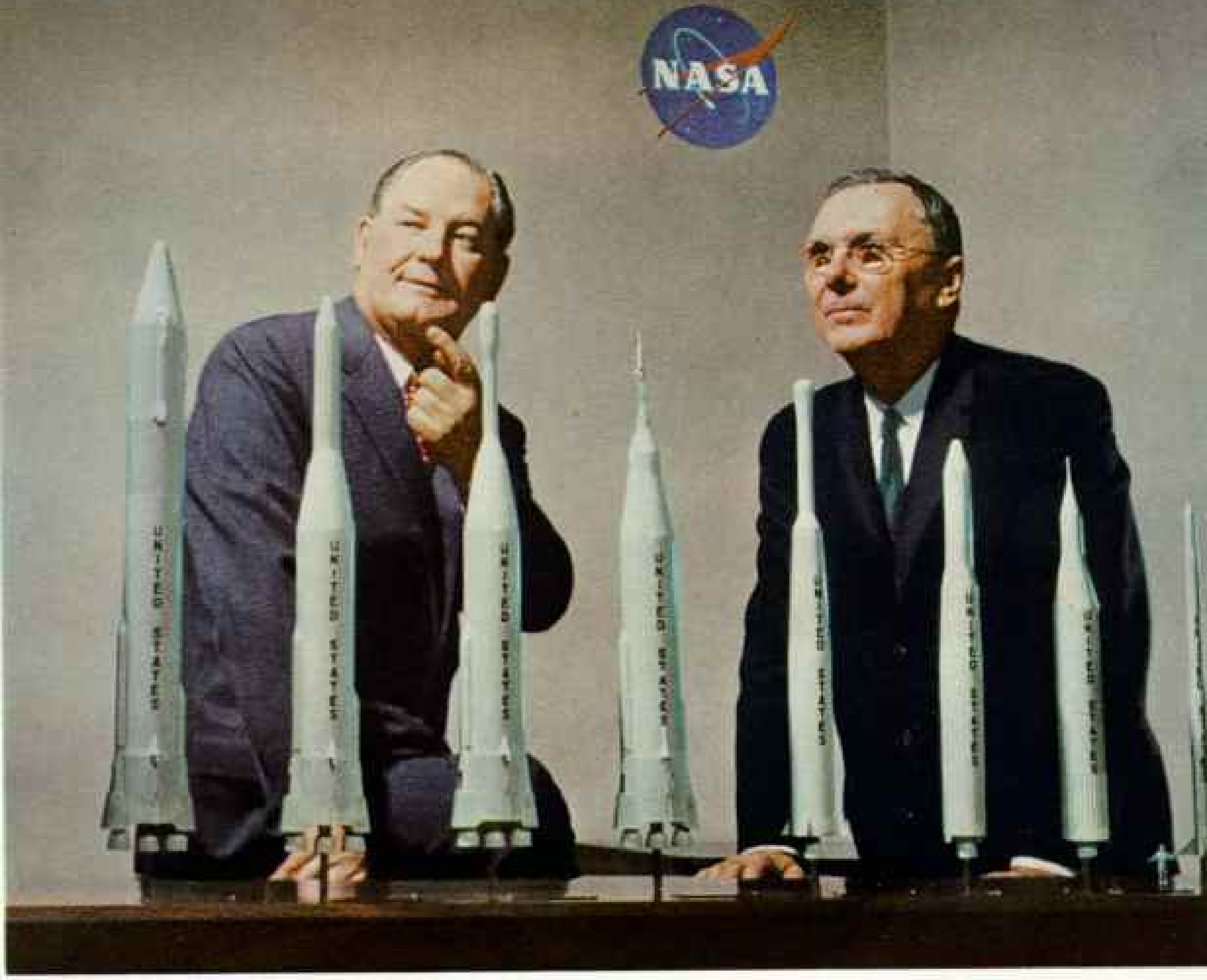
The astronauts, while intent upon scientific purposes, are not insensitive to the venturous romance of their task. Leroy Cooper spoke of "man's insatiable curiosity to know what the unknown holds." He told me they all shared that curiosity. "I've always had a strong yen to see what was on top of the mountain," he added.

Perhaps the astronauts seem struck from a single mold. But even on short acquaintance I thought their personalities differed markedly. For instance, one man impressed me as the group's conservative, inclined to point out and emphasize problems. Another I thought of as the radical spokesman; he minimized certain problems and seemed eager to cut corners and get into space.

But such differences are natural and healthy and even contribute to the program. Each astronaut has been assigned an area of specialization, such as the communications net or the recovery system. The seven keep one

NOVA SATURN

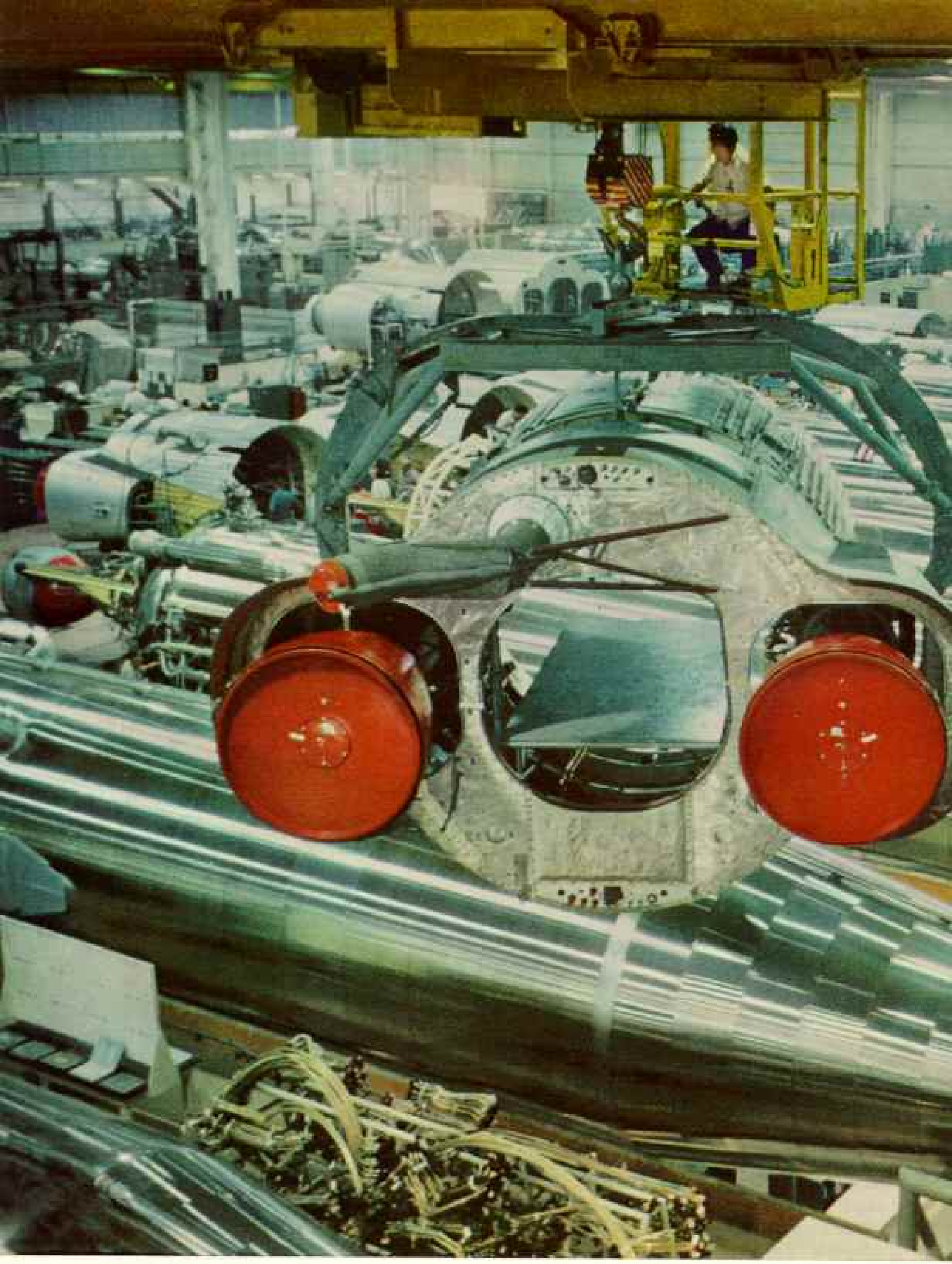
This family of 10 rockets, here represented by scale models, is NASA's arsenal for some 250 major launchings during the next decade. Dr. T. Keith Glennan, the space agency's Administrator, and Dr. Hugh L. Dryden, Deputy Administrator, survey the line-up. Dr. Glennan directs the agency while on leave from the presidency of Case Institute of Technology; Dr. Dryden headed the distinguished National Advisory Committee for Aeronautics, absorbed by NASA. Nova and Saturn, now under study and development, will dwarf all known rockets. Nova will stand 220 feet high, 70 feet taller than Saturn.



CENTAUR | ATLAS-AGENA B | ATLAS-ABLE | ATLAS-MERCURY | DELTA | THOR-AGENA B | JUNO II | SCOUT

another informed, debate and weigh various ideas, and make recommendations to project officials. Many of their ideas have been adopted. For example, the astronauts suggested the capsule's large observation port and improvements in the entrance hatch.

Engineers also have sought advice from the seven men on cockpit instrumentation, including development of an ingenious model of the earth that shows the capsule's position at all times. This little globe, marked for longitude, latitude, topography, and major cities, revolves inside the instrument panel. The astronaut views it through a window, just as if he were actually seeing the earth beneath him. A bull's-eye sight on the window pinpoints his position, and other markings show where he would land if he



Sleek Atlases Gleam Like Mirrors on a California Assembly Line

Atlas serves the Nation in a dual capacity: as the Air Force's first intercontinental ballistic missile and as a booster rocket for NASA space missions, including orbital flights by Mercury astronauts.

AQUACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER BATES LITTLEHALES © N.G.S.

At present America's most powerful rocket, the Atlas generates 360,000 pounds of thrust with liquid-fuel engines. Convair-Astronautics manufactures the missile in this plant near San Diego. Overhead crane swings a twin-engined booster section to be fitted to the base of a missile. After take-off the booster drops, and a sustainer engine supports flight.

terminated his flight with the retro-rocket.

Ever since their appointments, the astronauts have undergone rigorous training. They ride centrifuges, duplicating the crushing accelerative force they will endure; practice many hours with devices that simulate capsule control problems; and, in jet planes, experience that most unusual of sensations, weightlessness. While in orbit, centrifugal force evenly balances the tug of gravity, rendering the astronaut feather light. This effect can be duplicated for as long as 60 seconds in a jet flying up and over in a roller-coaster arc.

Some years ago I experienced the weird sensation above Edwards Air Force Base, California. The astronauts have trained at the same site. While floating in a North American F-100 cockpit, they practiced feeding themselves with soups and juices squeezed into their mouths from plastic bottles.

I thought weightlessness extremely pleasant. Some of the seven agree; others are merely indifferent toward it. One important fact seems established: At least for short periods, it does not interfere with bodily functions. "That's a nice thing about the human body," John Glenn said. "It seems to work independently of gravity."

First Spaceman May Be Picked by Lot

Which man will be first into space? If officials know, they won't say. They claim the decision may be made by lot. Air Force Lt. Col. John A. Powers, spokesman for the astronauts, and their "mother superior," says:

"If they maintain their present level of capability, it will not matter which one we pick or how we pick him; we will have six just as good behind him."

In the idiom of missilemen, the Space Task Group's "honcho," or boss, is Robert R. Gilruth, a brilliant, harried engineer. He told me something about the problems NASA faces in getting its first astronaut safely back to earth.

"On the first mission, the capsule will start to get out of the recovery zone after circling the earth three times." The planet's rotation, he explained, will constantly swing new terrain beneath the capsule. Not until passes 15 to 17, nearly 24 hours after take-off, will the astronaut again be in position for a landing in the Atlantic Missile Range recovery area.

"As we graduate to more ambitious space flights," Gilruth continued, "we shall have to add more recovery teams, each consisting of planes and ships linked by radio networks." I asked him what he meant by "more ambitious" projects. He was naturally unwilling to make too many predictions. "I can tell you this much," he said. "Research is in progress on the problems of orbiting a two- or three-man space station."

Imperturbable Alan Shepard permitted me to hover at his side one morning while he "flew" one of the simulators in which the astronauts train. Clad in a pressure suit inflated board tight, Shepard lay upon a contour couch and stared at instruments above his head. Needles jittered wildly as engineers fed problems into flight indicators. With his right hand Shepard operated a small control stick, correcting deviations shown by the needles. Other instruments recorded his score.

Tumbling Chair Operated by Jets

After the test Shepard told me it simulated an atmospheric entry trajectory and explained that the retro-rockets will make the capsule roll, pitch, and yaw. "It's the hardest part of the flight," he added. "The rest of the time we will be pretty comfortable."

Later I volunteered to ride a more elaborate training device, a chair that spins and whirls like a bit of confetti trapped in a powerful gust. Its name: MASTIF (Multiple Axis Space Test Inertia Facility). NASA built it in a huge wind tunnel at Lewis Research Center in Cleveland (pages 50-51).

My first look at the gadget touched off a bit of inward quaking. About 12 feet above my head a huge, thronelike chair tilted at a crazy angle within an elaborate framework of tubular metal. I glimpsed a cluster of round tanks amid the tubing, and engineer Francis J. Stenger explained that the tanks fed nitrogen gas to jets. Using the jets, he

Captive Atlas Engine Spews Fire Into a Smoke-blackened Canyon

Rocketdyne, builder of the powerful engines used in Atlas and other missiles, test-fires its products high in the Santa Susana Mountains of southern California. Towering test stands, erected on rocky heights above narrow canyons, tether the engines during trials. Tanks atop one stand feed liquid oxygen and a kerosenelike fuel to an engine. A water-cooled baffle plate at the base deflects raging flame into the canyon. Joaquin Murrieta, a bandit of gold-rush California, hid from posses in these rugged gorges. Film companies have used the canyons as sets for Westerns.

would set me whirling, but I could control them from the chair, he assured me, and bring myself right side up.

No astronauts had trained in MASTIF at the time of my visit. But test pilot Joseph S. Algranti said he had ridden the chair up to 20 revolutions per minute without ill effect. Others had experienced blurred vision and nausea at this speed.

Someone beckoned me to a ladder; I climbed it, slipped gingerly into the chair, and technicians belted me fast with, among other things, a broad girdlelike strap to support my insides. My right hand grasped a little control stick.

"Ready?" Stenger asked.

I heard a blast of escaping nitrogen. Then I sagged in the straps and looked speculatively at the floor; it was where the ceiling had been. When Stenger righted me, he said, "Now you take it."

Experimentally I rolled the chair and pitched it to get the feel of the controls. They seemed sluggish, far more so than in an airplane. But the sensation was mild. Since the chair lacked forward motion, no heavy-as-lead G loads, or multiples of the gravity force, could pile up.

Next I mixed yaw motion in with the roll and pitch, and for 15 minutes practiced bringing the chair upright and motionless. Mindful of my years and sedentary ways, I kept the r.p.m. well below Algranti's 20. Instruments faithfully recorded the chair's attitude, but I seldom referred to them, finding it easier to use a near-by flight of steps for position reference each time it spun into view.

Reference to surroundings rather than to instruments, at times, may also be easier for astronauts. An engineer told me later that NASA plans to install around MASTIF a backdrop showing earth and stars as they might look from a hundred miles up.

Gliders Will Succeed Mercury Capsule

Designers look upon the Mercury capsule as a crude first step in space vehicle design. Its long, curving fall through the atmosphere apes the plunge of a ballistic missile. Later vehicles will be bigger and will glide in the atmosphere.

Here designers run into the weight-lifting limitations of United States booster rockets. Atlas, our biggest, exerts 360,000 pounds of thrust; its Soviet counterpart attains an estimated 700,000 pounds. Moreover, the Atlas has only recently become available in quantity to NASA. At this writing all but one of our satellites have been orbited by lesser rockets, Thors and Jupiters.

For a time Soviet feats seemed dazzling by comparison.

Sputnik III contained a scientific payload of 2,925 pounds, far surpassing the best we were then able to achieve.

How did the lag occur? The United States military held back in booster development until weighty atom bombs could be scaled down in size, thus permitting smaller rockets. The Soviets, not waiting for reduction of bomb size, built far larger boosters. Now NASA, because it must use presently existing rockets, inherits criticism for a decision made long before the agency came into existence.

Many wonder, without making allowance for the booster lag, why NASA doesn't attempt more dramatic "firsts." Critics complain that it shows little disposition to do so and moves slowly, with too little money.

U. S. Leads in Satellite Box Score

"In the minds of the general public and news people, the space race, or contest with Russia, is a race for spectaculars," says Dr. Glennan. "In such a race the Russians hold all the cards because they have a thrust capability beyond anything we have. Because of this, they do not have to take the risks we do. They can use heavy guidance systems, whereas we cannot at present, and they can pick and choose their targets."

But Dr. Glennan places faith in the "soundly based program" outlined earlier. He points out that, as of May first, the United States had launched 18 earth satellites, compared to four for the Soviets, and the NASA chief also takes pride in such highly successful experiments as the *Pioneer V* probe (page 84). As for future spectaculars, the United States may for a time play tortoise in some respects to the Soviet hare.

Vast sums of money would not be a cure-all, according to Dr. Hugh L. Dryden, NASA's Deputy Administrator and, since 1951, a Trustee of the National Geographic Society.

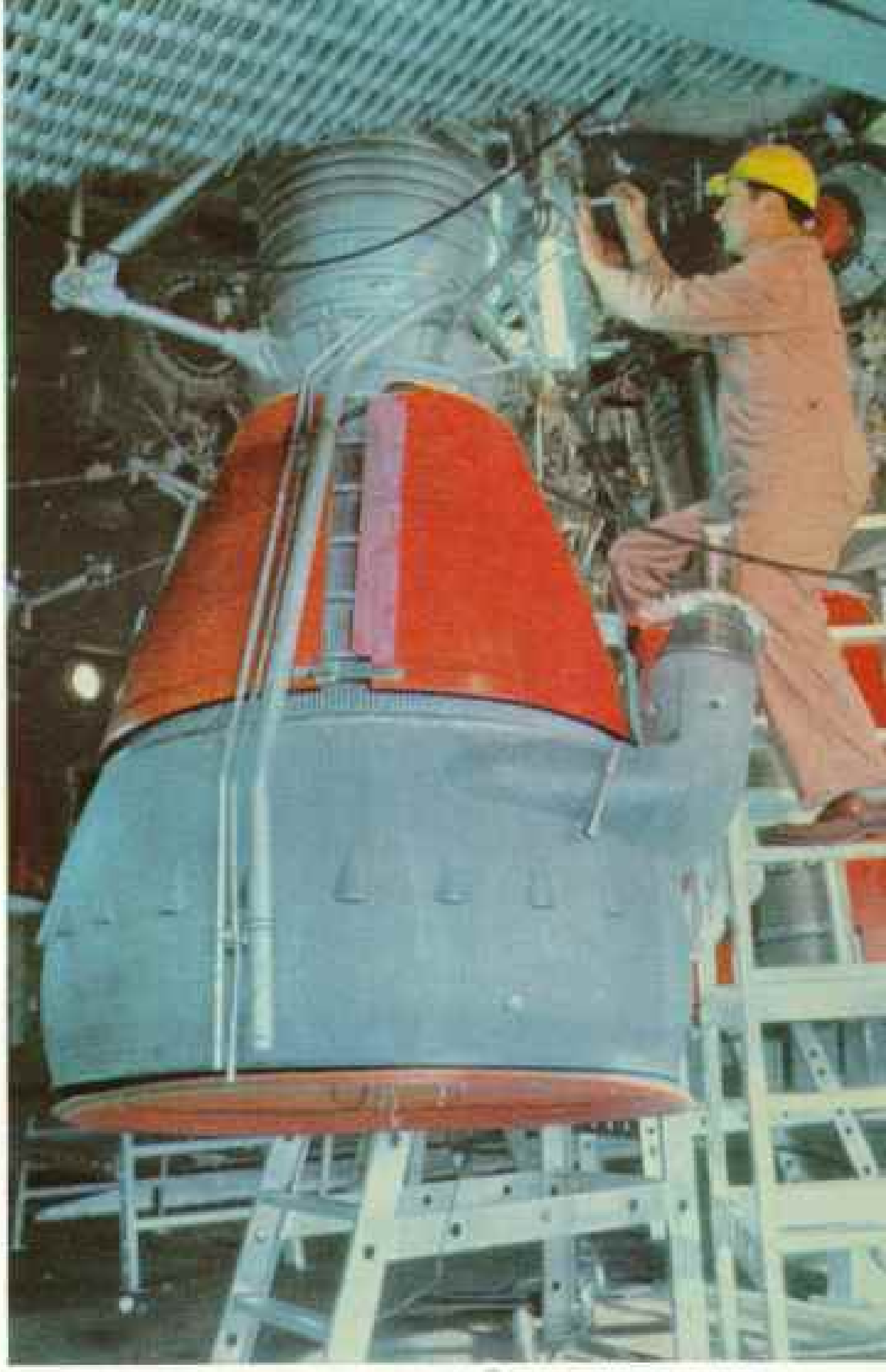
"We request money at a rate consistent with what we believe we can accomplish in a sensible, fast-moving program," he said. "The present budget will give a program that will rapidly increase our capability, and we believe it will put us in a leading position. We should feel greater assurance in meeting our schedules with more money, but I don't think we should make this a crash program

(*Continued on page 73*)

Like a Ponderous Bell, Saturn Rocket Nozzle Hangs From a Test Stand

Eight engines clustered together and firing in unison will give Saturn a thrust of 1,500,000 pounds—more than twice the estimated power of the Soviets' largest known counterpart. A team of former Army scientists, now transferred to NASA, is developing Saturn at the George C. Marshall Space Flight Center, Huntsville, Alabama. The scientists hope to declare their offspring operational in 1964, after flight tests at Cape Canaveral.

Meanwhile, Saturn's engines undergo ground trials at Huntsville. Here a technician adjusts one of the eight nozzles that expel flaming exhaust gas. Red glass-fiber shields protect delicate tubes encircling the nozzle. The tubes carry fuel, which helps cool the nozzle's walls before entering the firing chamber.



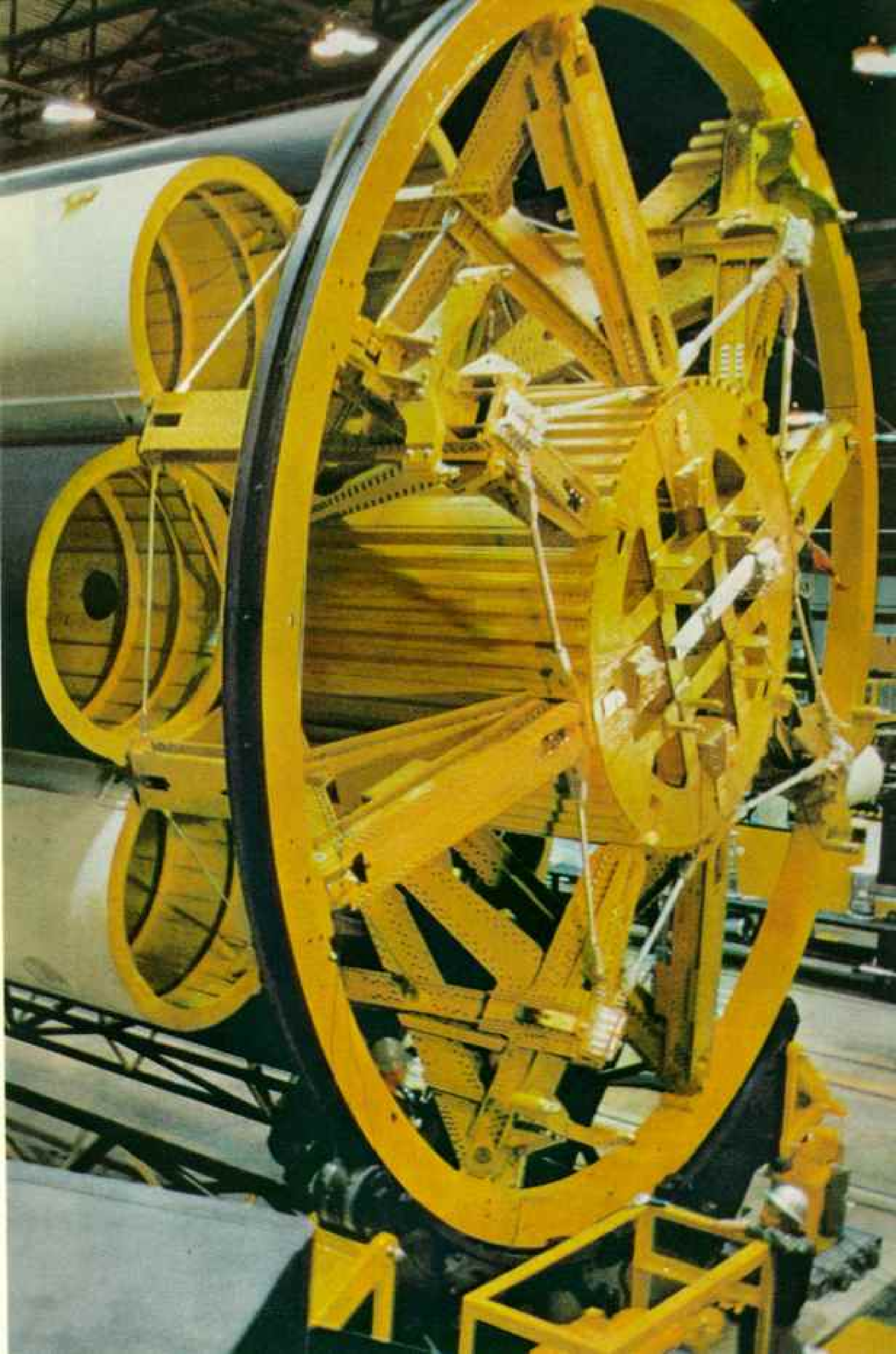
HIGH SPEED EXPOSURE BY DEAN CONGER © NATIONAL GEOGRAPHIC SOCIETY

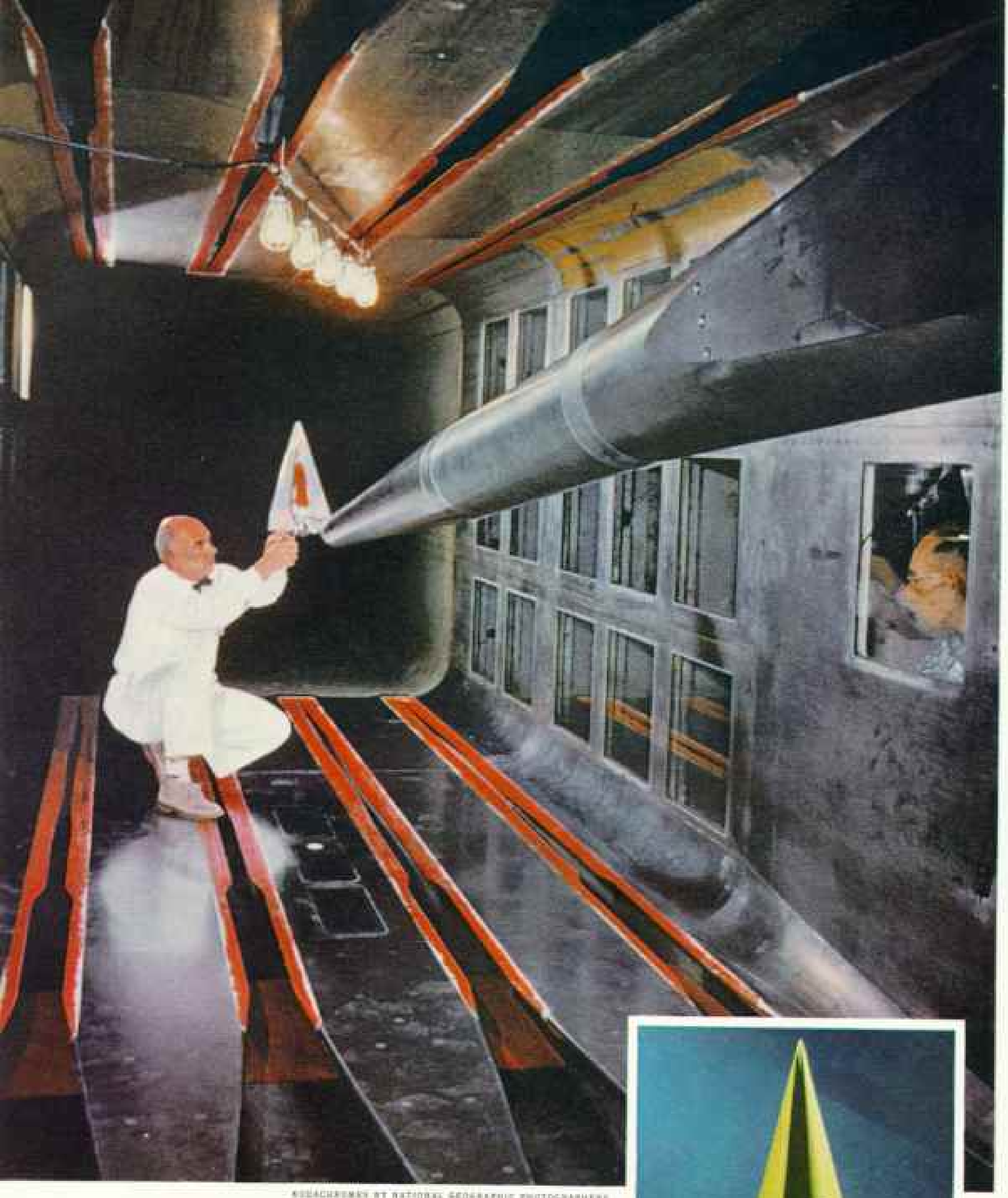
NASA's top rocket experts, Maj. Gen. Don R. Ostrander (left) and Dr. Wernher von Braun, observe work on the Saturn in a Huntsville laboratory. General Ostrander, lent to the space agency by the Air Force, serves as Director of Launch Vehicle Programs and supervises development of rocket boosters.

His famous colleague, Dr. von Braun, the former German rocket scientist, heads the Marshall Space Flight Center. In addition to building Saturn, this center also directs Rocketdyne's development of engines for Nova.

Metal trailer cradles Saturn's monstrous body—tanks for fuel and liquid oxygen—in a Huntsville laboratory. When completed, the rocket will cluster eight such tanks; each 70 inches in diameter, around a 105-inch main tank. Huge wheels rotate the body for ease of assembly. Too large to be trucked or airlifted, Saturn will ride to Canaveral by water. At take-off the giant will weigh more than 1,000,000 pounds. The men give a clue to the scale.

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY





RESEARCHERS AT NATIONAL GEOGRAPHIC PHOTOGRAPHERS BATES LITTLEHALES (ABOVE) AND DEAN CONGER © N.G.S.

Gliders shaped like speedboats represent current design in space ships. Unlike the Mercury capsule, which arcs to earth like a cannon shell, a glider would plane back from orbit and land safely. Cocking its nose high in the air, it would use the "hull" as a wing to gain lift. At just such an angle, technician Joe Pethel mounts a wooden "lifting body" on a long boom at Langley Research Center. Slots in the metal floor of this transonic wind tunnel permit expansion of air in the narrow test section, lessening turbulence. A more streamlined model (inset) copies a boy's paper dart.

with great duplication of effort and waste."

Associate Administrator Richard E. Horner says NASA cannot risk channeling its efforts toward limited objectives, however spectacular, at the expense of diversification.

The Soviets, he pointed out, have concentrated recently upon lunar probes. "But suppose they suddenly changed direction," Horner said, "and put their emphasis on, say, weather satellites. If they concentrated all their efforts in this field, they could make some very spectacular successes and people would say, 'The United States is beaten again.' Our feeling is that we must have a diversified program."

Horner also hit at the "nonsense" written about the race to the moon. He said rocket development for lunar flight is only part of the problem. We must also pin down a multitude of unknowns, such as the risk involved in sending men into radiation from solar flares or through the belts of charged particles trapped high above the earth.

NASA Plans Family of New Rockets

Meanwhile NASA attacks the booster lag on two fronts.

First, it plans to make better use of existing boosters. Their upper stages have been makeshift rockets not specifically designed for mating with Thors and Atlases. So NASA has had to pay a costly penalty in the ratio of take-off weight to payload weight. In the 142-pound *Explorer VI* satellite, the ratio was 740 to 1; with properly tailored upper stages, the ratio would have been about 50 to 1.

Such carefully crafted second and third stages should be available in the immediate future. Assembled in rocket systems named Centaur and Agena, they will match or surpass present Soviet payloads.

Later the program calls for new superboosters that dwarf present Soviet rockets.

One, the Saturn, clusters eight engines yielding a combined thrust of 1.5 million pounds (pages 69 and 70). Dr. Wernher von Braun and his team at Huntsville, Alabama, now transferred from the Army to NASA, are developing Saturn. They will begin testing their offspring's engines this year. When available, perhaps four years hence, the booster could ease a two-ton payload to the moon.

A second behemoth, the Nova, would cluster four new engines, each with a thrust of 1.5 million pounds, or six million total. This booster, not as far along as Saturn, is the only one that could lift enough equipment to land men on the moon and bring them back.

Certain wordsmiths of the press gleefully prod NASA by pointing out that in astronomy a nova is an exploding star. So far the name of the new rocket has not been changed, but various possibilities are being considered.

Big booster development, while replete with headaches, is not the only tough problem facing scientists who plan advanced space flight. Earlier I mentioned unprecedented heat. As an introduction to it, visualize this infernolike scene at the Langley Center:

I am standing at a respectful distance from a huge structure of corrugated metal shaped like a motorboat. Now engineers lower quartz-tube heating lamps over the bizarre hull. Someone throws a switch; lamps blaze like the sun. Though I stand behind a transparent plastic barrier, waves of heat engulf me; light stabs at my eyes despite protective goggles.

For many minutes engineers torture the structure with lamps that reach 4,700° F. Then the savage light fades, and I blissfully breathe cooler air.

That curious motorboat represented a big forward step in space vehicles, the "lifting body," designed to fly back to earth as a glider (opposite). The powerful lamps simulated the heat it would suffer from air friction on return from orbit.

New Metals Needed for Space Ships

In designing such a craft, engineers face more formidable barriers than they encountered in the Mercury capsule. True, the capsule sustains 2,600° F. on its blunt nose, but very briefly. A maneuverable glider would have to withstand as much as 3,000° on some parts of its surface, and the heating period would last 20 minutes.

Here designers run into a materials problem. Nickel alloys, for instance, lose strength as they approach their melting point, about 2,500°. So a feverish search is under way for better heat-resistant metals; graphite and various ceramics also are possibilities.

An ablative substance, as used on the Mercury capsule, could impose too great a weight penalty on a glider. But gases or liquids might be circulated through parts of the glider as coolants. Also, some thermal stress can be avoided by clever structural design. Corrugations in the motorboat, for example, permit an accordionlike movement

Supersonic Wind Blasts Frozen Motor Oil Shaped Like a Missile Nose Cone

When a missile cone slashes into the atmosphere, frictional heat vaporizes the blunt nose in a process called ablation. A fiery shock wave deflects searing temperatures from the cone's sides and protects the payload. To study ablation, scientists at Ames Research Center near Palo Alto, California, devised the "popsicle technique." They freeze dyed oil in molds, then subject the blunt-nosed models to wind tunnel tests. Peering through a glass port, an engineer (left) observes the effects. Gelatinous oil, torn from the model by air traveling three times the speed of sound, streams like molten material from an overheated missile. A cameraman records the action.

Raging air, heated to 3,000° F., envelops a wing section at Langley. Future space ships, gliding to earth, must endure such heat on leading edges of wings. Graphite protects this area at the bottom of the model.

Fluorescent oil, made eerily luminous by ultraviolet light, coats a model wing in a wind tunnel at Ames. Streaks and whorls in the oil trace patterns of air flow, enabling scientists to gauge the effectiveness of the design.

when the increasing heat causes expansion.

Frictional heating becomes a nightmarish problem during return flights from the moon. A lunar vehicle would hurtle into our atmosphere at 25,000 miles an hour—the speed it must kill before landing—compared to 18,000 miles an hour for a glider descending from an earth orbit. This is a difference in velocity of approximately 40 percent. One might assume that the difference in temperature between the two ships also would be 40 percent, but the heat rate is proportional to the square of the speed. Actually a moon ship would have twice as much heat to cope with as would an orbital glider.

NASA frankly says it can't handle this problem of doubled heat rate yet; it can't even duplicate the tremendous speeds and temperatures in wind tunnel experiments.

In the comic strips, space ships beat the heat by gently lowering themselves to earth with reverse-thrust rockets. Try to do it in reality, however, and you must build a ship at least 50 times as big as the proposed gliders in order to carry the necessary fuel for braking.

Moon Trip Requires Precise Guidance

Return from the moon also involves another severe problem, guidance. If the lunarnaut slams into the atmosphere at too steep an angle, he may be crushed by abrupt deceleration in the thickening air, and friction may make a fiery pyre of his ship. If the angle is too slight, his ship will merely graze the atmosphere; insufficiently retarded, it will hurtle past earth and out into space. So scientists have figured he must hit an "entry corridor" 60 miles deep.

But 60 miles is less than one percent of the earth's diameter, a fraction corresponding to the thickness of the skin on an apple. Suppose William Tell had been told, "Shoot the skin off the apple on your son's head—but don't hit the apple." That's the accuracy requirement returning moon voyagers face.

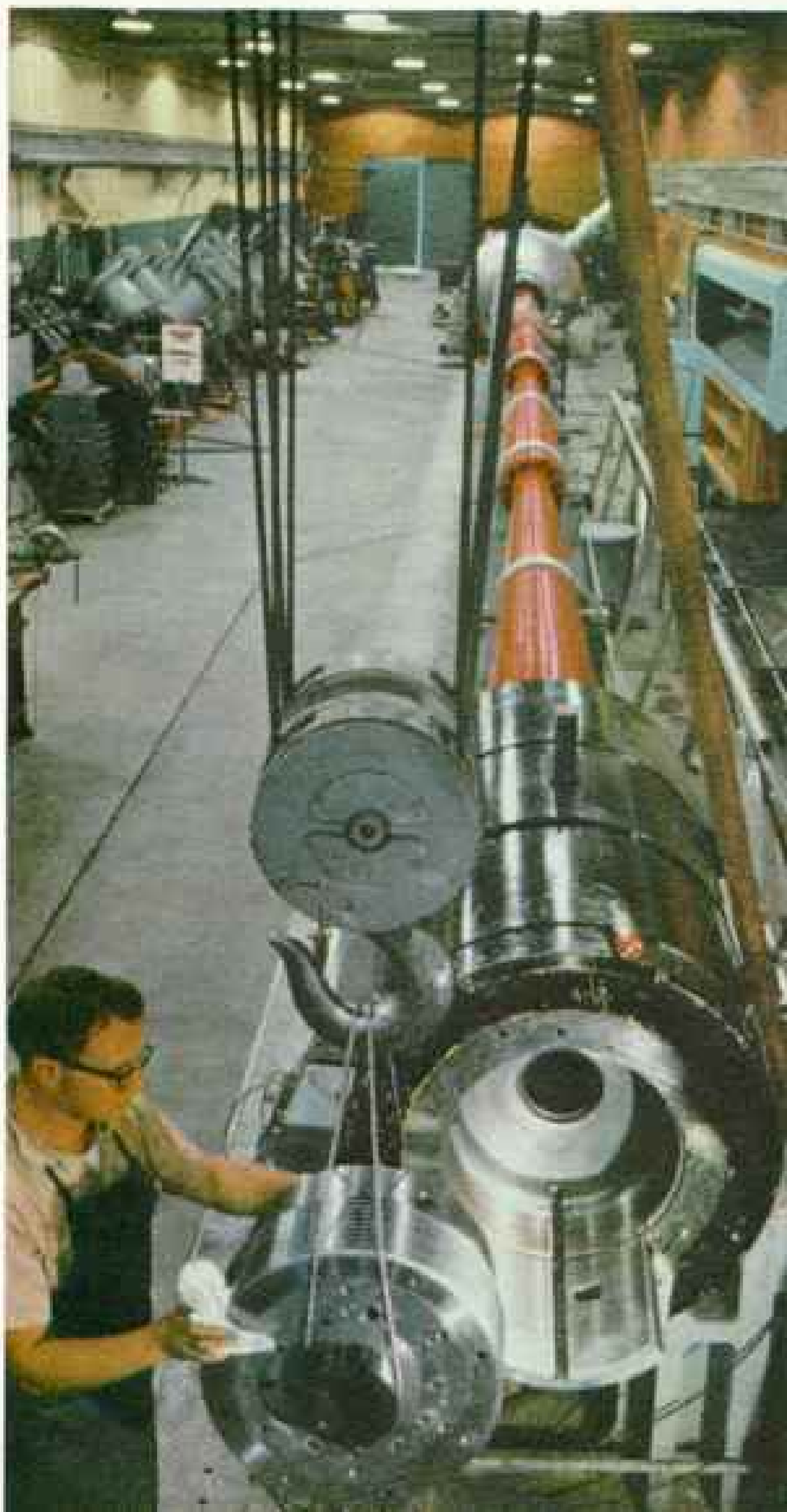
NASA, geared for a long pull, is confident it can solve these problems. The philosophy of its scientists was well expressed by Ira H. Abbott, Director of the Office of Advanced Research Programs.

"A good research man knows enough about the problems to be pessimistic," he told me, "but he is also optimistic enough to think it can be done."

Determined optimism characterizes NASA's attack on still another obstacle, meteor damage to space ships.

Scientists estimate that about 10,000 tons of celestial debris bombard earth's atmosphere each day, and this rubbish races through the solar system at 25,000 to 160,000 miles an hour. Fortunately most of it consists of extremely minute particles; meteors the size of a grain of sand or larger are believed relatively rare. But we can't ignore that sand grain. When traveling in the top range of meteor speed, it packs 100 times the energy of a bullet from a high-powered rifle. And something as big as a lead BB from an air rifle—well, you can compare its potential to the explosion of two sticks of dynamite.

The Mercury capsule runs little risk of being holed like a Swiss cheese. Its thick,



HIGH SPEED EKTACHROME (OPPOSITE) AND KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

Plastic Bullet Streaks From a Gun Like a Fiery Missile Falling to Earth

In their study of ablation, Ames scientists fire tiny plastic nose cones from powerful gas guns into the rarefied air of an altitude chamber. Photographer Conger bolted a camera inside the dark chamber and left the shutter open, obtaining the view above. Hot gas surrounds the gun muzzle (upper left). The cone, speeding 12,000 miles an hour, draws a white-hot track before shattering at the end of the tunnel.

Four six-inch naval guns are linked in tandem in a similar device at Ames. Compressed helium in the barrels propels the "bullet."

Guns also simulate meteor hits on space ships. These metal tubes represent radiator pipes. One at right, filled with water, exploded when struck by a nylon pellet. The other, empty, sustained a neat hole.

double-walled hull is virtually impregnable. But future space ships cannot be built like fortresses, and they will be exposed for long periods. They may require "meteor bumpers."

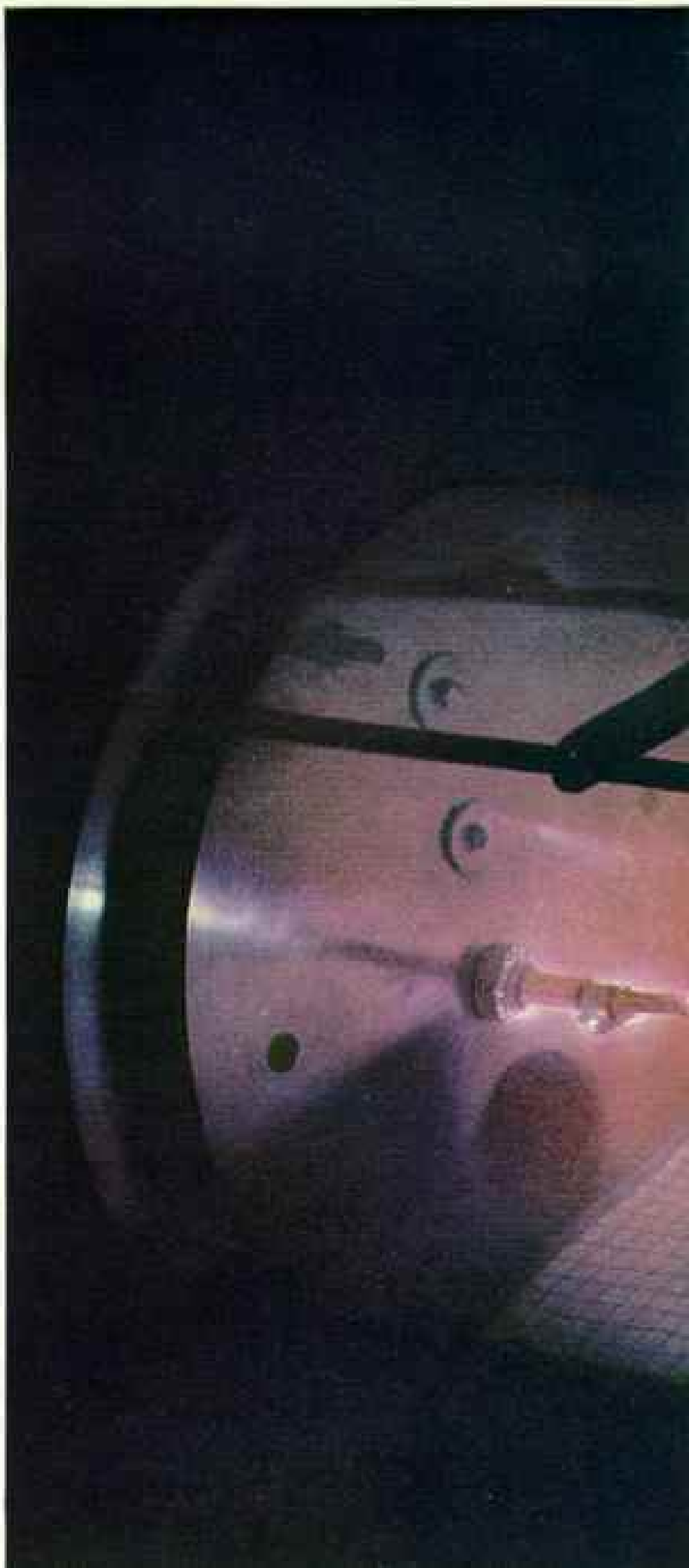
NASA is experimenting with bumper designs at its Ames Research Center near Palo Alto, California. Scientists needed a shooting range, so they built an ingenious one 700 feet long. At its head they linked in tandem the barrels of four six-inch naval guns. A powder blast smashes against a plunger, the plunger compresses gas in the gun barrels, and the gas sends a pellet into a target (page 76).

I saw many luckless targets. Take, for example, a chunk of lead. My fist fitted easily into a hole in its center blasted by a ¼-inch plastic sphere. Or take a block of granite. It bore a crater 2¼ inches wide, gouged by a ¼-inch nylon ball.

Then scientists showed me their experimental bumper, a four-layer sandwich of glass wool packed between thin sheets of aluminum. A quarter-inch nylon pellet had neatly holed three layers, but the fourth had stopped it.

Much remains to be learned about meteors, particularly their densities. But near home, at least, they don't seem too formidable. Our satellites probably have sustained a fine abrasion from impacts, but no one knows of serious damage. This fact cheers scientists planning the galaxy of ingenious new satellites.

These will perform specific services, whereas earlier ones collected environmental data. Weather observation holds boundless promise. Man has based his forecasts on surveillance of a mere fraction of his planet; satellites can scan the entire earth. So NASA envisions a network of perhaps seven meteorological robots in space. They will eye clouds and storms, record temperatures and radiation, and flash their data to receiving stations for relay to a United States Weather Bureau



Fuel of the Future Glows Eerily in a Scientist's Vacuum Bottle

Before man can journey to the planets, he must develop a rocket engine that consumes less fuel than chemical-burning types. NASA scientists hopefully experiment with a technique called "electric propulsion." An engine of this type would spew electrified atomic particles from its exhaust nozzle. The resulting thrust would push a ship through space at tremendous velocities.

Lewis Research Center investigates some of the problems with this luminous device. Scientist George Wise trips a switch that sends 200,000 volts surging into the huge bottle. The powerful current vaporizes a copper wire, whose atoms break down into charged particles. Rodlike parallel electrodes at bottom exert an electromagnetic force on the particles and direct most of them to the rear of the bottle. But many escape the main stream and ricochet from ping-pong balls suspended on strings around the electrodes. By measuring deflection of the balls against the checkered grid, Wise determines how effectively the rods channel the particles.

evaluation center near Washington, D. C.

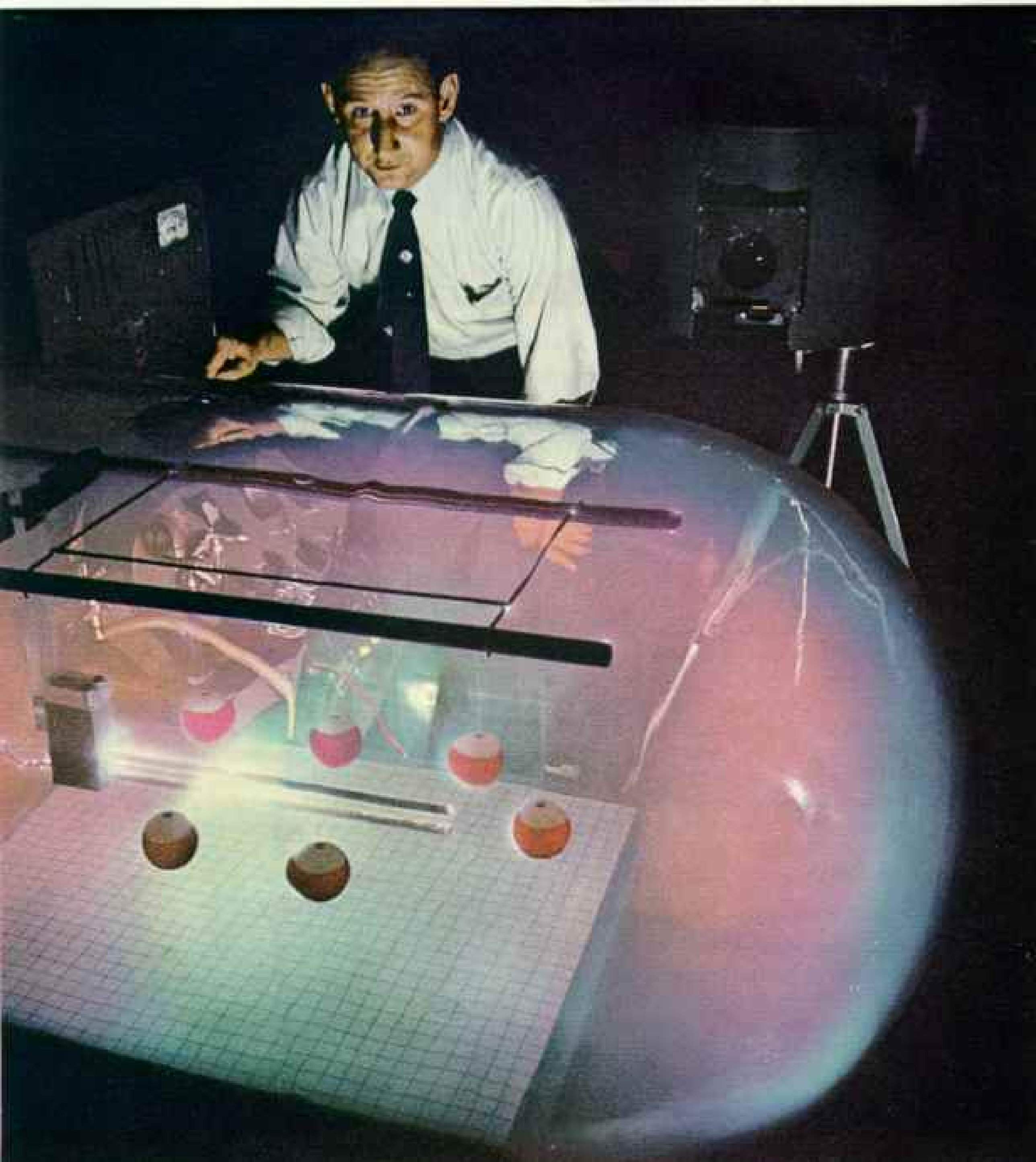
Tiros I, the television-equipped satellite launched last April 1, successfully demonstrated the practicability of weather reconnaissance from space.

Messages Relayed by Glittering Balloons

NASA also envisages 10 to 20 huge spheres of aluminum-coated plastic only one-third the thickness of cigarette paper. They would be fired into orbits 3,000 miles high, where they would inflate to a diameter of 100 feet, and shine as brightly as Venus (pages 82-83). Radio messages beamed at the huge balloons would bounce back to earth over intercontinental distances.

These spheres will comprise a "passive" communications system. But, more distantly, scientists foresee a net of "active" satellites bearing multichannel receivers and transmitters. They will pick up and relay television and radio programs, transoceanic phone calls, teletype messages, even photographs.

In time our satellites will become amazingly



KODACHROME BY DEAN CONGER © NATIONAL GEOGRAPHIC SOCIETY

AQUACHROME © NATIONAL GEOGRAPHIC SOCIETY

Weathervane or Bizarre Javelin? Model Space Ship Suggests Both

Electric engines would drive this curious craft. Workmen might assemble it on an orbiting space platform, using tools and parts ferried up by conventional rockets. Designers plan a nuclear reactor in the red nose to provide power for electric generators in the yellow tank. Rear tanks enclose engines and crew's quarters. Elongated radiator (center) dissipates excess heat from the reactor. Lewis Research Center, which specializes in propulsion, developed the model. A NASA technician holds it aloft.

versatile. One scientist assured me the day is not far off when a businessman in Los Angeles can chat with an associate in Paris by satellite relay—without the delays that sometimes vex him today.

Weather and communications will get the strongest initial emphasis, but satellites hold promise in many areas; for example, as navigational aids (typified by the Navy's *Transit I-B* satellite), as tools for geodetic survey, or as astronomical observatories. These and other possibilities have been explored in previous NATIONAL GEOGRAPHIC articles.*

Energy From Sunlight for Space Stations

It may seem strange, since NASA worries about meteor damage, that we should launch anything so flimsy as a plastic balloon. But these huge spheres are deceptively durable. In the vacuum of space they inflate rapidly. Though punctured, they will not collapse because they have no weight of air upon them.

Langley's Space Vehicle Group thinks lightweight, aluminum-coated plastic looks promising for many applications. It also looks weirdly beautiful when fashioned into shimmering models of futuristic space stations. William J. O'Sullivan, the group's chief, led me to a room filled with such models.

A gleaming 12-foot balloon first caught my eye. It might have been a beach ball awaiting some giant in a playful mood. Next my awed gaze turned to a softly lighted 12-foot antenna shaped like a soup plate. I gawked at it so long that O'Sullivan had to call my attention to his tabletop models: umbrellas of plastic stretched tautly over fragile ribs (page 82).

* See, in the NATIONAL GEOGRAPHIC: "How Man-made Satellites Can Affect Our Lives," by Joseph Kaplan, December, 1957; and "Space Satellites, Tools of Earth Research," by Heinz Haber, April, 1956.

Some of the devices, O'Sullivan said, would gather sunlight and convert its heat into electricity for television and radio transmissions back to earth.

"Fortunately we have up there an excellent source of energy," he commented. "Our studies indicate we can develop power in terms not just of watts, but of kilowatts."

Plastic structures, though appealingly light, obviously would be limited to unmanned vehicles. When scientists consider the design of safe, well-equipped ships for distant expeditions, they find that conventional rocket propulsion won't do the job. The fuel load becomes hopelessly large.

True, boosters and upper-stage rockets now in prospect will enable us to explore the moon.* We shall be able to fire instruments to the moon, easing them down with small retro-rockets, and even send men there and return them. But when astronauts visit Mars and Venus, they must be blasted through the void by some new means of propulsion.

Atom Rocket Holds Boundless Promise

That Jack-of-many-trades, the atom, may provide an answer. A nuclear reaction produces ten million times as much energy per pound of fuel as the best chemical rocket propellants, though only a fraction of this energy can be utilized. For some years the Atomic Energy Commission has been developing a nuclear rocket.† NASA now shares in this task, known as Project Rover.

An atom rocket would use a reactor to heat a light gas such as hydrogen. Expelled, the raging gas would give thrust. Since a reactor's heat output is not dependent upon combustion, there is no need for an oxidizer. As for hydrogen fuel, this type of rocket would consume only a third to a half as much as its chemical counterpart.

Consider what this would mean during a voyage to Mars by two ships, one powered by chemical fuel, the other by nuclear energy. They begin their journey from an earth orbit, and both weigh 150,000 pounds at the start. The chemical rocket reaches Mars and sends back its final rocket stage, as the payload, to earth. But this final stage can weigh only 3,000 pounds, too small for a human passenger. The nuclear system, however, returns a 20,000-pound, man-carrying payload.

Atomic rockets become even more attractive when scientists consider utilizing fusion, the process in which atoms join together rather

* See "Reaching for the Moon," by Allan C. Fisher, Jr., National Geographic, February, 1959.

† See "You and the Obedient Atom," by Allan C. Fisher, Jr., National Geographic, September, 1958.

Cutaway Model Bares the Fuel Tanks of a Promising Experimental Rocket

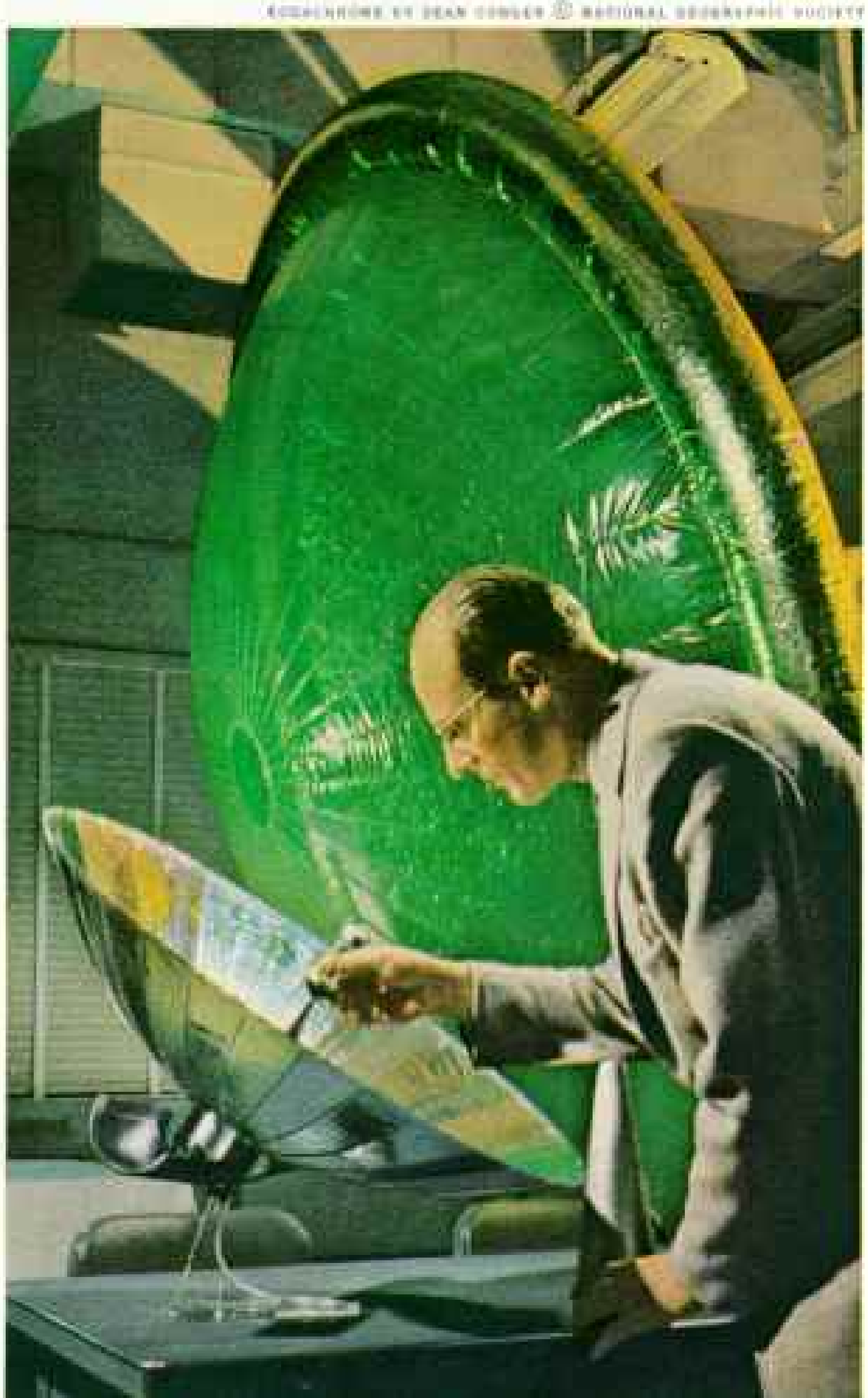
NASA is developing new and more powerful second- and third-stage rockets to mount atop the Atlas, Thor, and other boosters. With improved upper stages, the space agency can launch heavier payloads.

Here scientists examine a model of a proposed upper-stage rocket developed by Jet Propulsion Laboratory, a NASA contractor. Tanks would hold the oxidizer—nitrogen tetroxide—and the fuel—hydrazine. These chemicals, unlike most other liquid propellants, can be stored in rockets for relatively long periods.

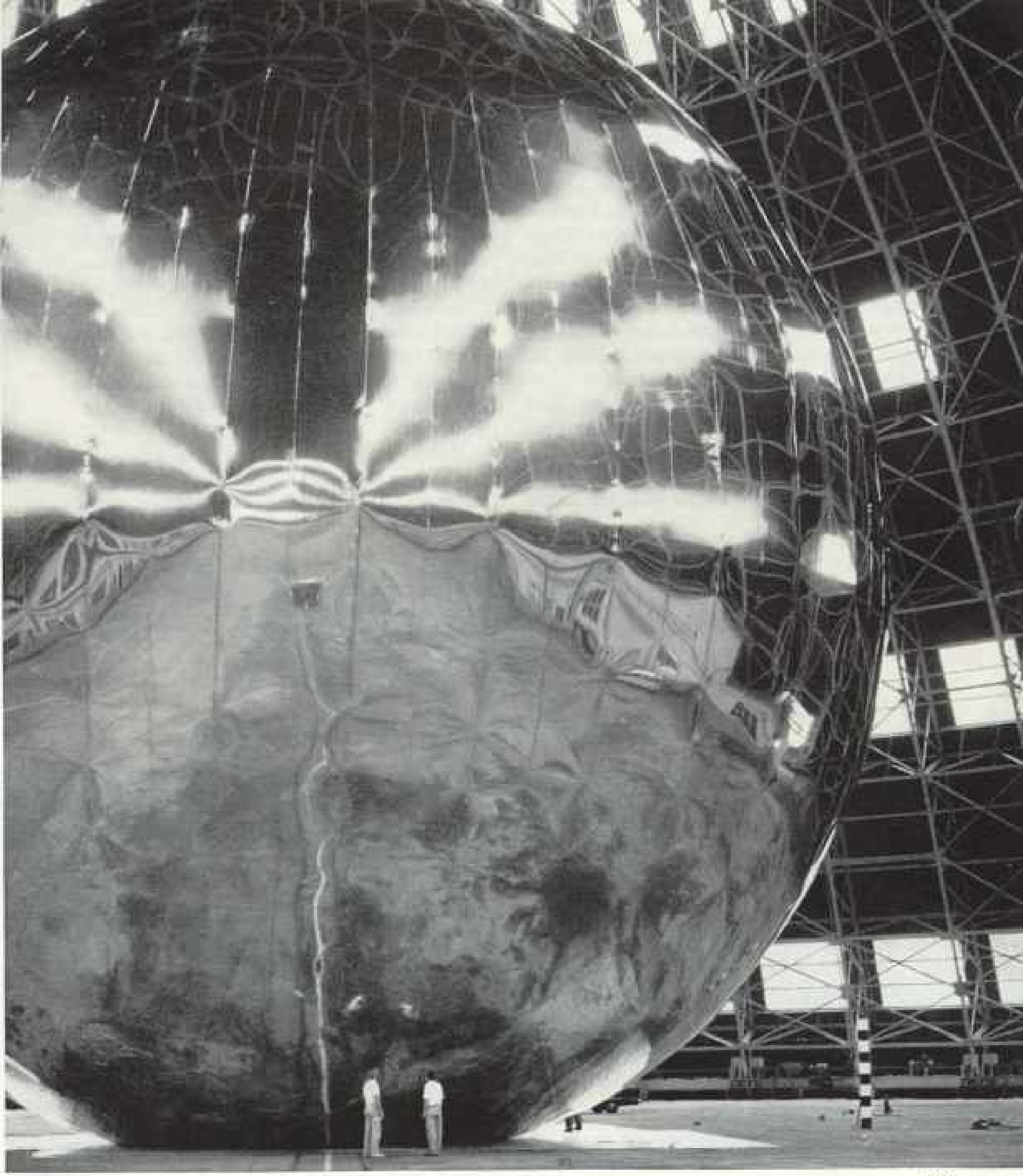
Kodachrome by National Geographic Photographer James Littlehales © N.G.S.

Transparent display sphere encases a satellite made of thin aluminum-coated plastic. Fired into orbit, the satellite pops from a container and expands to a diameter of 100 feet.

Fully inflated, the shimmering satellite towers above workmen in a hangar. NASA hopes to orbit 10 to 20 of the huge balloons; by reflecting radio signals beamed at them, they can relay messages around the globe.



Umbrellalike reflectors of paper-thin plastic may be used as space antennas or solar heating units. Scientist Walter J. O'Sullivan of Langley, who conceived the idea of plastic satellites, examines a model. The reflector would gather sunlight and convert its heat to electricity for broadcasts. Larger model in background is an antenna.



NASA

than split, as in fission. This difficult technique, used in the H-bomb, would yield incredible power. But, as Dr. John Evvard, a Lewis scientist, pointed out:

"Fusion is like a rabbit stew. Before you can enjoy the stew, you have to catch the elusive rabbit—and we're still chasing it."

The fission rabbit, on the other hand, has been captive for years, but it has not yet been harnessed effectively in rockets. Their compact reactors would have to operate at far higher temperatures than the big reactors now used to generate electricity. Here, as in space ship hull construction, we need materials more resistant to heat.

The atom may not be the only key to distant space flight. NASA hopefully experiments with another promising technique that makes Buck Rogers look downright Victorian. Scientists call it electric propulsion.

They long have known that extreme heat will ionize a gas, or strip electrons from its atoms. When a gas is ionized, it is given a special name, plasma. Unlike intact gaseous atoms, a plasma will conduct electricity—and that suggests two intriguing possibilities.

First, scientists can accelerate the entire plasma with a combination of electrical and magnetic forces, then shoot the fast-moving charged particles from a nozzle. They call that method plasma acceleration.

Second, researchers may choose to accelerate only the positively charged ions—atomic nuclei minus one or more electrons. A like, or positive, charge of electricity will repel them violently so that they hurtle from the nozzle. Result: an ion engine. The negatively charged electrons dump into the rocket exhaust.

NASA has tested small experimental engines of both types—but only in laboratories. They cannot run without electricity, and in space this need must be met by small nuclear or solar power plants still under development.

Such engines will never be powerful enough to lift space ships from the surface of the earth. But they require little fuel, and, once in space, they might accelerate a ship to the tremendous velocities needed for interplanetary flight.

Planners see chemical boosters lifting the parts of an electrical rocket into orbit around the earth. After assembly in space, the rocket

Engineers Groom *Pioneer V* for a Historic Journey Toward the Sun

On March 11, 1960, a multistage rocket arched into space from Cape Canaveral and hurled this 94.8-pound satellite into a solar orbit between earth and Venus. Since then, the sphere's instruments have radioed back data on temperatures, meteor impacts, cosmic rays, and radiation across millions of miles. Here a team from Space Technology Laboratories makes a prelaunch check atop a gantry tower. Paddles contain silicon cells that convert sunlight into electricity for *Pioneer V*'s radio transmitters. In flight the paddles fold against the sphere until it enters orbit, then spring open.

HIGH SPEED EXPOSURE BY LUIS MARDEN, NATIONAL GEOGRAPHIC STAFF © N.G.S.

would spiral around the home planet for a time, building up speed, then head for some distant target.

Again let's consider a Mars trip. When they reached a Martian orbit, astronauts would descend to the planet in a little chemically powered "space dinghy." Later they would rendezvous with the mother ship for the return voyage. A round trip might last 550 days.

NASA Supplants Older Agency

Junkets to Mars are the product of recent thinking, but NASA is not the Johnny-come-lately to space planning that one might assume. At its birth on October 1, 1958, NASA absorbed the National Advisory Committee for Aeronautics (NACA), a distinguished research organization. This predecessor, though concentrating on aviation, accomplished much spadework for the transition to space.*

The new agency's inheritance included 8,000 employees, many highly trained, and five installations: Langley, Lewis, and Ames, plus a rocket launching facility at Wallops Island, Virginia, and a flight research center at Edwards Air Force Base, in California.

Born half grown, NASA quickly matured. It took over the Navy's Project Vanguard team and assumed the Army's contract relationship with Jet Propulsion Laboratory near Pasadena, California. Acquisition of Dr. von Braun's group at Huntsville, Alabama, added 5,500 employees to the payroll, and the new agency also took title to Army laboratories there, valued at $100,000,000. President Eisenhower has named this installation the George C. Marshall Space Flight Center in honor of the late General Marshall.

Additionally, NASA is building the Goddard Space Flight Center at Greenbelt, Maryland, a multimillion-dollar laboratory named for the late rocket pioneer, Dr. Robert H. Goddard. With this accretion, says the agency, its rapid growth will be virtually complete.

Employees of the old NACA hold many of the new agency's key jobs, especially in research. They have long had a reputation for legerdemain in solving aircraft problems, but I was impressed at how easily they have adjusted to totally new areas of work.

Lewis Research Center, which specializes in propulsion, built a $13,000,000 materials-testing reactor at Plum Brook, a former Army Ordnance facility near Sandusky, Ohio. Few Lewis scientists knew much about nuclear engineering, but they educated themselves, designed the reactor, and soon will operate it. Their research aims at nuclear rocket problems and power plants for space ships.

At Ames Dr. Max. Heaslet heads a "think group" called the Theoretical Aerodynamics Section. He admits this old name is a misnomer because the thoughts of his men are now out in space. How do solar flares affect the warming of the earth? What do we know —and what must we learn—about planetary atmospheres? These are typical problems.

Heaslet's men, who formerly specialized in air-flow studies, now sacrifice many nights to the study of new disciplines, such as astrophysics. "You leaf and you browse," said Heaslet. "When one of the boys comes up with an idea, we submit it to the abrasive action of the group."

Robert T. Jones, a member of the group, suggested the swept-back wing for supersonic flight in 1945—unaware that a German had hit upon the idea at about the same time. Today the distinguished Jones gives little thought to airplanes. A mathematically inclined engineer, he obligingly lectured me for half an hour on an application of Einstein's relativity theory to space travel.

Switch From Missiles to Meteors

Another long-time Ames aerodynamic expert, H. Julian Allen, won fame as the brain behind the blunt-nosed missile shape. In earlier experiments warheads with needle noses burned up in the atmosphere. Streamlining had worked well in high-speed aircraft, since it lessened air resistance. But good aerodynamic shapes trap heat along their sleek sides; warheads, traveling far faster than aircraft, cannot withstand the savage temperatures.

"Half the heat generated by friction was going into the missiles," Allen told me. "I reasoned we had to deflect that heat into the air and let it dissipate. Therefore streamlined shapes were the worst possible; they had to be blunt." Allen's brain child works so successfully that the strong shock waves from today's nose cones carry off 99 percent of the frictional heat.

Not illogically, Allen seeks new clues to entry riddles by studying meteors. Reading up on the subject, he found that people who happened to be near falling meteors often

* See "Fact Finding for Tomorrow's Planes," by Dr. Hugh L. Dryden, Director of NACA, National Geographic, December, 1953.

reported a hissing noise. It was reasoned that the noise might be radio frequencies that were changed and made audible by contact with near-by objects, such as rocks or buildings. Sure enough, Allen's delicate instruments picked up radio frequencies in the wake of man-made meteors—the high-speed pellets fired by gas guns.

Now Allen plans a number of small receivers to record the voices of "falling stars." With this information he can compute the course and speed of meteors and deduce their heating rate—all aids in the continuing study of ablation.

Designers Seek New Aircraft

But space is not NASA's sole concern. It continues the aircraft research of its predecessor. Currently the agency works with the military on a family of strange machines, VTOL (Vertical Take-off and Landing) and STOL (Short Take-off and Landing) aircraft. Some look like freaks because they tilt their engines, or even entire wings, upward to give increased lift when rising (opposite).

Often no dividing line can be drawn between space research and research in supersonic aircraft. The fields tend to merge.

NASA, working on the design concepts of a 2,000-mile-an-hour jet transport, runs into a heat-resistant materials problem, just as it does in designing space ships. An aluminum airplane would succumb to a metal deformation known as "creep." Steel or titanium must be used—and the aircraft industry has little experience with these materials.

At Langley Dr. Richard T. Whitcomb has evolved several promising models for supersonic transports (opposite). Whitcomb brings to the job excellent credentials: he fathered the "area rule," a complex formula for reducing drag on aircraft. Applied to the Convair F-102, for example, it resulted in the "Coke Bottle"—a fuselage pinched near the middle.

Unlike a military plane, a supersonic airliner must be economical to operate. This is the big problem, but Whitcomb believes one can be designed that would offer "great savings to the airlines, which might be passed along to the traveling public."

That strangest of aircraft, the rocket-powered X-15, best illustrates the twilight zone between space and aeronautical research. Within the next year or so it will carry a man 50 miles high at more than 4,000 miles an hour. Never before has a piloted aircraft approached this altitude and speed.

Thin stubby wings will find no air as the X-15 noses over at the top of its trajectory. Then, as in the Mercury capsule, the pilot must control his craft's attitude with small jets fueled by hydrogen peroxide or suffer an erratic tumbling. Knifing back into resistant air, the X-15's nickel-alloy fuselage must keep its strength under a 1,200° F. onslaught.

The "missile-with-a-man-in-it" already has made headlines with flights above Edwards Flight Research Center (page 88). These have been warmups, proving trials by its maker, North American Aviation, Inc. For the big show, the X-15 has been taken over by NASA, Air Force, and Navy pilots, representing the program's joint managers.

The X-15 typifies our search for something that will *fly* back from space. The next step probably is Dyna-Soar, a still-secret Air Force-NASA glider to be boosted to near-orbital speed for a long flight back to earth.

North American, with attrition of machines in mind, built three X-15's. I timed my Edwards visit to coincide with a flight—and, lucklessly, found the temperamental trio sulking in their hangar, indisposed.

So I sought out an old acquaintance, Joseph A. Walker, principal NASA pilot for the X-15. At that time Joe hadn't flown the new bird, but he had spent endless hours in preparation for the task, working out on flight simulators and riding centrifuges.

I wondered how successfully those small jets, the ballistic controls for stabilization in airless space, would work. Scott Crossfield, North American's X-15 pilot, has experimented with them at moderate altitudes, but they still haven't been "wrung out," as the test pilots say.

"I don't think they'll do the job on the X-15 as easily as they do on a simulator," Walker said. "There is a mechanical lag in controlling the attitude."

NASA Develops Improved Controls

He hastened to add that the lag wasn't serious, but he pointed out that NASA already has something better in the works. Joe then showed me a Lockheed F-104 fighter rigged with small experimental control jets in its nose and wings. Walker, who has flown this Starfighter many times, told me the jets worked by electronic control, rather than mechanical linkage, and seemed more responsive.

Looking beyond the X-15 to Dyna-Soar, NASA's staff of 375 at Edwards envisions a system that would integrate reaction jets and aerodynamic controls in one "stick." The X-15 has two control systems, one conven-

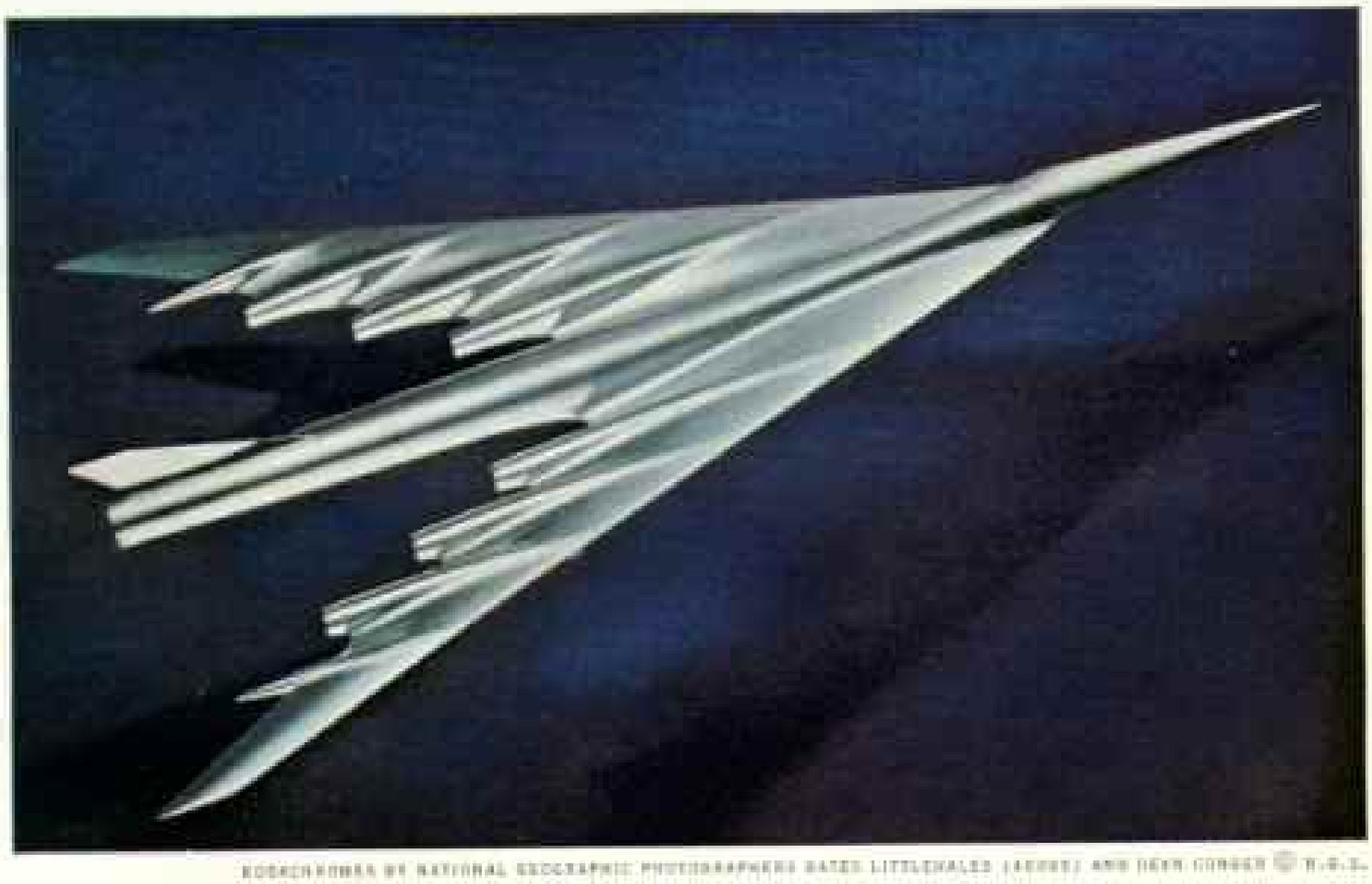
Tilting Wing Achieves Vertical Flight

Though its prime goal is the conquest of space, NASA also channels talent and money into aircraft research. The agency experiments with many odd-looking designs called VTOL (Vertical Take-off and Landing) and STOL (Short Take-off and Landing) aircraft.

This "convertiplane" tilts the wing to give increased lift. With wing and engines pointing straight up, as shown, it can land and take off vertically. When the angle of tilt is lessened, the plane requires only a short runway. Once safely aloft, the experimental craft turns the wing to a horizontal position for normal flight.

A technician installs the model in a wind tunnel at Langley. Electricity powers the propellers. In full scale the plane would use turboprop engines.

Some day you may ride a 2,000-mile-an-hour jetliner shaped like this swept-wing model at Langley.



Mother Plane Cradles Rocket-powered X-15 High Above California's Rugged Hills

Needle-nosed research craft, slung beneath the wing of a Boeing B-52, gets a lift into the stratosphere before dropping away for a test flight.

tional, the other operated by a lever called a sidearm controller.

I told Walker that several of the astronauts thought his test job more "hairy," or venturesome, than theirs, and I was amused at his response, born of a veteran pilot's fondness for wings, however stubby.

"Well, it's good to have those familiar old aerodynamic controls," he grinned. "We're not walking over the edge of a cliff, so to speak, with something new. We may be walking out to the end of a limb, but there is something else to step onto; let's say there's a nice big rock out there."

NASA, Air Force, and Navy experiment with the plane at Edwards Flight Research Center. Designers expect the X-15 to achieve 4,000 miles an hour and an altitude of at least 50 miles. Rushing air flexes the B-52's wing tip (upper). Pilots of two chase planes (lower) observe the flight.

Outside the hangar, gazing into a vivid sky etched with the contrails of high-flying jets, I found it easy to imagine NASA's future rocket planes high overhead, pushing across the doorsill of space, probing a frontier that has beginning but no end.

Then, as if it had been an admonition intended for our time, I recalled something Wilbur Wright said many years ago. His comment concerned the future of aviation, but it is equally applicable to the assault on space: "It is not necessary to look too far into the future; we see enough already to be certain that it will be magnificent."

Moraine Lake in Alberta's Valley of the Ten Peaks mirrors the Canadian Rockies;

Calgary Stampede!

Alberta Unearths

HATLESS and feeling out of place in my city clothes, I squeezed my way through the Wild West mob.

Virtually everyone else sported a ten-gallon hat. Most had on cowboy shirts, some wore boots and spurs and tight-cut Levi's. Cowboys under eight had six-guns on their hips, but their revolvers stayed holstered in awe before the real cowhands, tall and tough as lodge-pole pines.

Edmonton, Alberta's capital, blazes at night ▶

a hiker enjoys Alberta's matchless scenery

Oilmen plug a well at Rumsey

Her Buried Treasures

By DAVID S. BOYER

This was Calgary, a Canadian city which each July goes western with abandon in a six-day celebration.

For me it was the first step in a trip over the length and breadth of Canada's Texas-sized Province of Alberta, a land that looks and behaves like the western U. S. — only more so. It is a land of magnificent mountain scenery, of fabulous oil and gas deposits, giant cattle ranches, wheat farms, and burgeoning new industries. And of bucking broncos, and men who can ride them.

Eighth Avenue, Calgary's main street, was cordoned off for action. Cowboy quartets raked banjos and whined out ballads of the western range. Some of their cowboy mates huddled over smoking chuck wagon stoves, serving up flapjacks and bacon into the out-

CANADA'S PRINCESS PROVINCE

RICH IN FARMS, FORESTS, PARKS, OIL, GAS, AND BEAUTY

BRITISH COLUMBIA

SASKATCHEWAN

ALBERTA

PEACE RIVER DISTRICT

Peace River

Dawson Creek

McLennan

Beaverlodge

Grande Prairie

Valleyview

Peace River

Peerless Lake

Utikuma Lake

Lesser Slave Lake

Cadron Creek

McMurray

Athabasca Oil Sands

Athabasca River

Athabasca

Lac La Biche

Cold Lake

Fort Assiniboine

Barrhead

Athabasca River

Wildhay R.

St. Paul

Port Saskatchewan

ELK ISLAND NATIONAL PARK

Edmonton

Vegreville

Lloydminster

Hinton

Edson

Saskatchewan R.

Leduc

Pembina Oil Field

Lusear

Jasper

JASPER NATIONAL PARK

Wetaskiwin

Camrose

Wainwright

Ponoka

WELLS GRAY PROVINCIAL PARK

Maligne Lake

Sylvan Lake

Lacombe

Stettler

Oil pipeline to eastern Canada

Athabasca Glacier

Mt. Athabasca 11452

Columbia Icefield

Red Deer

Penhold

Bowden

Innisfail

Olds

Rumsey

Dinosaur Trail

Hanna

Munson

Drumheller

Nacmine

East Coulee

Oil pipeline to Vancouver and Puget Sound

HAMBER PROVINCIAL PARK

Columbia River

BANFF NATIONAL PARK

Lake Louise

Benjamin Creek

Mt. Victoria 11365

Mt. Eisenhower 9350

Banff

Bowness

Calgary

Mount Revelstoke National Park

Glacier Nat. Park

Revelstoke

Kootenay National Park

Mt. Assiniboine Provincial Park

Trans-Canada Highway

Bow River

Red Deer River

Turner Valley

High River

Brooks

Gas pipeline to Montreal

Nanton

Parkland

Redcliff

Medicine Hat

Claresholm

Oldman River

Fort Macleod

Coutts

Taber

Coleman

Blairmore

Couldale

Lethbridge

Cypress Hills Provincial Park

Pincher Creek

Sulphur Plant

Raymond

Cardston

McIntyre Ranch

Waterton Lakes National Park

Waterton-Glacier International Peace Park

Glacier National Park

Shelby

Kalispell

Alberta, Canada

Montana U.S.A.

Parks, Lakes, and Oil Fields Jewel a Prairie Princess

In regal style, Texas-sized Alberta lords it over her sister prairie provinces of Saskatchewan and Manitoba in both area and population.

Queen Victoria's daughter, the Princess Louise Caroline Alberta, gave her name to the province. Nature lures both tourists and capital: Scenery and winter sports attract thousands to the extensive national parklands; fertile plains produce a superabundance of grain. Oil, natural gas, and new industries are exploding wilderness crossroads into cities.

He's off at the first buck! A rider at Calgary's famed Stampede hits the dirt. Now it's up to the clown dodging in and out of his barrel to distract the bull. The job calls for courage, quick wits, and—of course—a barrel made of padded steel.

HIGH SPEED EKTACHROME © NATIONAL GEOGRAPHIC SOCIETY

stretched hands of tourists from a dozen countries.

Frontier carts behind teams of buffalo lumbered through the crowds. Feathered Indian bucks, stone-faced squaws, and copper-cheeked papooses in buckskins rode docile pintos nose-to-tail down a gantlet of cameras. In little clearings in the forest of white Stetsons, square dancers swung to and fro.

Yet all Eighth Avenue's activity could not compare with what was going on down at the Stampede grounds. Bucking horse riders from all over the western United States and Canada were battling some of the meanest cayuses in captivity. Junior cowpunchers, some freckled and scarcely nine years old, were tumbling on their heads over the horns of wild steers.

Calf roping, steer decorating, wild cow milking, wild horse saddling, Brahman bull riding—all the western rodeo events were there. And so were half a million cash customers, for the "greatest outdoor show on earth."

In the good old days of the Calgary Stampede, thirty-odd years ago, they raced real range chuck wagons, with spavined old range horses in harness.

Today's wagons, though they look as creaky as ever, have been streamlined, and the horses are racing thoroughbreds, matched for one of the biggest purses and most coveted trophies in Canada.

If there has been, since the era of Roman chariots in the Circus Maximus, a race with more frenzy, more daring, and more fear suspended in the throats of spectators, it must have been a shattering thing to witness.

Chuck Wagons Race for Royalty

As Queen of Canada, Elizabeth II flew to Calgary last July to watch the chuck wagon races. There was no doubt that this British Queen, who has seen the spectacular horse races of the world, was on the edge of her chair. I saw her wince as four horses spun themselves and wagon into a circular collision on the twisting breakaway before her pavilion.

The tangle dissolved without casualties, and you could hear all Calgary sigh. Calgarians wanted to spare their Queen the collisions

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David S. Boyer, of the NATIONAL GEOGRAPHIC's Foreign Editorial Staff, covers Alberta in the dual role of writer-photographer.

Members will recall Mr. Boyer's recent articles: "British Columbia: Life Begins at 100," in the issue for August, 1958, "Geographical Twins a World Apart," December, 1958, and "Portugal's Gem of the Ocean: Madeira," March, 1959.

of the previous night, when five of eight races ended in injury to contestants.

Well, the Stampede was a sample of what Alberta was made of. To be sure, it was only a show. But it gave me an insight into the brand of men and action I would encounter in lacing the province's highways, roads, and trails.

For a week Calgary had been splitting at the seams. Hotels and motels had standing room only. Now, abruptly, on Saturday night, peace descended. Within hours the tourists had packed their bags, folded their tents, and wearily slipped away.

Maybe I should have gone with them. On Sunday morning the city streets were as deserted as a campaign headquarters after election.

During the next few days, however, I met the real Calgary, the quietly booming metropolis of the cattle companies, the oil companies, the grain dealers—the basic industries that make Alberta one of Canada's richest areas in dollars per censused soul. I wandered through the city's elegant department stores, its celebrated zoo and dinosaur park, its pride-embossed Jubilee Auditorium (page 109); and I met some of its families.

Like Edmonton, Alberta's capital city to the north, Calgary has reason to be confident. These two cities, twin hubs of Alberta's empire, are the fastest growing metropolitan areas in Canada. In 10 years they have more than doubled to a combined population of half a million, about evenly divided. And Al-

Chuck wagons careen in this thundering version of a Roman chariot race. Four to a heat, ranch-style wagons at the Calgary Stampede dash between barrels in a figure eight, then circle a half-mile track.

Some fail to make it (right), and injuries are frequent, but the winner takes home prestige and cash.

Four outriders accompany each wagon through the course. Unlike the Romans, Calgarians permit no whips.

HIGH SPEED EXTACHROMES © NATIONAL GEOGRAPHIC SOCIETY

berta, riding a wave of phenomenal expansion and prosperity, has every economic reason to expect even more dramatic development in the future.

What lies behind this surging growth? To find out, I traveled first through the hinterland, where lie the wealth and wonders that create cities.

I could hope for only a glimpse of Alberta's vast, undeveloped north country; few Albertans themselves ever see this wild muskeg land. Yet much of it is arable, much of it rich in untapped oil, a land for the future. In the southern part of Alberta there is enough for today.

From Calgary, then, I drove first to the Canadian Rockies, which stretched jagged across the western horizon like a blue etching on the sunset. My destination was Banff, the neat and modest tourist capital of Banff National Park (page 98), where deer and bears frequent the roads.*

Park rangers export bears only when they prove to be incorrigible nuisances.

One old story about Banff tells of a Canadian Mountie's pet bear that habitually slipped his collar to prowl the town.

*See "On the Ridgepole of the Rockies," by Walter Meayer= Edwards, NATIONAL GEOGRAPHIC, June, 1947.

Snowmobiles thread crevasses on a sightseer's climb up Athabasca Glacier. Skis replace front wheels; endless treads provide traction.

This frozen river is a tongue of the Columbia Icefield, a 100-square-mile remnant of the last Ice Age straddling the Continental Divide. Snow streaks Mount Andromeda's sheer wall in the background.

One night, padding past the sleeping room clerk of a hotel, bruin stared through a doorway at a guest reading in bed. As the petrified lodger crawled out of bed on one side, the bear slipped in on the other.

Bolting to the lobby in pajamas, the guest shouted: "There's a bear in my bed!"

"Just a tame bear," the waking clerk replied wearily. "Comes in often."

I could almost believe it. Clerk John Fischer at the Timberline told me bears had visited his hotel dining room three times that summer —and the season was still young.

Bears Go to College in Banff

"One bear borrowed two sugar bowls off the tables, without disturbing the place settings," John said. "Another smashed our candy case and ate all the chocolate. When this sort of thing happens, the rangers trap them and carry them off into the hinterland. But they usually come back. We know them and they know us. They'll drink a Coke out of your hand. There's a $500 fine for feeding bears, but it doesn't say anything about giving them a drink."

Bears even go to college in Banff, Senator Donald Cameron, director of the University of Alberta's Extension Division, told me with a smile.

"You should have seen the expression on the face of a rather staid Toronto professor when a bear wandered into his lecture here one day."

Senator Cameron, I learned, is the man responsible for building, from a start of tents and log cabins 27 years ago, one of the most respected and glamorous summer schools in the world, the Banff School of Fine Arts (page 108).

As we chatted, my eyes kept wandering to the window behind the senator, which framed a dramatic Rocky Mountain landscape.

"Don't you have trouble getting people to study in this beautiful place?" I asked.

"On the contrary. Most of our seven hundred students try to do too much. They register for too many courses and work too hard. With all the arts here together, the inspiration is tremendous."

"Imagine getting paid to work up here!"

That was the exclamation I heard next morning as students Trudy Kohlberger of Toronto and Norm Hamilton of Edmonton and I tied our horses near the timberline high up in the Rockies. We looked down on the glacial green teardrop that is Lake Louise, insignificantly puddled beneath the glaciers and storm-chiseled peaks that form a bastion about Mount Victoria (page 118).

Trudy and Norm were students who chose, not summer school, but jobs in the Chateau Lake Louise to pay wintertime tuition at home. Trudy worked as a waitress; Norm, a medical student, was here for his fourth summer as a bellboy.

My horse, Clarence, snorted and grumbled about the rain and hail and snow that started as we hunched our way up rockslides and glacial snow to the Plain of Six Glaciers Teahouse. We were soaked and cold, but the storm, writhing down from the Olympian heights of Victoria, was beautiful in its very bitterness, and I knew I would remember Lake Louise with more affection than the hotel guests who saw it only over teacups from their balconies.

"Some of them start out to climb up here," Trudy said. "But mostly they turn back. They leave the mountaintops pretty much in the hands of us employees."

Teahouse managers Patricia Denholm and Betty Jane Mills strung our wet clothing to dry before a log fire at the teahouse and started our chilled blood racing with glasses of hot, spiced *Glühwein*. It was like reaching the hospitality of the monks of the Great St. Bernard Hospice in the Swiss Alps. And, in fact, Pat and "B. J." lived like monks on their mountain, without radio or telephone.

"But we always have the kids from the chateau dropping in," Pat said. "For breakfast, midnight steak fries, any time. They go hiking and climbing whenever their day off starts, whether by daylight or moonlight."

Scientists Probe a Glacier's Heart

Nursing a few poignant recollections of my junket with Clarence, I was happy enough a day or two later to be climbing another glacier on foot. This time I went to interview a party of physicists-turned-glaciologists, professors from the universities of Alberta and British Columbia who had found a good excuse to "get out into the field and pitch a tent."

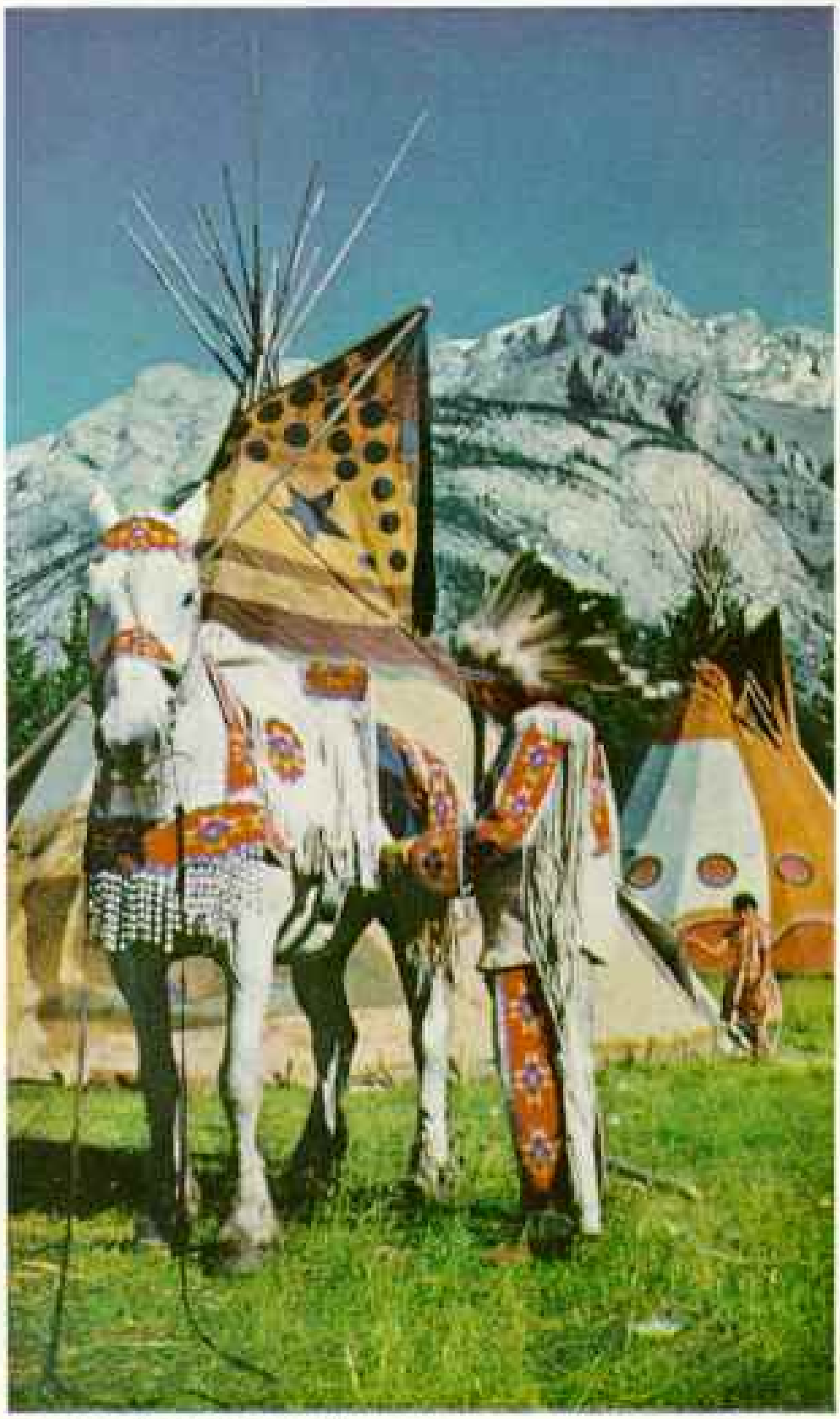
They were making, for the Canadian National Research Council, a two-year study of the mechanics of flow of the Athabasca Glacier. This tongue of the Columbia Icefield melts into the Arctic Ocean by way of the Athabasca River; other tongues send their waters to the Pacific via the Columbia and to Hudson Bay through the Saskatchewan River.

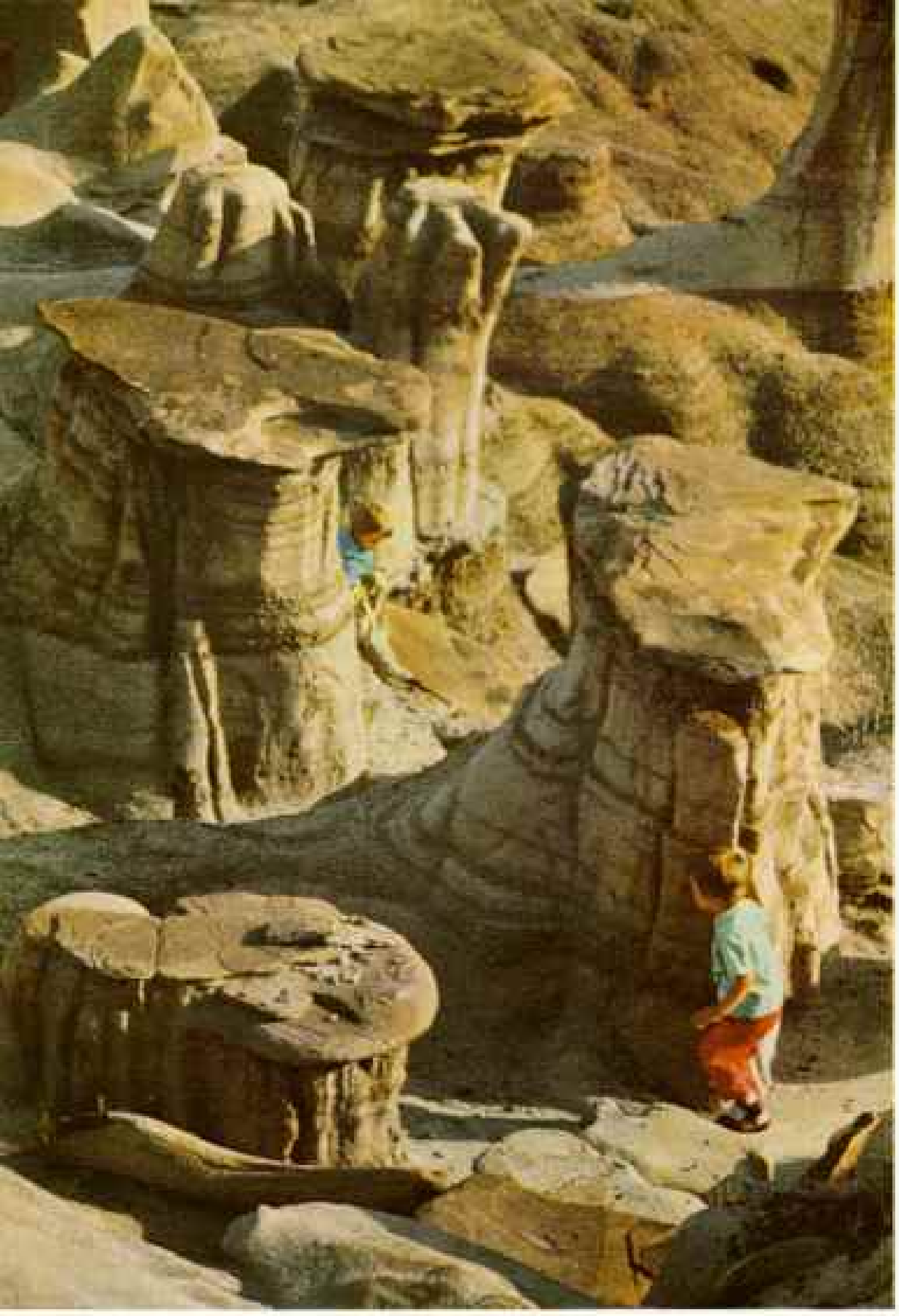
(Continued on page 101)

Banff's Fairy-tale Chateau Nestles in a Glacial Landscape

Thrusting its towers upward beneath the massive bulk of 5,550-foot Tunnel Mountain, the Banff Springs Hotel offers luxury in the wilderness to thousands of visitors in Banff National Park. Tourists call the hotel's vista across the Bow River valley toward Lake Minnewanka "the million-dollar view." Sulphur baths comfort tired hikers. An aerial tramway scales a 7,495-foot slope of Sulphur Mountain, where this photograph was taken.

Beadwork brightens horse and rider at the annual Indian Days celebration at Banff. Stony Indians from the near-by reserve at Morley set up decorated tepees on their old-time meeting ground at the foot of Cascade Mountain. Rated among Alberta's finest horsemen, they make the four-day celebration a July highlight of the tourist season with races, rodeo events, ceremonial dances, and singing.





Small Explorers Dare a Goblin to Pop Out

Pillars of eroded clay in the badlands of the Red Deer River valley near East Coulee make an eerie playground for young Albertans. The rains and floods of eons carved the formations, called "hoodoos" from their strange appearance.

Ancient seas once covered this area, but they vanished 60 million years ago when the upthrust of the Rockies split the earth's crust. Today the badlands slice through the heart of some of Alberta's finest wheatland.

"It's a dinosaur's tooth," William R. Fulton tells his grandniece. This Drumbeller resident has spent 50 of his 80 years hunting fossils. The Red Deer River valley near his home holds a fabulously rich fossil trove; many museums exhibit its dinosaur relics.

The ammonites on the table, shaped like a ram's horn, are primitive mollusks that lived about 100 million years ago.

The party's camp looked like some I had visited in the Antarctic; it was pitched on the glacier ice. Dark tents provided insulation against the heat of the sun; as the rest of the glacier slowly melted, little ice platforms grew up beneath them.

"Probably the first time you've had to step up into a tent," said geophysics graduate student John S. Stacey, born in England. "Come in and have a spot of lunch."

Henri Vetter of the University of Alberta and Stan Paterson of UBC joined us for a quick meal of ham-and-egg pie. Forks paused in mid-air as an avalanche of glacial ice thundered down off Mount Andromeda behind us.

"Quite frightening at night," commented Stacey. "Takes a bit of getting used to."

Fast cups of coffee, and the geophysicists were off again across the ice to continue drilling a hole through the glacier with an electrically charged copper "hot point."

How to Handle Grizzlies—Usually

Rows of flags, surveyed at intervals, are an easy way to measure the movement of a glacier's surface, but the rate of flow down deep is a complicated problem. These new glaciologists were planning to lower an inclinometer into the piped hole. The device would measure tilt of the pipe at several points between the surface and bottom of the glacier. These measurements were to be repeated the next summer to reveal how much the hole had bent under pressure of moving ice. Results would shed light on the glacier's inner activity.

The Athabasca is known to thousands of tourists. During the summer season, a parade of snowmobiles carries visitors onto the glacier (page 96). I hitched a ride on one of them, heading back down the glacier's steep snout. Several little old ladies peered apprehensively past the driver's head down the frightening incline.

"Don't be nervous," the driver said. "I'm nervous enough for all of us. Just do as I do: close your eyes."

Bill Ruddy of Jasper, who operates the snowmobiles, advised me not to leave the Rockies without seeing Maligne Lake; and for the purpose he put me in the hands of his father-in-law, Jack Hargreaves, who has spent a lifetime guiding hunters in the mountains.

"We may see some grizzlies on the rockslides up here," Jack said as we launched a boat for the 36-mile tour. "A grizzly won't bother you if you let him know you're there. Just walk up and shout at him. That's worked for me every time but one, and that time I had to get out of there at 100 miles an hour. It was matrimony season, and that bear had his wife along with him."

Maligne Lake was turning and narrowing, and quickly we were surrounded by Matterhorn-like pinnacles that punctured the inflated afternoon clouds. Waterfalls and glaciers spilled over the lips of hanging valleys from between the shoulders of dark lateral moraines deposited in forgotten ice ages. For sheer beauty, even in the Alps, I had never seen anything to surpass it.

Emerging from the national parks, I started for the oil fields surrounding Edmonton, the city of government that sits, both literally and figuratively, on a multibillion-dollar reservoir of oil and natural gas. They joke in Edmonton about water wells so permeated by natural gas you can light the kitchen faucets.

En route, however, I stumbled into one more diverting night among the kind of men who have the fortitude and fortune to make a living in the mountains. Around a campfire I talked with some of Alberta's best woodsmen, men who teach "survival" to Royal Canadian Air Force crews.

"In the summer," said one of them, Mike Kelley, "people ask, 'You get paid for doing this?' In the winter they say, 'I wouldn't have your job for anything in the world!'"

Survival Menu May Include Mice

I prodded a thick beefsteak broiling in the coals at my feet and felt a stab of conscience over the thirty RCAF flyers camped about us in the woods. They were boiling up the pittance of emergency rations allowed them, perhaps flavoring it with a fish caught on a string from a parachute shroud line, or with a squirrel trapped in a homemade snare.

Flying Officer Perry Cunningham caught the look in my eye.

"Mind you," he said (Albertans tend to preface remarks with "mind you"), "we don't keep them really hungry. They get one day's survival ration for three days. That keeps 'em hungry enough to get out fishing and hunting, or scrounging for berries or roots. But if they were starving, they'd have a hard time concentrating on making fish nets out of shroud lines or snares out of sticks and wire.

"We make them eat anything they catch, even if it's a mouse. Mind you, they sometimes throw part of it away. We teach them to boil

Honeycomb lights blaze from glass-walled office buildings as bustling Edmonton works after dark. Alberta's capital and largest city welcomes commerce and culture; oilmen and meat packers run their industries within sight of the University of Alberta.

The dome tops the provincial legislative building, reminding Edmontonians of their keen but friendly rivalry with Calgary, a disappointed contender for the capital.

Symbolic wings raised in frozen flight, a sculptor's concept of the Canada Goose forms a fountain in front of Edmonton's city hall.

Irreverent Edmontonians refer to the maze of twisted pipes as the "spaghetti tree."

The Queen presides in portraiture, as His Worship, the Mayor of Edmonton, and his councilmen conduct the city's business.

everything. That way, when they've drunk the broth, they get all the juices and all the benefit."

In 12 years, these instructors have put nearly 8,000 RCAF men through summer, winter, and arctic survival courses. In addition, flyers from the army, navy, and Mounted Police undergo the experience, as well as pilots from the U. S. and other NATO countries.

Learning about oil in Alberta is akin to studying rice in China. One can begin in either Edmonton or Calgary; each of these cities calls itself "The Oil Capital of Canada."

From the cities the quest leads to improbable places: into the Rockies; northwest into the discouraging marshland Canadians call muskeg; northeast to the Athabasca River, where lies the greatest known concentration of oil in Canada. Unexploited and trapped in sand, it frustrates the engineers of a hundred oil companies.

Black Gold and the Good Life

From a dozen areas oil and natural gas stream into pipelines stretching to Ontario and Quebec and to the Pacific coast. In some fields wells are restricted in output, awaiting the day when Alberta can sell even as much as half the petroleum products she is ready to market.

Yet the problems of Alberta oil, however frustrating, are temporary, and everyone in Alberta knows it. Even with problems, oil makes for the good life. Alberta has sold a billion barrels of her black gold. And the provincial government, which happily owns 87 percent of the mineral rights over its vast domain, has realized a billion dollars in royalties, sales, and rentals.

Mind you—as Albertans would say—a billion dollars in revenues represents only a fraction of the wealth surging through the economy of the province as a result of oil. And it all started only 13 years ago.

KODACHROMES (ABOVE AND OPPOSITE) BY DAVID S. BOYER AND HIGH SPEED EKTACHROME BY CHUCK ROSS © N.G.S.

I heard the story from Carl O. Nickle of Calgary, co-editor of *Oil in Canada*, and publisher of the *Daily Oil Bulletin and Canadian Oil and Gas Directory*.

"We've had small booms and busts in Alberta since the turn of the century," Mr. Nickle began. "Our only major producing field of the 1930's, Turner Valley, was overexploited and depleted to meet the requirements of World War II. Exploration and development dwindled. A few companies persisted. In February, 1947, Imperial Oil Ltd. drilled into a bonanza at Leduc, near Edmonton.

"That started it. From a million dollars a month before Leduc, we skyrocketed, by 1956, to spending a million dollars a *day*—about seven hundred dollars a minute—to find and develop new oil in Alberta!

"Unfortunately, we have had long delays and frustrations in obtaining permission to export our surpluses. Then we have faced problems finding markets, both in the United States and in Canada. The oil business is one of the most complex in the world; the channels of distribution are well established, and you don't break into them overnight. Also, we

Giant Nozzles Spray a Bunyanesque Woodpile

Attracted by vast timber reserves and plentiful water supply, the pulp and paper industry makes a welcome addition to Alberta's economy.

Here, jets of water from 50-foot towers help reduce summertime fire hazard in a huge wood storage yard at Hinton. From the 250,000 cords of spruce and pine dumped here like jackstraws, a flume floats logs to an adjacent mill for conversion to high-quality paper pulp. The process takes 30 million gallons of Athabasca River water daily, more than the city of Edmonton uses.

Two million scientifically forested acres will replenish this $5,000,000 stack at the plant of North Western Pulp and Power Ltd.

have strong competition from cheaper oil produced in the Middle East and Venezuela.

"Today, however, we believe we are approaching a continental oil policy in which the United States and Canada can cooperate for mutual benefit, and which will mean a more equitable utilization of our petroleum resources."

Alberta's natural gas resources may run to more than 25 trillion cubic feet of proved reserves, enough to supply the entire United States for two years; and her oil possibly to more than 27 billion barrels, enough to last the United States for nearly eight years. At least twenty-three of those oil billions are tied up in the Athabasca "tar sands," misnamed by early discoverers who mistook the hardened surface outcrops of oil for asphalt.

Unless you watched carefully for wells, half-hidden in woodlands or waving grainfields, you could travel much of Alberta and not be conscious of oil. The great refineries of Edmonton, of course, you could not miss (page 110). And soon you would learn to spot the silver tanks where crude oil is partially treated before being piped to refineries.

To find the glamour of the drilling rigs, however, often means excursions into wild terrain. In the muskeg country up north, drilling crews can work only in winter, when the swamps are frozen and will support heavy equipment.

I drove with Jim Rennie of Imperial Oil into the mountains to watch a million-dollar hole being drilled at Benjamin Creek. Toolpusher Al Bennett stopped work long enough to tell me what was going on:

"We're down 3,000 feet and hope to hit oil at 13,000. But it'll be a year yet, the way things look. If we hit—this is a wildcat, you know, no proved field around here at all—we'll go into a flap. We usually have ninety days to decide which half of a reserved acreage Imperial will retain. You can't hold pieces more than three miles square. Then all the other companies get to bid, at provincial auction, on the pieces in between."

Pincher Creek was my next stop on the oil story. Pincher Creek is natural gas, one of the largest fields in Alberta. British American Oil's processing plant there can turn out 145 million cubic feet a day.

"Sweet" Gas Pays Extra Bonus

"Until about ten years ago," engineer John Beddome told me, "most of the gas discovered in Alberta was what we call 'sweet'—that is, free of hydrogen sulphide, a poison. This gas is sour and wet. We wouldn't want to pipeline it any farther than we have to because it

Grain Elevators Spike a Prairie Horizon

Alberta's sprawling wheatfields, once the pride of the province, now plague farmers with overproduction. Like the clouds above this pastoral vista at Parkland, the grain surplus shadows Alberta's economic future. Great Britain and Japan buy large quantities; shiploads go free to needy nations. Yet thousands of elevators and granaries remain packed with the overflow from years of bumper crops.

As a result, farmers are reducing their wheat acreages and turning to other crops.

Alberta's industry today is catching up to agriculture as the province's economic mainstay.

Golden barley pours into a granary in the Peace River District. Growing demand for barley for malting and hog feed has boosted production of the grain until it ranks as Alberta's second crop, after wheat.

corrodes the pipes seriously. That's why the plant is right here in the field."

Some valuable by-products are extracted before sweet gas is pipelined to the east—propane for bottled gas; butane and condensate for fuel and gasoline; and sulphur, which British American sells mostly for papermaking, fertilizer production, and uranium refining.

Wheat Grows Where Dinosaurs Roamed

Awaiting shipment, immense stepped blocks of sulphur stand gleaming in the sun (page 112). Against the mauve foothills that overlie the Pincher Creek sedimentary formations, the blocks dazzle the eye with the brilliance of light they reflect. They are like unfinished pyramids of gold, one of the legacies to Alberta of the marine life that died in the seas covering this province 60 to 300 million years ago.

Dinosaurs of the Mesozoic Era were contemporaries of the tiny creatures that contributed their remains to the rich fuel and chemical deposits of Alberta. Mayor Eneas Toshach of Drumheller took me along the scenic Dinosaur Trail in the badlands, where some of those caught and fossilized in the mud are exposed from time to time as erosion cuts through the earth (page 100).

Near the fossil hunting grounds grows some of the best wheat in the world. For years farmers of this region, and their youngsters in Crop Clubs, have produced prize-winning wheat.

"We usually get about 35 bushels to the acre," farmwife Mrs. David Adams told me. "But last year the Wheat Board could only take a fraction of our crop. All those granaries out there," she waved a hand toward a row of wooden sheds, "are full, and we're building more" (page 106).

I heard more of the wheat surplus story in Calgary from Mr. Leonard D. Nesbitt, retired official of the Alberta Wheat Pool, a gigantic farmers' grain-marketing cooperative.

"Our surpluses are caused by many things," he said, "most of them similar to those that created the wheat glut in the United States. International politics. World marketing problems. Price supports. Farm mechanization. Improved seed grains. Fertilization and increased productivity per acre.

Bumper Crops Stuff Alberta's Silos

"But what really pushed Canada into the drastic surplus column was the string of bumper crops from 1950 to 1956. In those years we produced 165 million bushels a year more than the long-time average. And we've never been able to get out from under it."

More and more surplus wheat—and barley and oats—is being used to fatten livestock for market. Almost every farmer keeps swine or

KODACHROME (ABOVE) AND HIGH SPEED EKTACHROME © NATIONAL GEOGRAPHIC SOCIETY

beef cattle. For many, it is the major farm operation. Half a century ago, Alberta was a land of cattle kings, big ranch spreads, and open range. Today, about half of the beef dressed by Calgary and Edmonton packing houses comes from farm lots or from commercial feeders.

But feed lots are neither very romantic nor photogenic. And there are still some big ranches. I was invited to visit two of them. They were ranches, spelled without a "w."

Ranch Versus "Rawnch"

"There are ranches and rawnches, you know," as John Cross at the A 7 put it. "A rawnch is something you keep. A ranch is something that keeps you. This is a ranch."

John is a son of one of the early cattle kings, and his A 7, in the foothills of the Rockies, is the oldest ranch in Alberta to remain in one family.

He is also a maternal grandson of Col. James F. Macleod of the North West Mounted Police,

The Bard's Words Resound on a Mountain Campus

Students from all over the continent come to the Canadian Rockies for summer work. At Banff's School of Fine Arts, operated by the University of Alberta, they pursue courses in writing, ballet, music, and painting.

These actors-in-training romp through Shakespeare's *Much Ado About Nothing*. Productions often are presented in the Jubilee Auditoriums of Edmonton and Calgary (right).

Calgarians pack their Jubilee Auditorium at a performance by a Scottish bagpipe band. Seating 2,700 persons, the auditorium is among the world's most versatile, with facilities for concert, drama, and convention.

Imperial Oil's Refinery Creates a Glittering Chemical Castle

Within a hundred-mile radius of Edmonton's "Refinery Row" lie some of Canada's richest oil fields. Experts estimate the reserves of the near-by Pembina field alone at almost a billion barrels.

Pipelines carry Edmonton's petroleum products west to Vancouver and Puget Sound, east to Toronto. Marketing problems curtail production, but exploration for new fields goes on at a cost of nearly a million dollars a day.

Laying a pipeline, crewmen wield shovels to unclog the teeth of their trench digger. Behind them, the fresh ditch stretches across the prairie near Drumheller.

When completed, the six-inch line may warm an Albertan's home or fuel a Montreal factory.

who established Fort Macleod in 1874. The colonel brought the first law and order to the Indians and to the "whiskey traders" from Montana who preyed on the Indians' gullibility. That is how young Alberta is; it has been a province only 55 years.

Summer Fun Becomes Winter Ordeal

"You're just in time to help us move some cattle," John had greeted me. "Can you ride?"

I had, by now, more or less forgotten Lake Louise and Clarence. "A little," I said.

After two days, I could, a little. I had to, just to keep up with John, his wife Eleanor, and cowboys Wayne Schlosser and Sandy Porter. I even began to consider it exhilarating, driving Herefords out of aspen groves and moving them across mountain meadows from leased range to deeded A 7 land near the Oldman River (page 114). There was a sensation about it of freedom, of simplicity and closeness to nature; for some reason it reminded me of the contentment of working a

KODACHROMES © NATIONAL GEOGRAPHIC SOCIETY

trout stream. When I spoke of this after the roundup, John's unshaven face broke into a wry smile.

"Everybody who comes in the summer thinks it's fun," he said. "You should come and help us gather cattle in February when it's 40 below.

"You could be standing out there in the snow skinning a dead calf, and then putting the skin on an orphan and trying to mother it up with the bereaved cow. Or you could ride out with Wayne at daylight to see which cows need to be brought in for calving."

I knew all about Wayne's starting at daybreak. I had bunked with him the night before. He wound the clock but didn't set the alarm. He checked it every few minutes after four o'clock, and at five he got up and went out to wrangle the horses.

"Notice I call it 'gathering cattle,' not rounding them up," John added. "The roundup is a thing of the past. Alberta's ranchers used to work together on the open range, rounding up everything for spring branding. All our fields are fenced now. That's another lovely winter job, riding fences to make repairs."

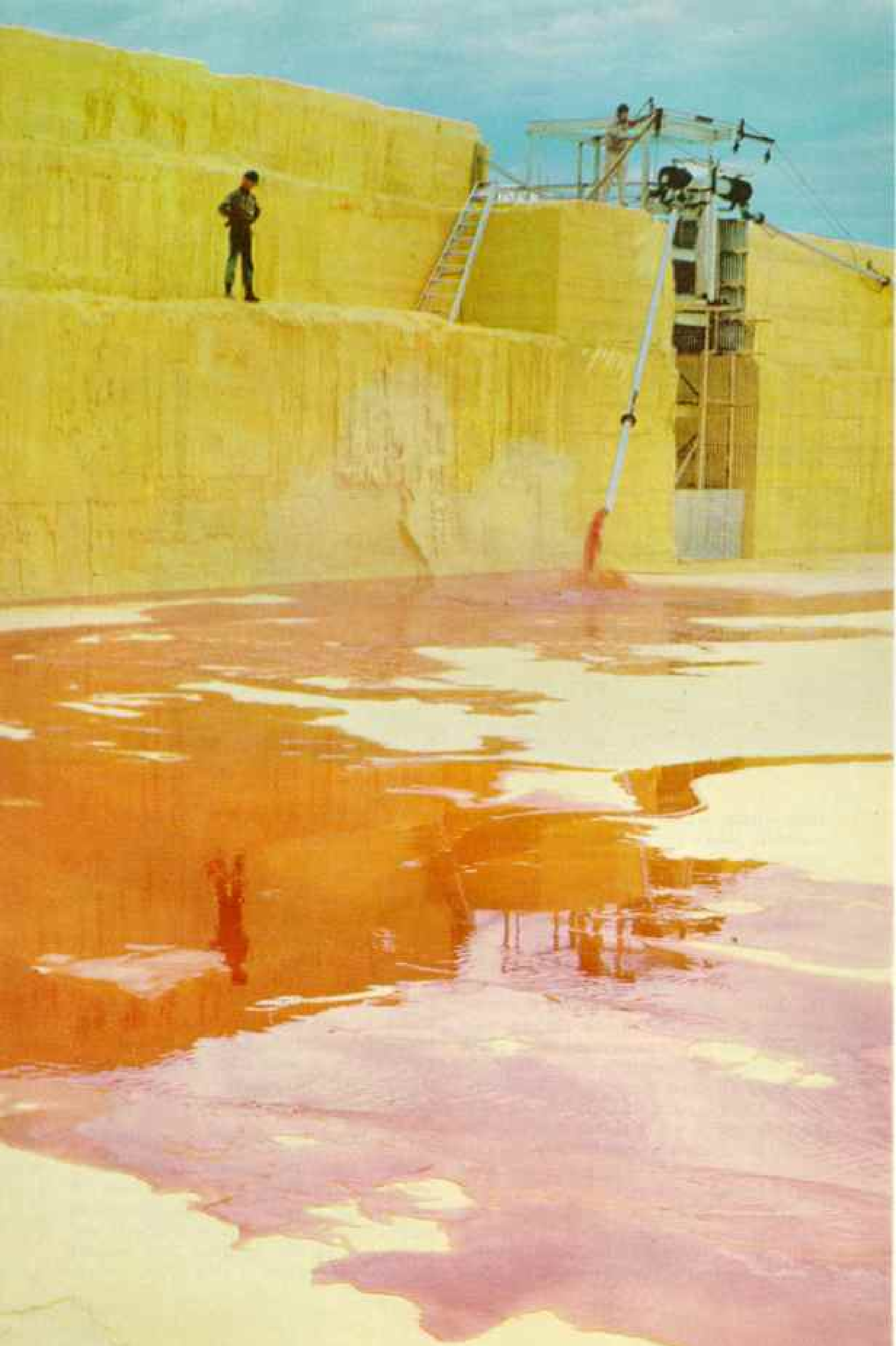
There are 125 miles of fences on Ralph Thrall's McIntyre Ranch south of Magrath, and 100 square miles of range. Thrall's is one of the biggest layouts of deeded land in Canada. He leases nothing.

Thrall is a U. S. citizen, and when he left a job as clerk in a Minneapolis bank after World War I, he says he "didn't know a Hereford from a jackass." Today he runs 4,000 head and keeps a herd of some of the finest registered Hereford stock in Canada.

You spell this ranch without a "w," too.

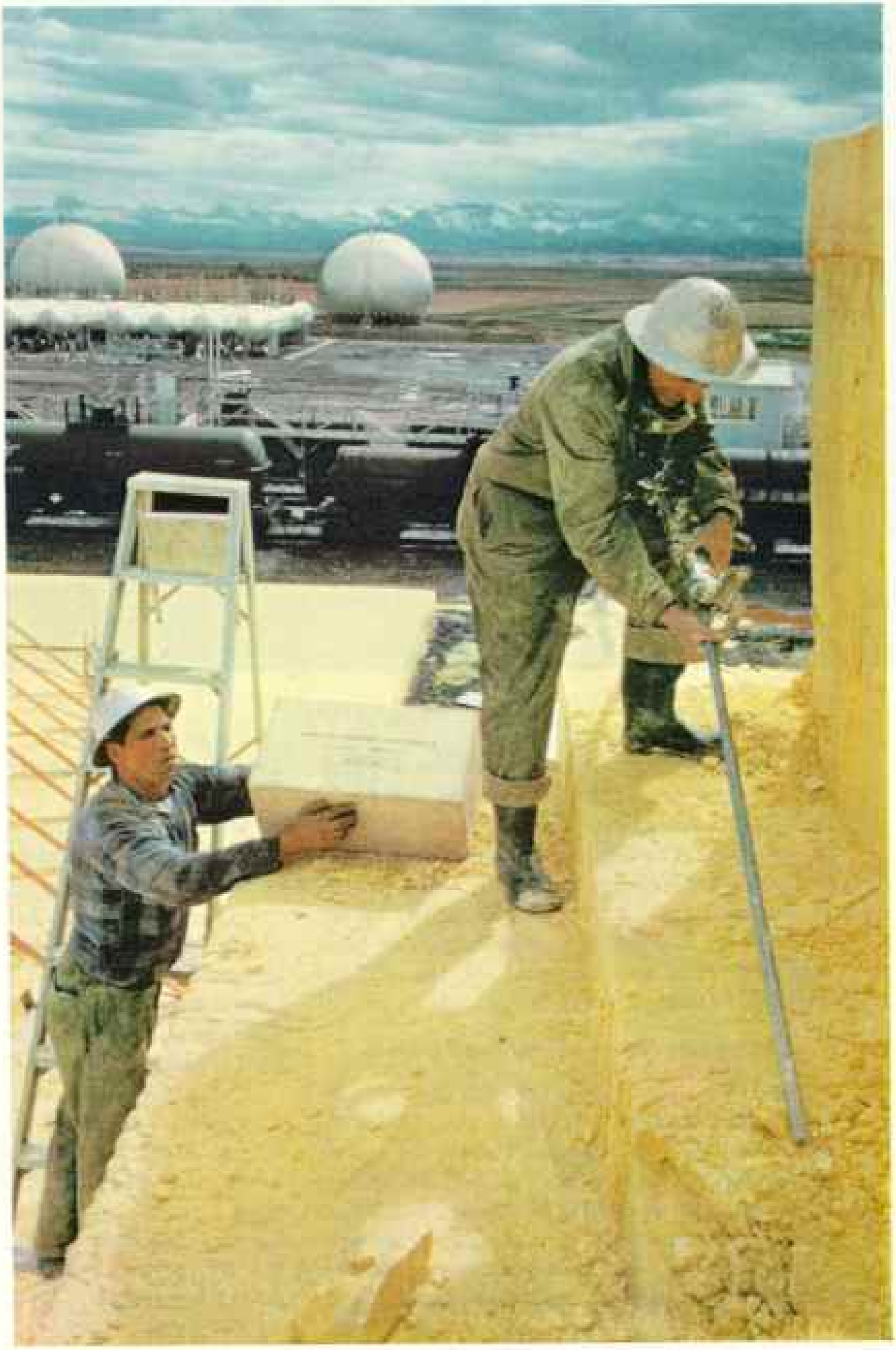
Beef Goes South for Winter Vacation

When I was there, buyers from Ontario were watching Thrall and his cowboys cut out a couple hundred head for shipment to eastern feed lots. Although most Alberta beef is dressed in the province, long-distance shipping—to market or even to pasture—is



Golden wall of brimstone dams a scarlet lake of liquid sulphur in a huge storage block at Pincher Creek. The sulphur, extracted in liquid form from natural gas, turns yellow as it dries. The purified gas flows into the Trans-Canada pipeline. Sulphur figures vitally in the manufacture of paper and in uranium refining.

Preparing to dynamite, workmen drill a hole in a sulphur block to crack loose a shipment. Squat spheres store condensate, another natural gas by-product used in high-quality gasoline. This processing plant, operated by the British American Oil Company, Ltd., sits atop one of the world's major natural gas fields.



still part of the cattle business. "One dry season I shipped 3,000 head to Texas and back, just for winter grass," Ralph Thrall told me.

On this sometimes parched prairieland, water is a critical commodity. The first mayor of Lethbridge, Charles A. Magrath, recognized that, and what he did helped to turn southern Alberta into one of the richest vegetable-farming areas in Canada.

Sugar Beet By-products Feed Cattle

Magrath urged the Mormon pioneers of Utah, the irrigation experts of the continent, to send settlers to Alberta. Today, the towns of Cardston, Magrath, Taber, Lethbridge, and Raymond are full of Mormons. Irrigation ditches cut the fields in a regular gridwork, carrying water from new reservoirs, and this semidesert land, not unlike irrigated Utah, has become the sugar beet capital of the nation.

At Taber I visited one of three refineries of the Canadian Sugar Factories Ltd., a company that shares its profits with 1,600 farmers.

General manager Ian Angus, formerly a sugar cane expert in the Dominican Republic, showed me four beet pilers stacking 8,000 tons a day (page 116). Besides sugar, this refinery produces dried molasses beet pulp and feed molasses for Alberta's beef herds.

The same story, of irrigation, vegetables, and cattle feeding, was going on in Lethbridge. Stanley Broder, who farms some 5,000 acres, was pouring some 500 tons of corn, peas, carrots, and other crops daily through his freezing factory, the largest in Canada. His refrigerator can store 8,000,000 pounds of frozen vegetables; and on the corn husks, car-

Rump Roasts Plod Tableward With a Rain-soaked Escort

Alberta produces a fourth of Canada's beef. Major packing centers at Edmonton and Calgary ship large quantities to the United States. Housewives who prefer small cuts from young steers baffle some Alberta beef raisers, who favor meat from larger and more mature animals, like these on the A 7 Ranch.

Prime and portly after fattening on leased forestland, the cattle head for the ranch and the scrutiny of skilled buyers.

A veterinarian (below) applies metal eartabs to Ontario-bound yearlings, attesting their health.

rot tops, and potato peelings he feeds 3,000 cattle.

This was one season that surely did not lack rain. Farmlands were being irrigated from heaven almost daily. Grain farmers were beside themselves with anxiety. Even hail, the annual midsummer scourge that cuts like a scythe across the midriff of Alberta's wheatlands, had become a minor matter in a threatening general grain-crop disaster.

Nevertheless, hail had annihilated many a mile of waving wheat and barley. Two days after one savage hailstorm, I talked with Irvin Palmer near Sylvan Lake. "Two years ago, hail wiped me out," he said. "There wasn't anything left but stubble sticking out of the mud. Last year I bought hail insurance.

Nothing happened. This year I took a chance. Monday I lost half my crop."

The provincial and federal governments, and farmers and others as well, are trying in various ways to ensure Alberta against hail.

Irving P. Krick Associates of Canada Ltd. are paid by farmers to "seed" prospective hailstorms with silver iodide particles carried aloft from smoke pots. Their object is to turn moisture into harmless snow or rain before hailstones form.

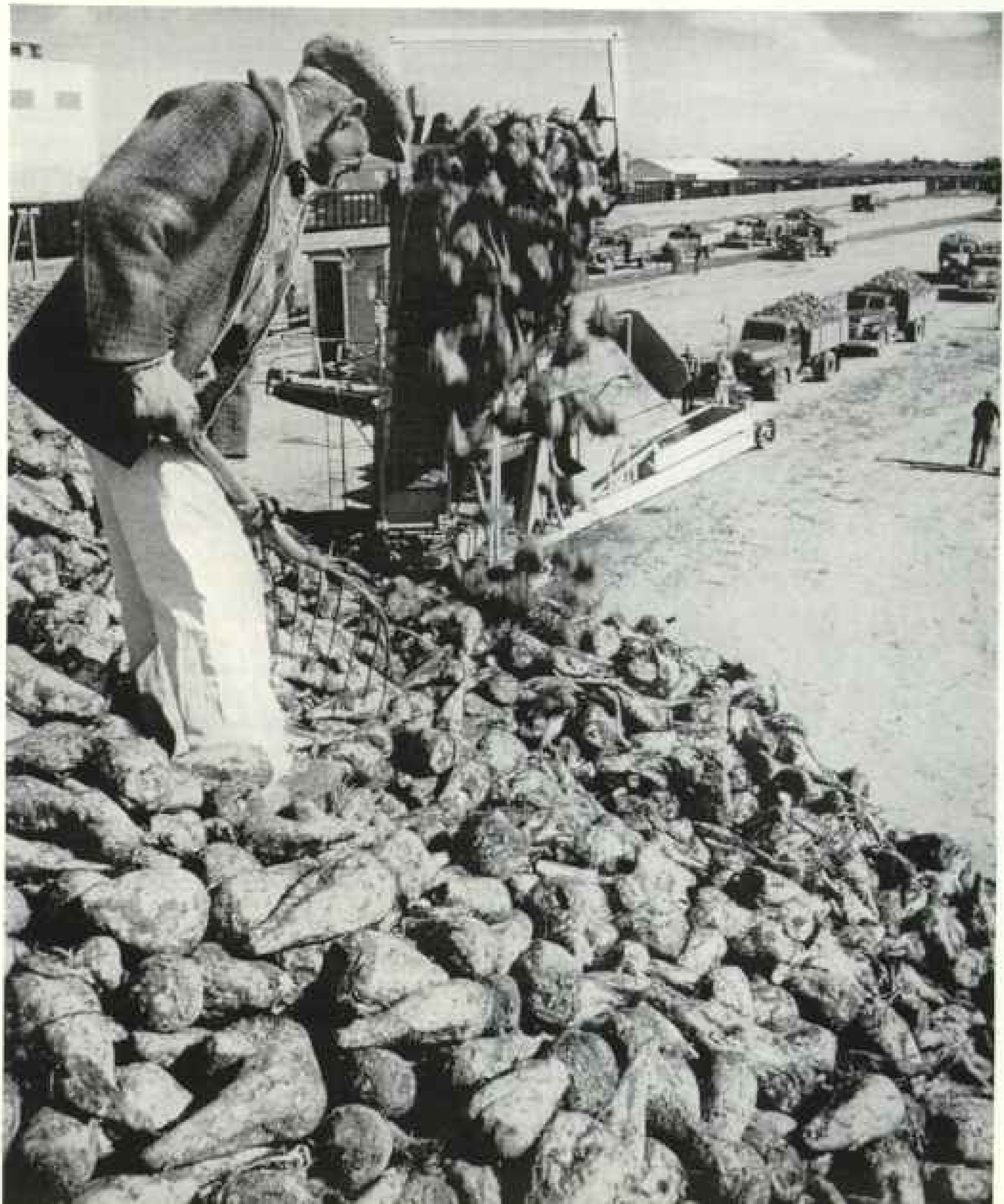
There is also a group of scientists who occupy a small building on the RCAF training station at Penhold. Calling their project "Alberta Hail Studies," these delegates from the Research Council of Alberta, the Meteorological Service of Canada, and McGill University at Montreal study hail the way nuclear physicists study the atom.

Radar Takes Hailstorm's Pulse

With radar they make motion pictures of hailstorms. From thousands of reports from farmers, they chart areas of storm intensity. More basically, they study why different sorts of water freeze and under what conditions.

Robert Barklie of McGill's physics department summarized progress to date:

Sugar beets for candy and cattle feed arrive at a Taber refinery



"The freezing of a water drop depends on its size, the temperature change, the length of time it is subject to cooling, and the impurities present. The purer the water is, the lower the temperature required to freeze it. Our next step is to determine the exact freezing properties of the water in these hailstorm clouds."

When last I saw Dr. Barklie, he was in deep conference with an RCAF pilot, discussing the possibility of flying into storms to collect water samples.

"We have no advance theories," I was told by Dr. Richard H. Douglas of the Meteorological Service, director of the field program. "When we know more, we will perhaps be able to determine whether and how and when to try to freeze water in a gathering storm. There may or may not be a big 'pay-off' from all of this. We can only work and hope."

Insurance for Alberta's farm future was paying dividends at two other widely separated experiment stations I visited.

Two belts of farmland slash across the muskeg and forest of the Peace River District—belts known colloquially as the North Peace and the South Peace. At the town of Beaverlodge, in the southern belt, I talked to agricultural experts working to broaden the base of farm economy.

"This is really livestock country," a federal animal husbandryman said. "Or it should be. Gradually we're getting these grain farmers to turn more land into forage crops and start feeding vitamin A to their pigs. In 25 years you're going to see a lot of cattle, sheep, and swine up here."

By then Peace River swine herds may be largely made up of an outstanding new breed, the Lacombe, developed over eight years of intensive hybridization at the Canadian Experimental Farm at Lacombe.

HIGH SPEED EXTACHROME © NATIONAL GEOGRAPHIC SOCIETY

Stripping nets clean of lake herring, these youngsters at Lesser Slave Lake contribute to milady's wardrobe. Most of the annual catch goes to neighboring fur farms as mink food. The plane brings whitefish and trout from lakes farther north for truck shipment to Chicago markets.

Gas Well Replaced Keys to City

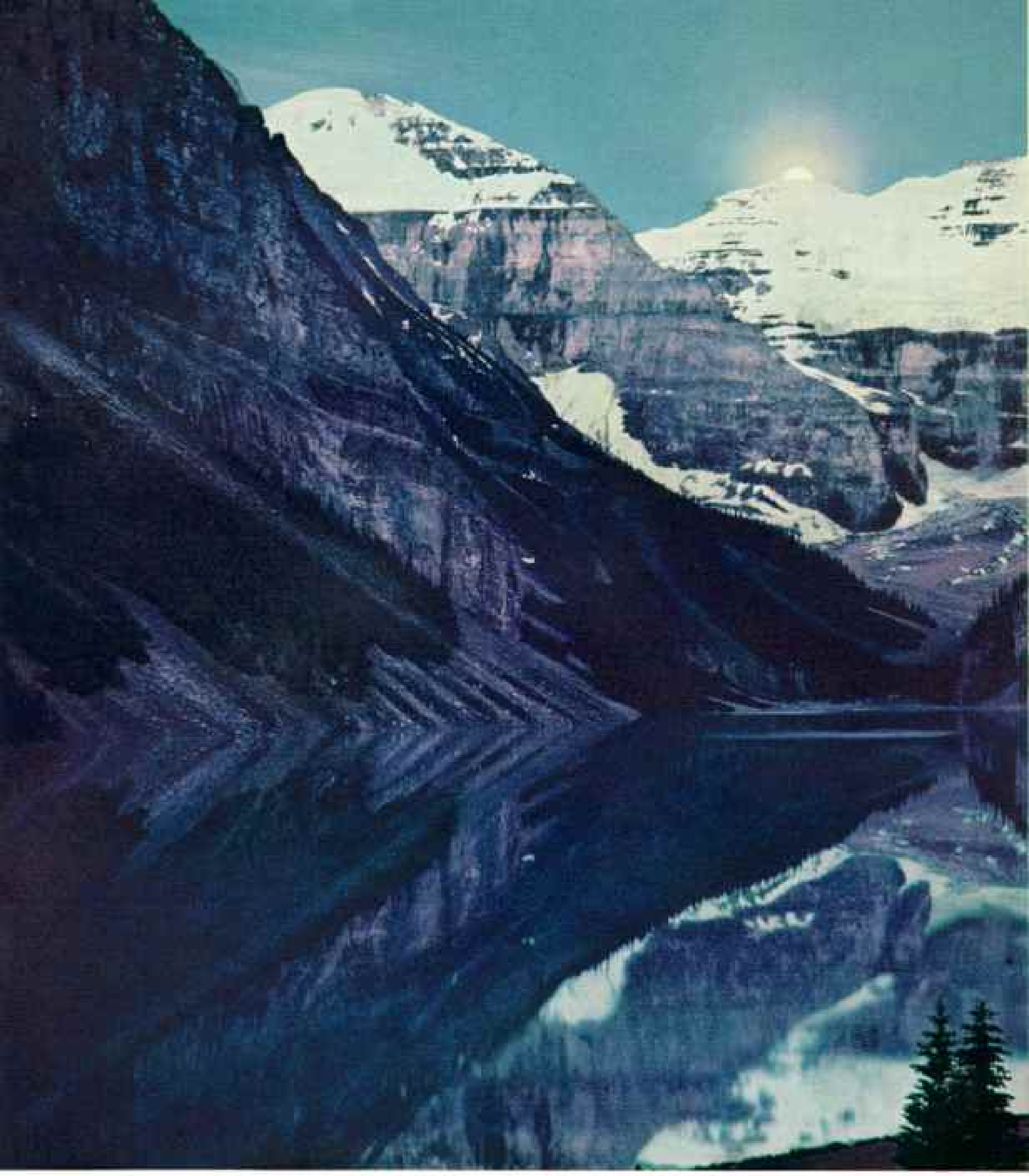
"The public today wants less fat in its bacon and pork," research officer Huibert Doornenbal told me. "Besides other qualities, we are breeding to produce a lean pig."

Since new animals are still comparatively rare, the government distributes them to would-be breeders by draw.

While Alberta's future, like its past, will always be intimately associated with agriculture, the vistas in the minds of its leaders are landscaped with visions of new industry.

In Medicine Hat, a thriving city on the southern prairie, I watched the city fathers welcome a new rubber-tire manufacturing plant to town. Once upon a time the "Hatters" presented new industries with free gas wells. For the tire plant, the city generously drilled several water wells.

Rudyard Kipling once called Medicine Hat "the city with all hell for a basement." He was referring to the natural gas pool beneath the town, and he could have used the same

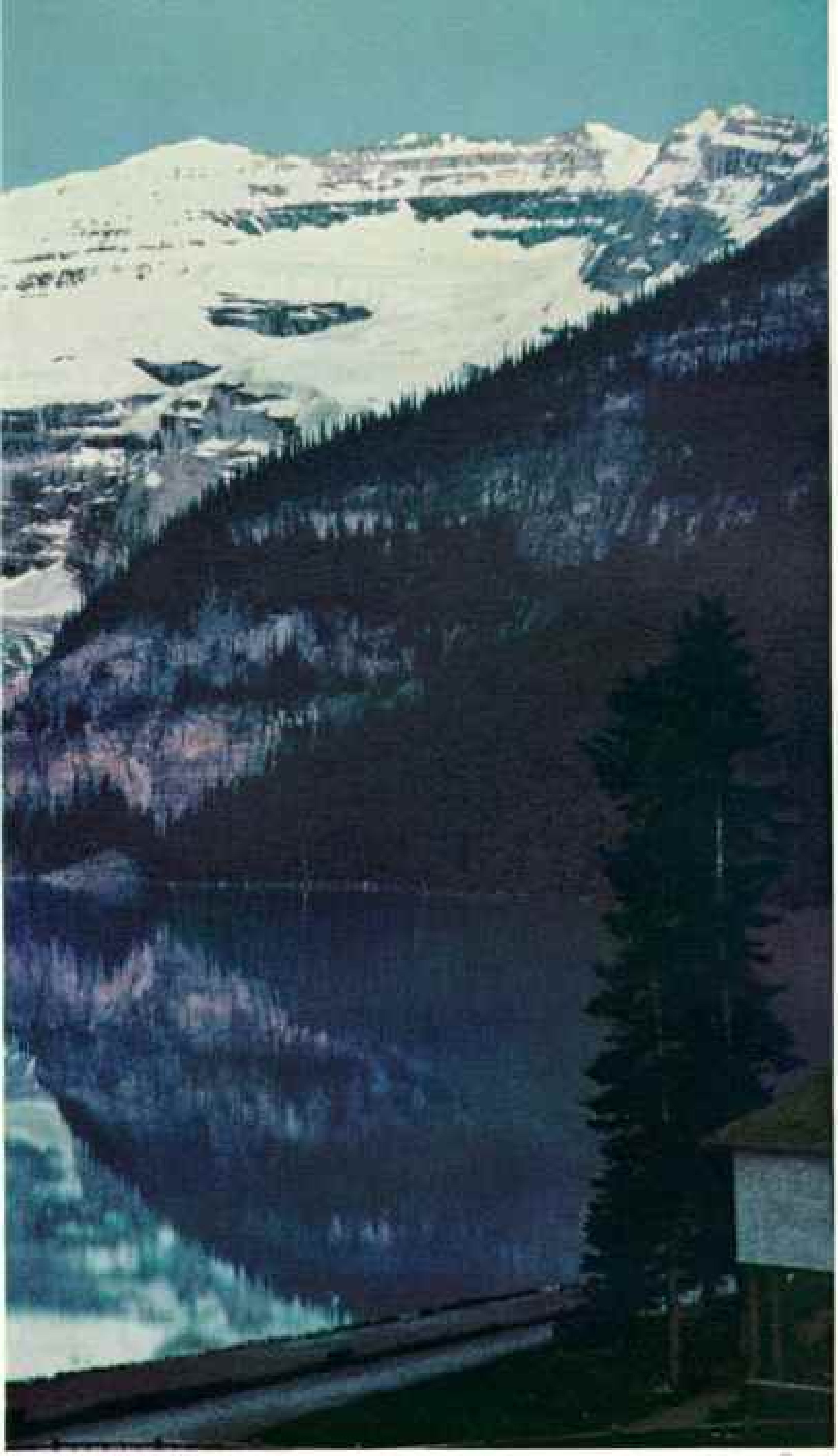


expression in other parts of the province.

Edmonton has an even bigger basement full of gas—and a blooming prosperity because of it. Using inexpensive gas for heat and power and chemical raw materials, industry has invested three-quarters of a billion dollars in the capital city in a dozen years.

Manufacture by Canadian Chemical Company Ltd. of nylon thread from natural gas derivatives is one example of Edmonton's richly endowed bargain basement. In near-by Fort Saskatchewan the chemical-metallurgical plant of Sherritt Gordon Mines Ltd. refines nickel, copper, and cobalt with hydrogen and ammonia produced from gas, and as a by-product of the process makes ammonium sulphate fertilizer.

Edmonton's city fathers, as one expression of confidence in the future, have erected a $3,500,000 modernistic city hall (page 102).



Moonlight makes a sapphire of Lake Louise in this dramatic time exposure showing the moon setting behind Mount Victoria. Here, the Stony Indians are said to have told the first white explorers in 1882, the Great Spirit painted a reflected picture that will never fade.

Lake Louise honors Princess Louise Caroline Alberta, the same daughter of Queen Victoria whose name graces the province.

A roped climber (above) walks a treacherous ridge between two crevasses.

Photogenically, I found it inviting my camera even more than Alberta's legislative building or the $5,000,000 twin of Calgary's Jubilee Auditorium.

My own faith in Alberta's future will take me back there one day. There are things about the place that stay in your heart.

When I go, the wet grain fields I passed in leaving the province will be forgotten. So will the snowstorm that buried part of the crop.

When next I see Calgary's cowboys on bucking broncos, when I visit Edmonton and prairie farms and oil refineries, Alberta is almost sure to be an even more dramatic place. The young princess of the plains has her problems—how to sell surplus oil, what to do with surplus grain, how to increase markets for her beef and pork. But these are the best kinds of problems, mind you, as Albertans very well know.

HIGH SPEED EKTACHROME © NATIONAL GEOGRAPHIC SOCIETY

Speeding launch's glowing wake streaks Puerto Rico's Phosphorescent Bay in a time exposure. Lamps wink from houses; photoflash lights the foreground. Boat riders enjoy the glittering show.

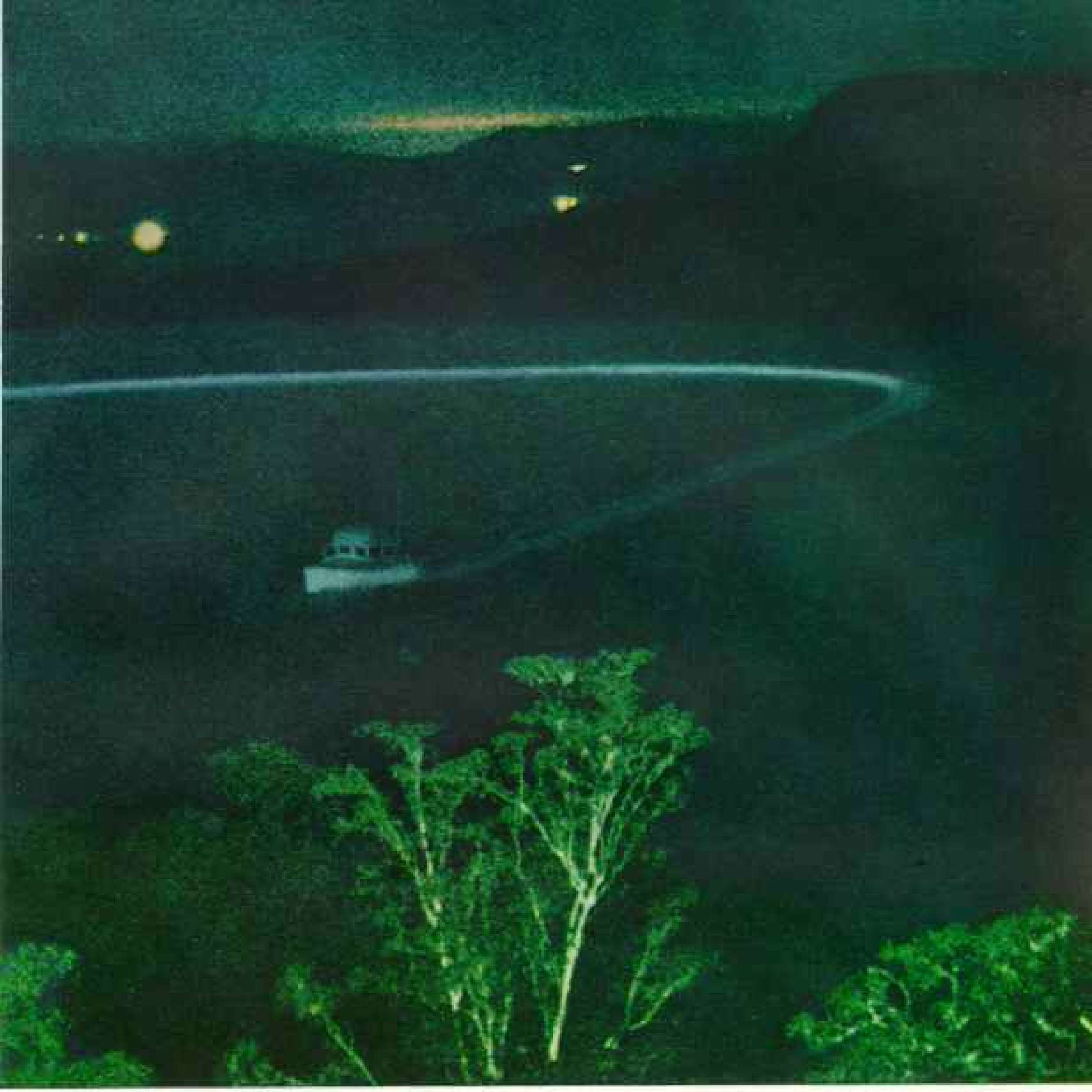
Sailing a Sea of Fire

By PAUL A. ZAHL, Ph.D., National Geographic Senior Staff. *Photographs by the author*

I AM SURE no boy ever experienced a weirder Halloween than 11-year-old Benny Benavent when, last October 31, he accompanied his father and me on a strange ride to a secluded bay in southwest Puerto Rico.

The scheduling of our trip had nothing to do with Halloween, but the almanac indicated no moon that night, and total darkness was essential to the success of our mission.

The fishing and resort village of Parguera was already half asleep as we pushed away from the dock. Respect for the reef shallows



Mangrove shores ring Puerto Rico's remarkable "bay of fire." Favored with moderate tides and a narrow link with the Caribbean, the lagoon's calm, vitamin-rich waters harbor millions of micro-organisms that glow in the dark. Best displays occur on moonless nights. Map below locates Phosphorescent Bay.

held our speed under five knots as we crawled eastward for perhaps two miles, about a thousand yards offshore.

Finally the pilot spun the wheel, and we entered the narrow portals of Puerto Rico's famed Bahía Fosforescénte (map, opposite).

Immediately we observed the first of a series of startling phenomena. Our churning wake, previously barely visible, turned eerie white—dim to start, then rapidly brightening as we neared the center of the bay. Knifing through black water, our speedboat left a radiant trail.

Fish Blaze Like Roman Candles

Our bow offered an even more arresting spectacle. Strange cometlike darts were shooting away a foot or so beneath the surface—fiery paths left by scores of fleeing mullets, halfbeaks, and porgies. It was like sitting on a cache of exploding Roman candles.

On command of Benny's father, Dr. Arturo Benavent, a dentist from Mayagüez and owner of the boat, the pilot stopped near the center of the bay. For a few minutes our wake persisted, then faded to extinction. These waters glow bright only when agitated.

This phenomenon is often called phosphorescence, although bioluminescence is a better term, because phosphorus as such is not involved in the process. It occurs in seas and oceans throughout the world and is usually seasonal or sporadic. But here, in this marine pocket of some 60 acres connected to the sea by a narrow inlet, "fire" charges the waters every night of the year, and to a degree encountered in few other places. The blacker the night, the brighter the sea appears.

Dr. Benavent reached overboard and cupped a handful of water; immediately his hand glowed spectrally and dripped sparks. I tossed a small stone into the bay; it landed with a splash of flame.

"One night a year or two ago I was out here when it suddenly started to rain," Dr. Benavent was saying. "Every drop hitting the surface glowed like that. The bay boiled white from shore to shore."

We began our preparations for the evening's task: to capture on color film—for the first time, to our knowledge—the ghostly glow of Phosphorescent Bay. (A local photographer, Frank McFerran, has made black-and-white exposures.)

Dr. Benavent strapped a life jacket on his son. We drew in the dinghy we had in tow, and Benny, who was to be our photographic model, hopped aboard. "Hold on tight," his father cautioned, as we let out line and the boat slipped back into the blackness.

By now I had my tripod and camera securely set up just behind the cockpit. Benavent checked the dinghy and its occupant with his flashlight beam. Then, satisfied, he signaled for full speed ahead. In a second our propellers were churning up a maelstrom of incandescence. Quickly the dinghy materialized out of the darkness with Benny in it, sitting

Luminous froth surrounds a masked swimmer photographed by electronic flash

upright and hanging on for dear life. Round and round the bay we went, trailing a great glowing flourish shaped like an enormous "V" (below). Earlier I had needed a flashlight for camera adjustments; now I could see unassisted.

Finally I completed my camera work. The pilot decelerated slowly so that our wash would not swamp the dinghy. The light diminished, and darkness again enveloped us.

"Some Halloween ride, eh son?" Dr. Benavent called back toward the dinghy. We pulled it alongside and helped little Benny aboard, wet but wearing a broad grin.

During my stay in this dry, desertlike corner of southwest Puerto Rico, my main object was to study the micro-organisms responsible for the bay's amazing luminescence and to probe possible reasons for their abundance here. The facilities of the University of Puerto Rico's Institute of Marine Biology, on the islet of Magueyes off Parguera, were made available to me through the courtesy of its director, Dr. Juan A. Rivero.

On many of my 30-odd visits to the bay we would slowly tow a net about the size and shape of a large silk stocking. Its mesh was so fine that minute creatures suspended in the water would be carried through the open leg and toe into a quart bottle.

Ashore, the contents of the bottle were put through a coarse filter to strain out larger, nonluminescent organisms. Then I would place a sample of the remaining plankton under a powerful microscope.

Immediately revealed was a fabulous microcosm—key to the bay's luminescence. There in the depths of the microscope tiny objects swirled, each gleaming like a bit of frosting on a Christmas cookie (page 127).

Most prevalent were greenish, slightly irregular orbs, no more than 1/500th of an inch in diameter, each propelled by two threadlike tails. Well-named *Pyrodinium* (from *pyros*, the Greek word for fire, and *dinos* for whirling), these are the bay's lanterns, thriving there by untold billions with other plankton species. Part animal (*Pyrodinium*

Caribbean water glitters like star dust as *Blue Marlin* cruises the bay of fire

Bouncing atop the fiery wash, a phantomlike dinghy follows a speedboat. Dr. Arturo Benavent rides in the stern seat; his son braces himself in the skiff. The bow bears the initials of the National Geographic Society. To "freeze" the moving boat and its passengers in these time exposures, Dr. Zahl used a low-powered stroboscopic flash.

can move), and part plant (it contains chlorophyll), this extraordinary organism photosynthesizes during daylight and luminesces at night. *Pyrodinium* and two other organisms, *Noctiluca* and *Pyrocystis*, are the sea's dominant producers of diffuse light.

No one knows why nature provided these protoplasmic specks with built-in neon tubes, or why they glow brightest when the water is agitated, or why the light produced has little or no heat. Their "batteries" are buried in each cell's metabolic system, specific details of which are but sketchily understood.

Bioluminescence is not unique to these marine primitives. Bacteria, fungi, jellyfish, insects, mollusks, worms, fish, and even the prochordates—primitive ancestors of the vertebrates—have luminescing representatives.

Firefly light production is well understood chemically, and its use in recognition and mate attraction has been much studied.*

Some deep-sea fishes, living as they do in a world of perpetual darkness, are thought to use their light similarly, and in some cases as a lure or even as a scare device.†

But for every species whose reason for luminescing is understood, there are a dozen for which it makes no apparent sense. Indeed, since copepods and other zooplankton feed voraciously upon *Pyrodinium*, its advertising glow would seem to be a liability.

We know that firefly twinklings involve oxidation of a substance called luciferin in the presence of an enzyme called luciferase. A related chemical process is probably involved in the glow of marine micro-organisms.

Why do *Pyrodinium* swarm in such large numbers in only a few remote bays, and specifically in Puerto Rico's fire bay? One answer is based on the recent finding by biologists Paul and Lillian Burkholder of abundant vitamin B_{12} dissolved in the water there. Since plankton absorb basic chemicals directly from the water they live in, this could be a crucial factor in their proliferation.

Salt-water "Broth" Supports Luminescence

But where does the bay get its extraordinary amounts of B_{12}? Possibly from the scavenging bacteria known to exist in vast numbers in the bay's muddy bottom and amid the tangle of rotting mangrove roots and leaves lining its shores. The narrowness of the bay's channel to the open sea, plus its moderate tides, also may play a part. Without daily drainings and dilutings, the bay may accumulate enough phosphates, nitrates, and vitamins to form a rich, stable culture "broth." Some years ago, New Providence Island of the Bahamas group, 800 miles northwest of Puerto Rico, boasted a similar fire bay. But when its narrow outlet to the sea was widened, the luminescence disappeared.

Before I left Puerto Rico, an intriguing experiment in photography occurred to me. Would water from the bay provide enough illumination to photograph a human subject?

My collaborators in this research were Dr. Luis R. Almodóvar of the Marine Institute, and Institute aides Pedro and Daniel

Focusing a powerful lens on plankton, the author studies the secret of the lagoon's luminescence: the gleaming specks on the page opposite. Here Dr. Zahl works at Puerto Rico's Institute of Marine Biology.

Teeming, single-celled dinoflagellates swirl under the microscope. Glistening orbs with greenish centers are *Pyrodinium bahamense*, the bay's dominant light producers, magnified 250 times. Waters rich in vitamin B_{12} may explain their abundance in Phosphorescent Bay.

* See "Torchbearers of the Twilight," by Frederick G. Vosburgh, NATIONAL GEOGRAPHIC, May, 1951.

† For a fascinating account of light producers of the ocean deeps, see the author's "Fishing in the Whirlpool of Charybdis," NATIONAL GEOGRAPHIC, November, 1953.

Sea-water Shower Turns a Man Into a Faceless Specter

Twenty bucketfuls (left) caused research biologist Luis R. Almodóvar to glow like a ghost. Millions of luminescent organisms clinging to his hair and shirt emit shimmering light.

To catch the eerie result, Dr. Zahl used black-and-white film with a 5,000 ASA rating and a fast F1.4 lens. He kept the shutter open for 50 seconds.

For some reason, the author reports, micro-organisms failed to glow during a previous attempt when water was pumped over the man.

Rosado, who were father and son. We sailed out on the bay one night when conditions were once more ideal: no moon, a quiet sea, and intense phosphorescence.

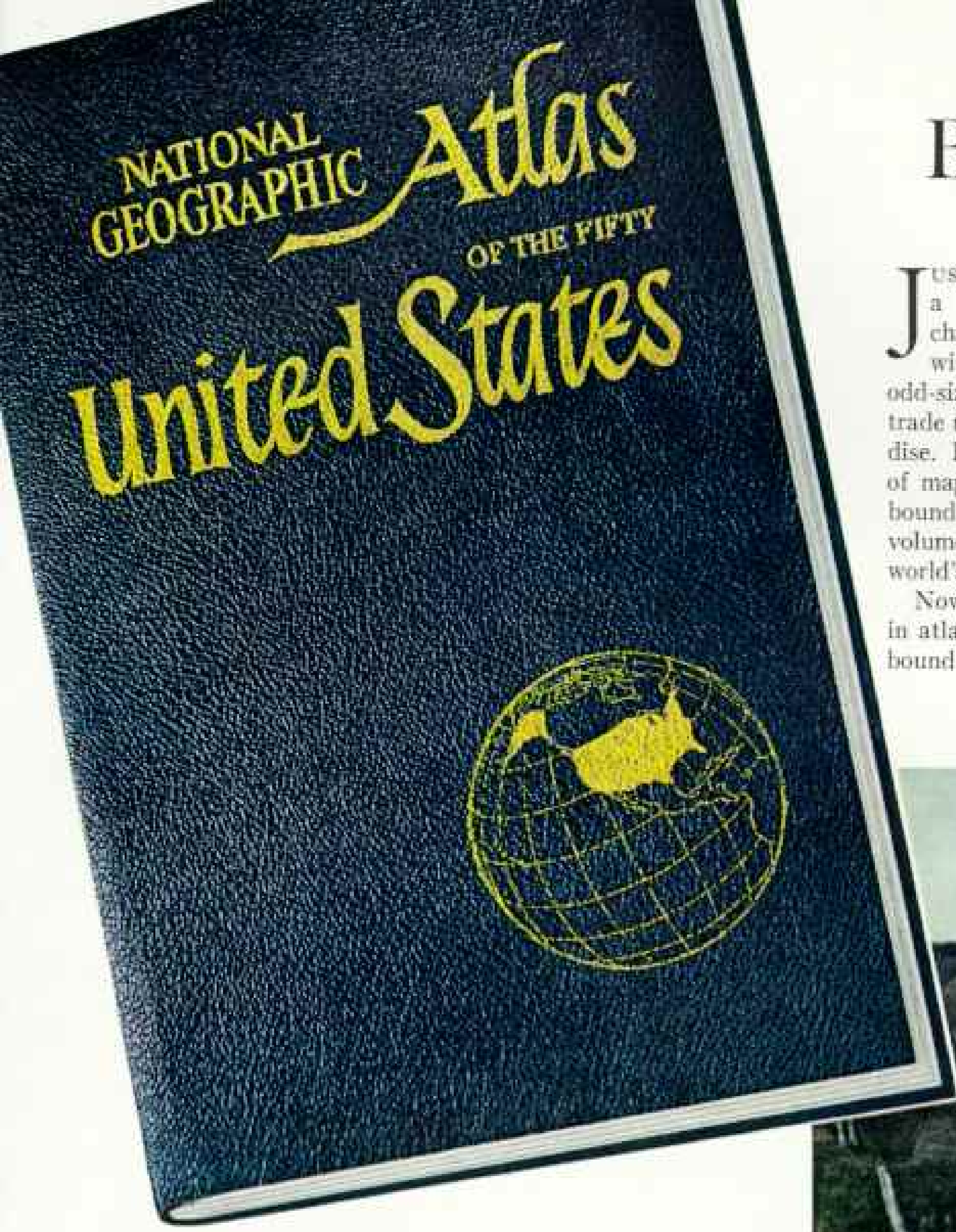
While I held the flashlight, Almodóvar, already in swimming trunks and a T shirt, pulled a diving mask down over his eyes and nose, then, as I directed, perched himself on the bow of the boat. Daniel and Pedro took standing positions on the gunwales, one on each side of him. Each held a bucket attached to an eight-foot rope.

Glowing Bay Water Creates a Portrait

With all lights doused, I yelled, "Start!" Daniel threw his bucket overboard with a splash and drew up a load of shining water. Hoisting it over Almodóvar's head, he began slowly to pour. Where the stream struck our subject's pate, it burst into flaming brightness and splashed down, still on fire, over his shoulders, arms, and torso. Working in relays, the men flooded Almodóvar with the glittering fluid. With each bucketful a little more light was registered on the film of my open-shuttered camera (opposite). Finally, after 20 buckets, I closed the shutter, crossed my fingers, and called a halt.

Almodóvar took off the mask and cleared his throat. Each cough brought forth a cloud of luminosity—some of the thousands of *Pyrodinium* cells that had trickled into his mouth during the deluge. His hair, too, for a few minutes continued to sparkle as if strewn with diamond dust. When these stars died, Almodóvar was again a normal, non-fire-breathing man.

Later, as we made ready to go back to Parguera, I caught sight of a silver crescent low in the sky. It was the first-quarter moon, betokening an end to my work on Puerto Rico's Phosphorescent Bay. Now, with the queen of the heavens flooding the earth with her radiance, *Pyrodinium*'s fire would seem to fade a little. But it would return when the nights grew black again.



Bringing

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Hawaii's miniature Grand Canyon, spectacular Waimea Canyon on the island of Kauai, offers breath-taking vistas of sheer red rock shawled with green forests and spangled with waterfalls. To pinpoint the scenic wonders of our 50th State, these vacationers find an invaluable guide in the large-scale map of Hawaii, one of thirteen 10-color maps in the new National Geographic **Atlas of the Fifty United States.**

America Into Your Home

By MELVILLE BELL GROSVENOR President and Editor

maps ever brought out by the National Geographic Society. Fittingly, this outstanding volume is an atlas of the United States; publication this month occurs at a time when Hawaii's star becomes the fiftieth on the United States flag—and makes old U. S. atlases out of date.

During the 60 years that have passed since it borrowed plates from the U. S. Government to print its first map, the National Geographic Society has become one of the best known and most respected names in cartographic publishing. Its map department has contributed original techniques and projections to the science of cartography, and its world-wide distribution has played a major role in popularizing the use of maps. More than 200 million copies of Geographic charts have been distributed.

The new National Geographic **Atlas of the Fifty United States** stands as a pinnacle of achievement in this 60-year history of cartographic leadership. Its 19-by-25-inch charts offer an unrivaled collection of up-to-the-minute data about our changing Nation. Earthquake Lake, for example, born last August in the upheaval that rocked Montana and Yellowstone, appears on the map of the Northwestern United States.

Rocket symbol marks an Idaho base on the Northwest U. S. map. The new Atlas locates 18 recently announced bases for launching missiles tested at Cape Canaveral, Florida (left).

The new Atlas contains thirteen 10-color charts, each spread across two pages: A map of North America, a general map of the United States, six large-scale regional maps, separate charts of Alaska and Hawaii, a map of the populous Northeast from Washington to Boston, a display of the Nation's 182 national parks and monuments, and another sheet providing greatly enlarged charts of the 12 most popular of these vacation areas.

Regional maps in the Atlas overlap generously. As a result, many of the 48 conterminous States—that is, States with joint boundaries—get double coverage. The densely populated parts of Canada along the U. S. border also appear in detail.

Much of the new Atlas's value stems from the 32-page index that lists every name printed anywhere on the maps—hamlet or hill, monument or metropolis. There are more than 30,000 in all, each identified and located by page number and by guiding coordinates.

Maps and index combine to give a mine of information about the rapidly changing United States. The size of type in which a city's name is printed, for example, indicates its relative size. You will see, too, which highways reach it, how railways serve it, what historic sites or points of interest are near by. So up to date is such information that the maps include locations of intercontinental missile bases recently made public by the U. S. Air Force.

ALLAN C. FISHER, JR., (OPPOSITE) AND NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS NEBBIA © N.G.S.

Fiery lava, creating 400 acres of new land and wiping out two villages, brings change to the map of Hawaii (page 36). Chief Cartographer James M. Darley checks last-minute revisions.

The National Geographic **Atlas of the Fifty United States** represents a tremendous amount of painstaking handiwork and geographic research. Because much of the cost of producing it has been borne by The Society's Atlas Map program, this outstanding publication can be offered to members for only $6.75. Copies may be ordered from the National Geographic Society, Dept. 44, 16th and M Streets, N. W., Washington 6, D. C.

Both in my work and at home I have found that getting "the Atlas habit" is like making a friend of the dictionary: through frequent use each becomes a pleasant companion, a sharpener of knowledge.

"Hottest spot in the Nation today was at Stovepipe Wells in California's Death Valley," the newscaster reports. Reach for your Geographic Atlas—and turn a statistic into a place. "How far is Alaska from here?" your seventh-grader wonders. Open your Geographic Atlas—and a growing mind absorbs another fact.

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The Atlas is, in short, a reference particularly designed for this kind of constant service. The maps are bound in durable, dark-blue covers of simulated leather that add an attractive touch to shelf or table. Each double spread opens flat, with nothing hidden by the center fold. The most permanent inks available and sturdy paper made to the National Geographic's exacting specifications ensure lifetime service of each Atlas chart.

Over the years Geographic maps have gone with explorers to the Poles, accompanied military leaders into battle, been used by Presidents of the United States at their White House desks, served millions of people in all walks of life. Now, in your hands, the new National Geographic **Atlas of the Fifty United States** can find equally valued use as a handsome, handy reference—an authoritative tool for exploring the fascinating face of these changing United States.

Return of the Trumpeter

Conservationists battle to save the world's largest wild swan

By FREDERICK KENT TRUSLOW

Photographs by the author

A LOUD brassy call rang across the lake, reminding me of the time our elder son first tried to blow a trumpet.

"Listen!" my wife Mildred exclaimed. "Trumpeter swans?"

I nodded, my pulse quickening. Such a tremendous avian sound could be produced only by the world's largest waterfowl, using all the power in its 30-pound body to blow through its huge windpipe.

Hot Springs Create Winter Refuge

It was to study and photograph this rare bird that we had come to Red Rock Lakes National Wildlife Refuge, high in the isolated Centennial Valley of southwest Montana (map, page 148). Here the only large group of trumpeter swans in the United States lives in a year-round haven shielded from two great dangers—man and migration. From man by law. From migration by physical features of the valley and by help from conservationists.

Though air temperature in this part of Montana falls to a bitter 40° below zero, there are ponds in Centennial Valley that remain partly unfrozen all winter long. These spring-fed waters are warmed by the same boiling heat from inside the earth that makes Old Faithful geyser blow off once an hour in Yellowstone National Park, only fifty miles to the east.

"Here they come," Mil said, "two of them!"

The trumpeters approached above the marsh grass and flew low over the water, a magnificent sight of pure white in the afternoon sun, their necks outstretched, their wings spreading eight feet from tip to tip.

We watched spellbound until our trumpeter pair disappeared, having given me hope that my search would be truly fruitful at last. For I had come a long way in my wild trumpeter chase, commissioned by the National Geographic Society.

I had caught only glimpses of trumpeters in Yellowstone National Park. Later, at Jackson Hole, Wyoming, in Grand Teton National Park, I managed to photograph a pen—as the

Trumpeter Convoys Her Brood Across a Lake in Grand Teton National Park

Largest and handsomest of waterfowl, the trumpeter swan has staged a dramatic comeback from the brink of extinction. Named for its resonant cry, the snowy giant—five feet long with an eight-foot wingspan—once faced the fate of the heath hen and the Labrador duck. In 1935 only 46 adults could be counted in the continental United States. Today, thanks to conservation, the number approaches 700, with another 100 in Alaska and 700 in Canada—a total of 1,500 of these lordly birds left alive.

female swan is called—and her powder-puff brood (page 135). In Oregon, in Malheur National Wildlife Refuge, I had watched a trumpeter couple courting (page 142).

But what I wanted most was to find a nesting pair. For that, it seemed, chances should be good here at Red Rock refuge, because this is the place the trumpeters like best.

Conservationists have taken some 130 trumpeters from Red Rock to Malheur over the past 20 years, seeking to give the birds another foothold. But with the exception of two pairs in 1958, none remained to nest at Malheur.

Valley Matches the Swans in Beauty

Could I find a swan couple hatching a family here, and would I get close enough to the nest for good pictures without disturbing them?

That day we had driven west from Yellowstone past Henrys Lake and crossed the Continental Divide. Suddenly, ahead of us and below, we had sighted Centennial Valley, 40 miles long and 6 miles wide, stretching out green and lush to the west. Upper Red Rock Lake—and beyond it Lower Red Rock Lake—shimmered silver against the setting sun.

We had stopped to let the beauty soak in. Then had come the long descent into the valley, where we saw the pair of swans beside

Nesting swan finds privacy in the marshy meadows of Red Rock Lakes National Wildlife Refuge, a 40,000-acre sanctuary in southwestern Montana. Major breeding ground of trumpeters in the United States, the remote valley nestles 6,600 feet high, under the rim of the Continental Divide. Lofty Centennial Mountains wear snow patches all summer long.

Weary of incubating, a pen, or female, stretches and preens atop the nest. Then, curving her long neck backward and tucking her black bill under a wing, she settles once more on the mound of reeds and grasses. A trumpeter clutch contains three to nine large, dull-white eggs. Incubation takes about five weeks.

the first of the two lakes. Now we drove the last eight miles to the 7 L Ranch, whose owners, Andy and June Forsythe, helped us stow our gear in a comfortable log cabin. After supper I explained my plans.

When I undertook the Geographic assignment, the U. S. Fish and Wildlife Service had granted me a seldom-given permit to photograph and study the trumpeters closely, just as it had done previously in the case of other rare species of birds.*

In addition, the service had generously loaned me an advance copy of its publication, "The Trumpeter Swan," by Winston E. Banko, to give me valuable history and statistics.

The trumpeter swan (*Olor buccinator*) was a fairly common bird in colonial times. Trumpeters wintered as far south as California, Texas, Louisiana, and North Carolina, and most of them probably migrated to northern Canada to raise their broods.

Winter Feeding Keeps Flocks Alive

During the 19th century the birds were slaughtered for their beautiful plumage to provide adornments, powder puffs, and down coverings. By 1900 the species was nearly extinct. Only a few pairs in Yellowstone National Park were protected, thanks to the act of Congress covering all wildlife within the park. The Migratory Bird Treaty Act of 1918 legally guarded all trumpeters in our country from hunters. But it was almost too late. In 1931, four years before the Red Rock refuge was established, only 35 of the great birds were seen in the United States.

Thereafter the swan population slowly increased, thanks to protection of the breeding ground and an important change in the swans' migration habits. They had begun to avoid perilous long flights and to remain instead in and around Centennial Valley.

Here, supplemental winter feeding in the open water by the Fish and Wildlife Service is essential. Each winter, refuge personnel put out about a thousand bushels of wheat and barley, doling out the grain in twice-weekly installments.

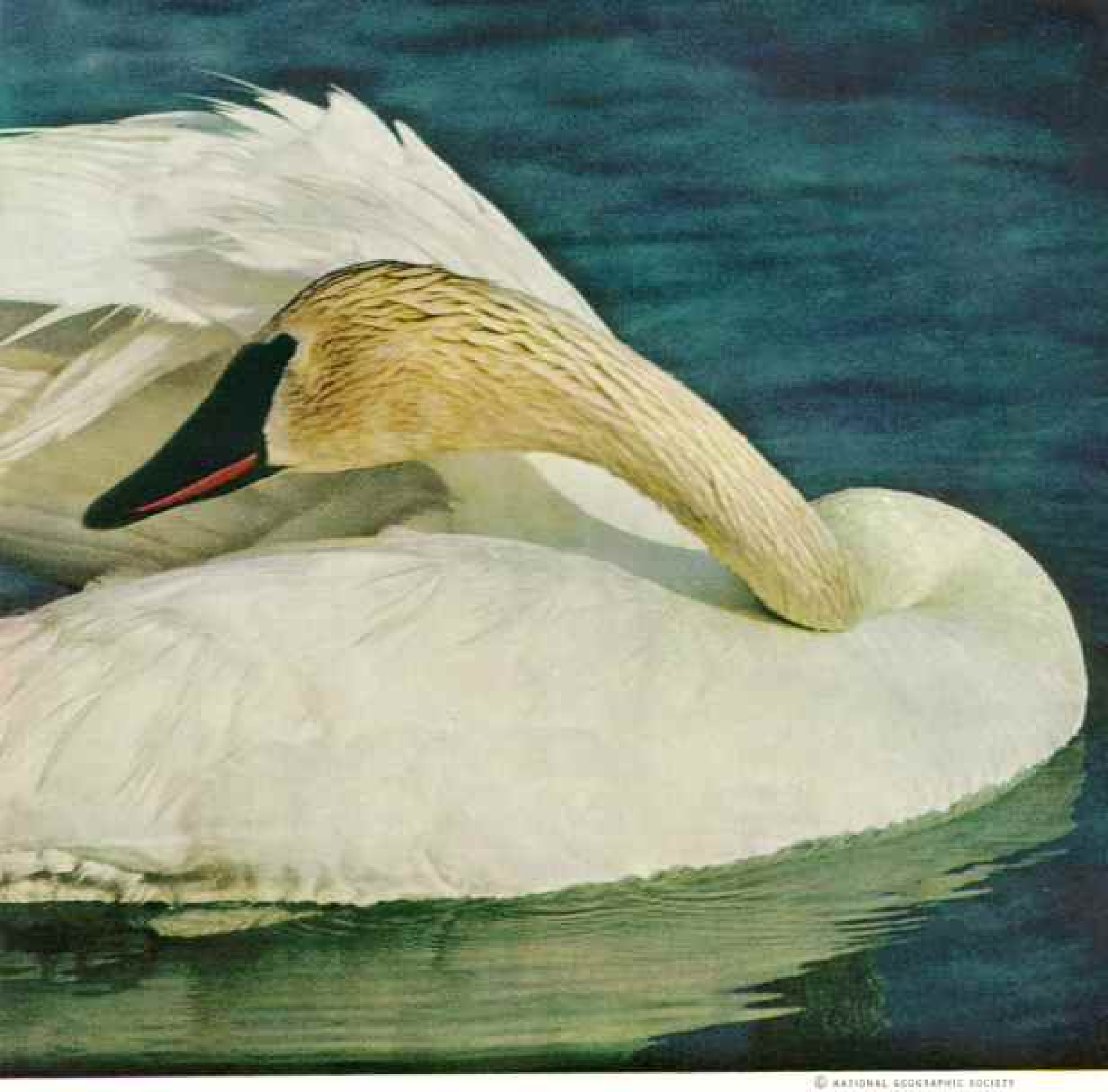
Now the Fish and Wildlife Service estimates that the trumpeters in the United States, excluding Alaska, number nearly 700. Yet I believe a single calamity—an epidemic disease, lack of food, or nesting failure for one reason or another—could wipe out nearly all these magnificent birds south of Canada.

Shooting of other waterfowl is still permitted on Lower Red Rock Lake during the hunting season. The swans are legally protected, but there is the ever-present danger of one of them being shot accidentally. And lead pellets eaten by them have been found in the stomachs of dead swans.

Trumpeter in profile shows her "grin line,"

Altogether there are approximately 1,500 trumpeter swans in the world. This includes roughly 700 in Canada and about 100 in the Copper River region of southern Alaska. In contrast, the smaller whistling swans (*Olor columbianus*) are estimated at 80,000 along the Atlantic and Pacific flyways.

* See "Whooping Cranes Fight for Survival," by Robert Porter Allen, with photographs by Frederick K. Truslow, National Geographic, November, 1959.



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a salmon-red streak on the lower mandible. Iron in the water stained head and neck feathers

As I pondered these things, a swan trumpeted across the valley in the moonlight, and I fell asleep to that reassuring music.

The next morning Mil and I drove five miles east along the valley road to refuge headquarters at Lakeview. Brilliant mountain bluebirds and black-and-white magpies perched on the fence posts. Two badgers sat upright beside their den and stared at us as we went by. Near the shore of Lower Red Rock Lake an ungainly Shiras moose fed in the marsh, water dripping from the swamp roots in its mouth.

Chester R. Markley, who manages the 40,000-acre refuge, said he'd gladly help us.

"But those trumpeters are wilder than eagles," he warned. "During molting season, we use air boats to catch them for banding and shipment to other refuges, like Malheur. Once they've been chased, those swans never forget. They'll take off before you can get within half a mile."

Markley introduced his assistant, Dr. Charles Hansen, a biologist. "We have about seventy nests this year," said Markley. "I know your field experience and careful methods. Anything you two decide is fine."

For a week Chuck Hansen and I checked every bit of nesting territory, looking for the best nest to work: an isolated site that would let us photograph without disturbing the other swans. We needed a nest whose tenants were

Wary of an approaching boat, temporarily flightless trumpeters in molt flap wildly away.

Man-made muskrat lodge (below) camouflaged the author at Red Rock Lakes refuge, permitting him to take his extraordinary photographs. So realistic was the blind that Mr. Truslow was able to take portraits of nesting trumpeters at less than 30 yards' distance. Here Dr. Charles Hansen, a biologist at the refuge, removes gear.

A few at right retreat with dignity. Other waterfowl share Upper Red Rock Lake

near the end of the incubation period—for, the closer to hatching, the less easily scared away the incubating bird will be.

We moved by car, jeep, and skiff, observing the trumpeters from a distance through binoculars. What Chet had said about their wildness proved to be an understatement.

At our approach the swans took off from their water runways like heavy bombers under full throttle. Their big webbed feet, digging into the water at full running speed, threw up fantails of spray eight to ten feet high. After a run of 100 feet or more, the big birds were airborne and retracted their huge landing gear close under the tail (page 146).

When landing from any considerable height, the swans lose altitude rapidly, with the sound of braking wing action. On final approach they go into flat glides. Just before touching water, they tilt their necks and bodies up and extend their legs far forward, webbed feet pointed up at a 45-degree angle to the surface. Water shoots high as the feet take the landing impact.

Seeing the swans at a distance was one thing, but getting close for nesting pictures was another matter.

Steam-shovel Method Builds a Nest

It is surprising how little cover an incubating swan needs to hide her great white body. Now and then she raises her long neck like a periscope and projects her head just above the grass for a brief look about (page 136).

After several days we discovered an isolated nest in a little bulrush marsh seven miles west of the refuge. When we were still more than a quarter of a mile away, the pen abruptly left the nest. We approached cautiously to examine the structure. Built

Quivering wings raised and partly extended, the cob (male) and pen literally walk atop the water as they approach each other in mutual display.

A monogamous bird, the trumpeter is believed to mate for life, pairing off at about three years of age. Breeding begins at about five. These swans frequent a protected pond in Malheur National Wildlife Refuge, Oregon, where trumpeters transplanted from Red Rock Lakes mingle with more than 210 other species of birds but rarely nest (page 137).

Trumpeters' Courtship

two feet above water on a muskrat lodge, it measured about five feet in diameter.

The "steam-shovel" method the swans often use to build such a nest is interesting to watch. Grabbing a big billful of vegetable material, the trumpeter pivots 180 degrees and throws the load toward the nest site. Circling the nest and continuing this operation, the swan piles up the material and keeps movement to a minimum.

First Nesting Swan Proves Too Shy

Before leaving, the pen had covered her eggs against exposure and the view of predators. We discovered four eggs, each about four and a half by three inches. A full clutch may number anywhere from three to nine. Originally white, the eggs were now spotted and stained brown from incubation. We figured that the swan had been sitting at least two weeks. It would be roughly three more before the cygnets would hatch.

This nest seemed ideal for what I had in mind. We set up my blind 150 feet away and retreated to a distant observation point.

Three hours passed, and the swan had not come back. Unwilling to take any chances of the eggs being chilled when the sun's warmth waned in late afternoon, we picked up the blind and again withdrew.

Within three-quarters of an hour we saw the pen get back on her eggs. But we knew we could not work this nest—the swan was nervous, obviously frightened by the blind.

Masquerading as a Muskrat

We cranked up the refuge's old Army weasel, with its truck body and tank treads, and plowed through the marshes in search of another nest. Water splashed over the floor boards, and mud flew out from both sides as we crossed channels and dropped into bog pits.

One day Chuck pointed to a nest about a mile away, on the shoreline of Upper Red Rock Lake, an easy spot to reach by skiff. With our glasses we saw the incubating pen, with her protecting cob swimming close by.

Mated pairs guard their territories jealously and generally attack all trespassers. This was an isolated nest, all right, for Upper Red Rock Lake is "bachelor" quarters for more than 150 nonnesting swans.

Looking toward the nest again, I noticed two muskrat houses in the water behind it.

"Chuck, how about building a muskrat house over our blind?" I suggested. "Maybe those swans won't know the difference."

"Worth a try," Chuck said.

We loaded my collapsible canvas blind and equipment into the skiff and set out across the lake toward a small grassy point near the nest. The trumpeter was off her eggs now, on the afternoon feeding trip with her mate.

When we reached the point, we found that it was really only grass growing in 10 to 20 inches of water. There was no solid ground to set the blind on, so we poked its bottom into the soft mud 120 feet from the nest, leaving about three and a half feet of the blind out of the water.

As I crouched inside, Chuck passed in a folding campstool, two waterproof equipment boxes, and the tripod, which I lashed to the top of the blind. The canvas seat of the stool just cleared the water.

Radio Links Observer With Shore

We covered the entire blind with a four-inch layer of vegetable matter, leaving a hole for the 400-millimeter lens and an entrance in the back.

The result looked like an extra-high muskrat lodge (page 140). Before an hour had passed, the trumpeter returned and climbed back on her nest, taking no notice of the new muskrat

house which had so magically appeared there.

The sun was low over the western wall of the valley, and we called it a day. That night I didn't sleep much. I could hardly wait for morning.

At 3 a.m. I was wide awake and turned off the alarm before it could ring. Mil heard me mutter as I fell over a chair in the dark. She murmured something. "Why go to a muskrat house at this time of night? . . . You might drown . . . I wish you wouldn't go."

Dawn was creeping into the eastern sky when we headed the skiff for our nest. The trumpeter swam away before we could see her clearly. We sloshed the equipment 50 yards from the skiff to our blind, and I crawled in. My boots were half full of water, so getting wet no longer mattered.

I sat on the stool, lowered the two equipment boxes into the water, and set up the tripod so that the head was about a foot above water. Then I grabbed my gear as Chuck passed it to me. I tied a walkie-talkie, which I'd brought along for communicating with Chuck, to the top bolt of the blind. My rubber lunch bag floated on the water between my knees.

"I'll keep you posted on the swans with the walkie-talkie until they come in," Chuck said. "After eight o'clock you can call in directly to the headquarters set. Good luck!" He plugged the hole with grass and was gone.

Half an hour later Chuck called: "Swans coming around the point to your left, heading for the nest. Get set."

Pen Completes Her Morning Coiffure

There wasn't enough light yet for good photography, but I glued my right eye to the camera view finder and waited tensely. Less than 10 minutes later the pen appeared in the lens, next to the nest.

She looked about, peered over the top of the nest, then climbed aboard. Stretching her neck, she shook herself like a dog, starting with the tail and working forward along her 60-inch length. The water flew.

Uncovering her eggs, she turned them with

her shiny black bill, her bright-red "grin line" on the lower mandible showing brilliantly in the early morning sunlight. Her feathers were pristine white except for her head and neck, which were flecked with rusty brown—stains from iron compounds on the lake bottom.

A long period of preening followed—wings, tail, underparts, sides, back, and neck, up as far as her bill could touch. She combed each tail- and wing-feather with her bill, then rumpled and smoothed out all the short down. Her coiffure completed, she settled down gently on the eggs, curved a neck longer than her body over her back, tucked her bill under one wing, and went to sleep.

Tribulations of a Swan Watcher

It was still too dark for the camera. I just had to wait and hope, watching through the long lens that brought the swan so close I almost felt I could reach out and touch her.

Offshore several trumpeters were feeding in the shallows 50 yards from the blind. First they stood up, treading water rapidly to churn aquatic plants free from the bottom. Then it was bottoms up, as their heads and necks went down to feed on the loosened vegetation. When the swans took off and flew directly over the blind at full speed, the swish of air

Swan Family on a Cruise Heaves To for Diving Drill

"Parents let the young birds frolic about in open water but herd them in tight formation near shore," observes the author. The cygnet above appears engrossed by father's diving demonstration; actually, the downy youngster waits expectantly for aquatic insects and tidbits that the cob scrapes from the bottom.

Feet tucked under tails, powerful wings cleaving the air, a snowy squadron

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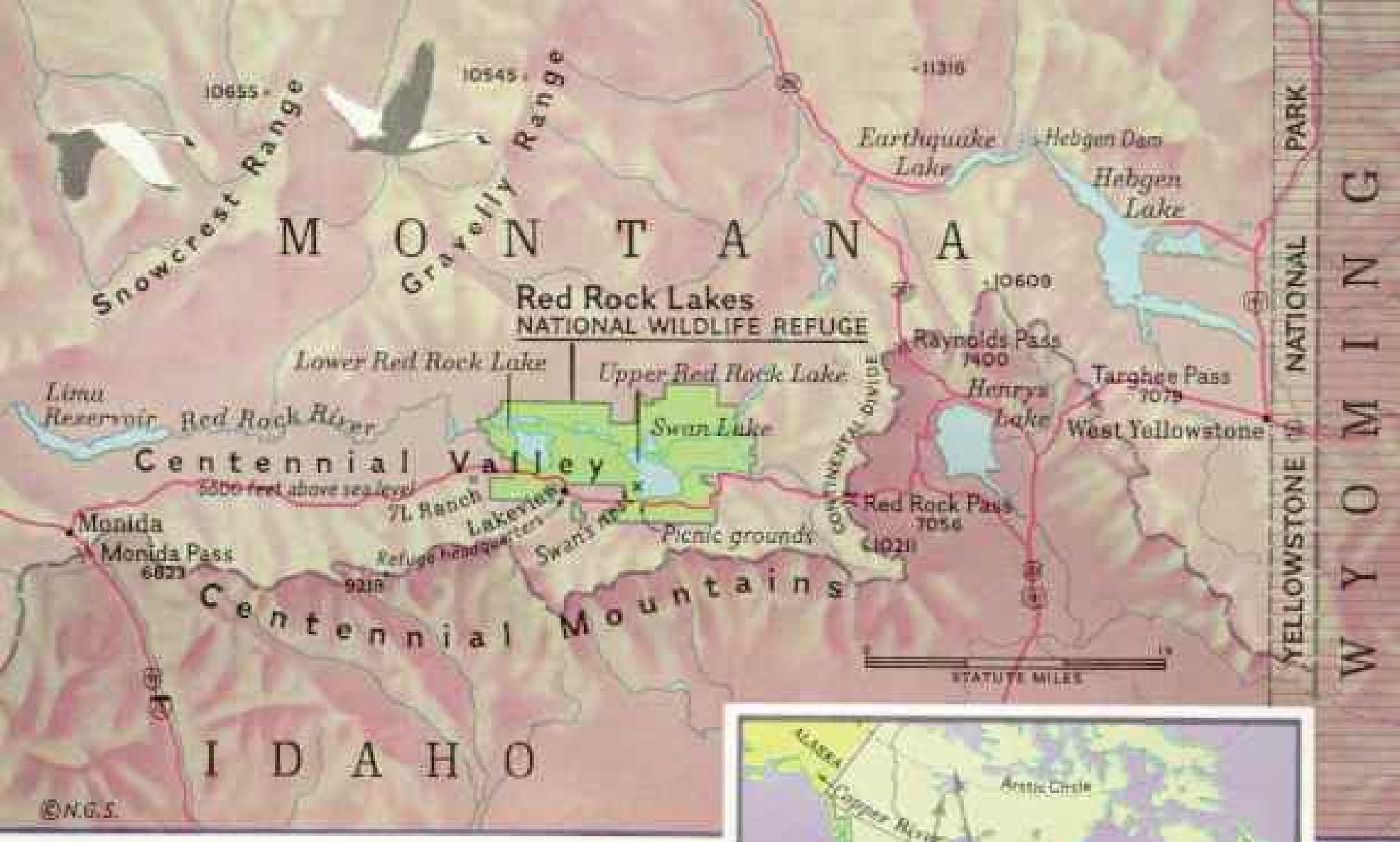
takes off into the western sky. Trumpet notes float back on the wind



Red Rock Lakes refuge in Montana proves an ideal sanctuary for the rare trumpeter swans. They remain throughout the winter. Their retreat felt moderate tremors from the near-by Hebgen Lake earthquake last summer.

Busy flyways lacing the continent carried swans from the Gulf States to the Arctic Circle 150 years ago. Today the trumpeters no longer make long migrations. In winter Aransas National Wildlife Refuge shelters the few surviving migratory whooping cranes.

and the clatter of huge flight quills sounded like jets with something loose.

As the sun rose higher, the temperature in my blind had changed from freezing cold to intense heat. I managed to peel off my sheepskin coat by easy stages without knocking over the tripod.

Marsh gas bubbled up around my legs, so I unzipped four inches of the blind fabric on the side away from the nest and pushed the covering vegetation slightly aside. A little air seeped in and I felt better.

Now the light was right for pictures. The trumpeter had finished her nap. As I looked through the lens, her long neck curved down with a snakelike motion as she scooped up a soggy mouthful of sedge from the water.

She started to level and rebuild the top of the nest. I am sure that she never heard the shutter clicking inside the thick grass-and-sedge walls of our man-made muskrat house. In midmorning her mate swam up, and off they paddled for an hour's foraging.

Then I realized that my legs had gone numb. Amid great contortions I got my boots off in the cramped space and rubbed some feeling into my feet and calves.

Floating Lunch Table Holds a Meal

Before the swans returned, I had lunch—sandwiches and coffee balanced on a floating equipment box.

All afternoon long I got pictures of the swans in action, and it was after five when I finally called Chuck for relief. I had been in the blind 13 hours, up to my middle in water much of the time.

People ask how I can stand such long hours. Well, the hours don't seem long when a lot of things are going on around me. I'm no longer

What Does Fate Hold in Store for the Trumpeter Swan?

The pose of this preening beauty seems to ask the question. The great bird exists nowhere in the wild except in North America.

a watcher. I feel part of the wildlife group, and thanks to the secretive blind, the birds' actions are completely normal.

When Chuck pulled me out of the blind, I was temporarily paralyzed from the waist down. But I was happy.

Before leaving, we moved our studio closer for the next day's shooting—80 feet from the nest. Again we followed the same schedule. At 80 feet the swans seemed no more aware of my presence than at 120.

Besides nesting shots, I got pictures of a pair of trumpeters with their downy gray cygnets in a near-by cove (page 144).

Dangerous Waters Call for Convoy

The parents were bottom feeding about 20 feet apart, and the cygnets rushed back and forth between the two to see what papa or mamma would bring up for them. As a water bug or beetle appeared, a tiny bill would snap it up. The youngsters tried to imitate the parents and dive, but their buoyancy and inexperience hindered them.

While the family was in open water, the parents paid little attention to the cygnets, letting them romp. But when the time came to head for shore, play was over. The cygnets went into convoy formation, head to tail, father leading the way and mother covering the rear. Danger might lurk in the grassy banks.

I watched this family for 10 days. The female would brood the cygnets at home during the night, or on rainy days, or just after they had been on a long expedition. The young swans used the home nest as a playground, and the parents used it as a preening place. The cygnets, from the time they hatch until they start to fly three or four months later—as 15- to 20-pound youngsters—are seldom apart from their parents (page 135).

June ended, and we packed our gear to leave. As we passed the picnic grounds beside Upper Red Rock Lake, we saw our swan incubating her eggs in the rain.

Now, back in my study in Summit, New Jersey, I can still hear the wild trumpeting of the swans across the valley in the moonlight. They will do their part to perpetuate their magnificent species. The rest is up to us.

Hope for Survival of the Trumpeters Springs From a 4½-inch Egg

Hours old, this cygnet huddles against the eggs of its brothers and sisters. The egg in center foreground is being pipped for the debut of a second cygnet.

WINSTON E. BANKS, U. S. FISH & WILDLIFE SERVICE

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COVER: *An astronaut, his capsule glowing like a furnace coal, enters the atmosphere* (page 49).

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As the second season's work gets into full stride, expedition scientists are a step closer to solving the mystery: Studies of centuries-old pollen uncovered in Long House (above) show that climatic or soil changes in the 13th century may have starved the Indians out. In an early issue of the NATIONAL GEOGRAPHIC, members will receive a vivid report on this fascinating research project—one of the many made possible by their annual dues.

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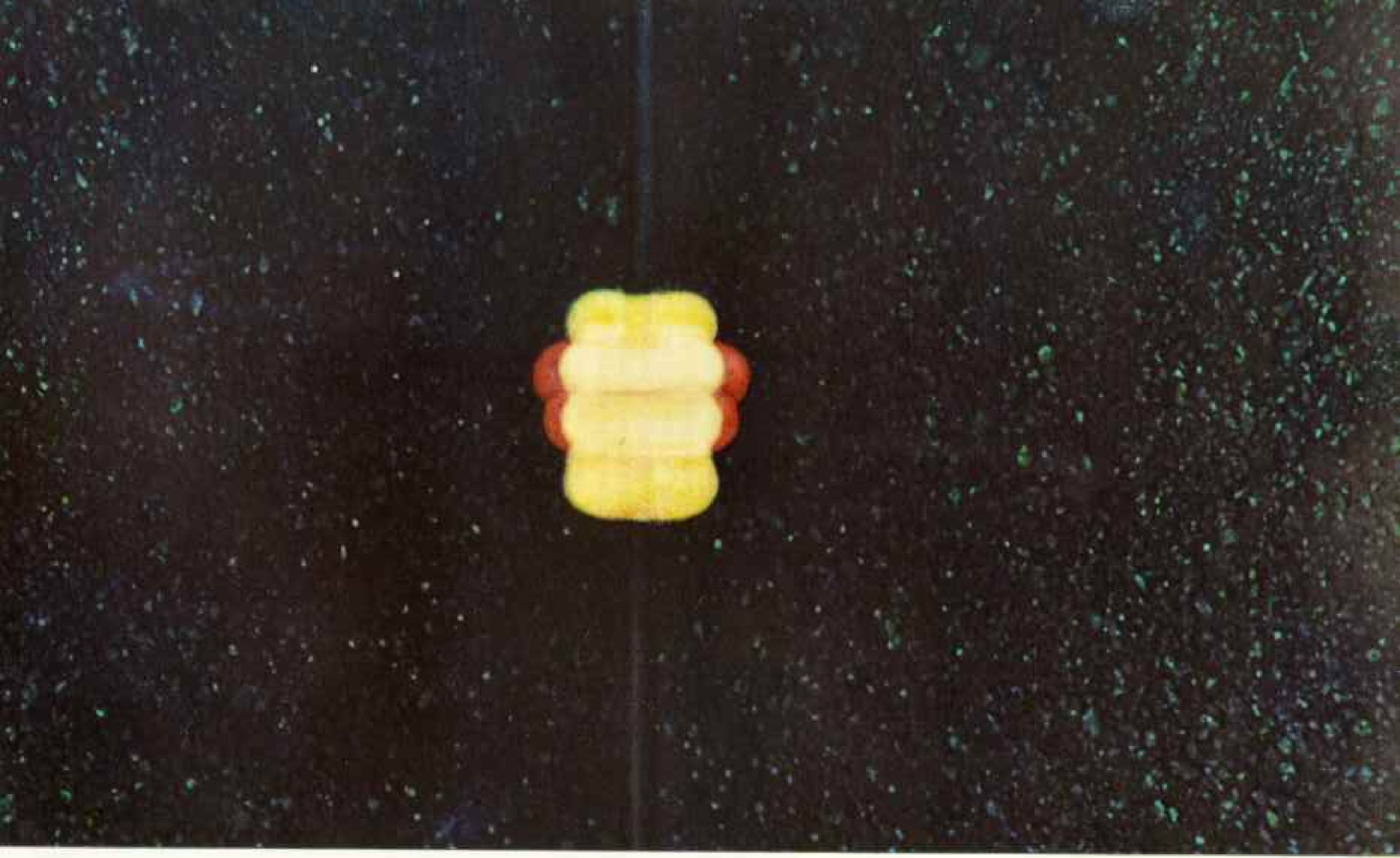

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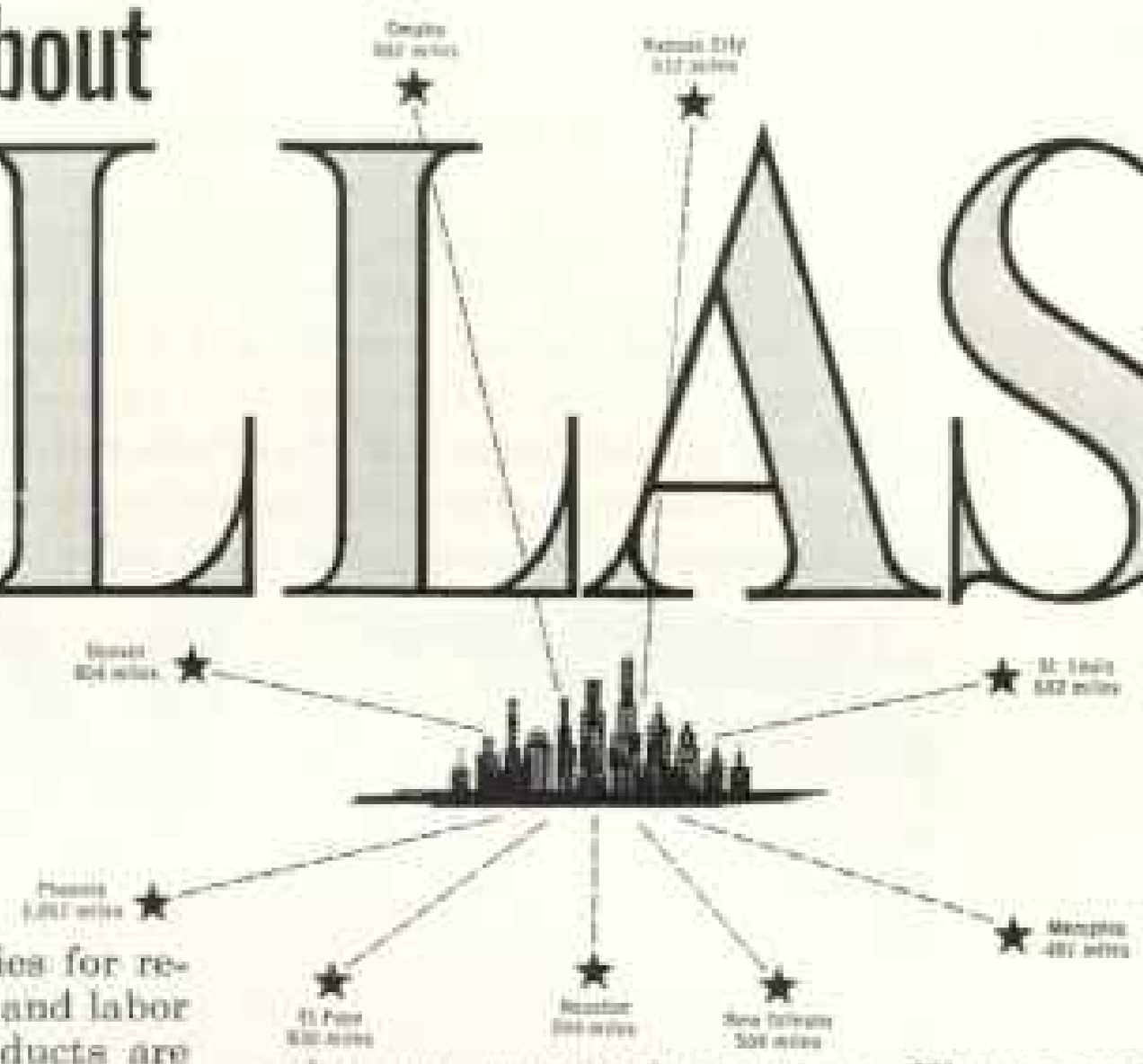
defense but also for peaceful exploration, cultivation and colonization.

information about DALLAS for industrial site seekers



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Gas: 351 million cubic feet of natural gas delivery capability to Dallas within 24 hour period; supply backed by over 13,000 wells within 200 miles of Dallas.

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THE COMMUNITY: 117 elementary schools averaging 28.7 students per class, and 29 junior and senior high schools averaging 30.2 students per class.

In addition, there are 24 private elementary, and seven private high schools. There are four universities and colleges in Dallas. 115 parks and seven community centers. Eleven major hospitals, and 1,106 physicians registered with County Medical Association. A city budget of $2,150,000 for general health and welfare.

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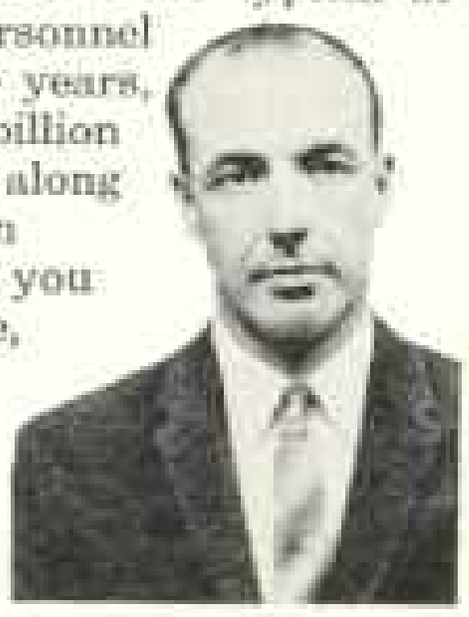

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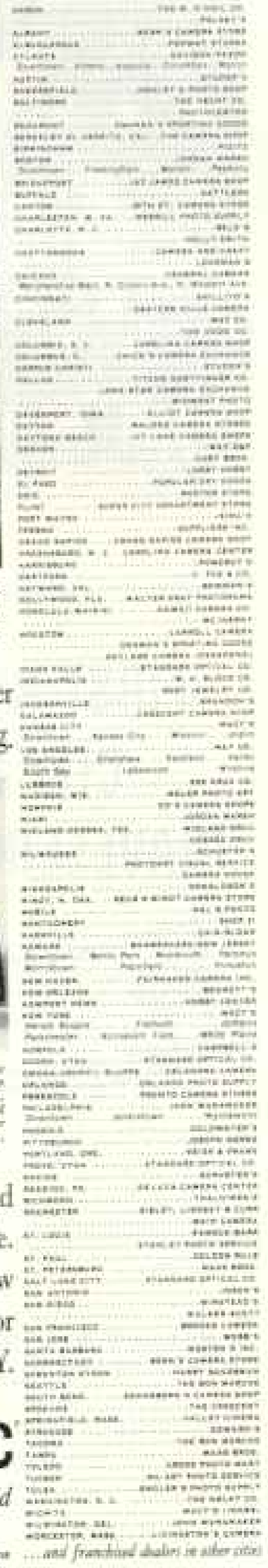

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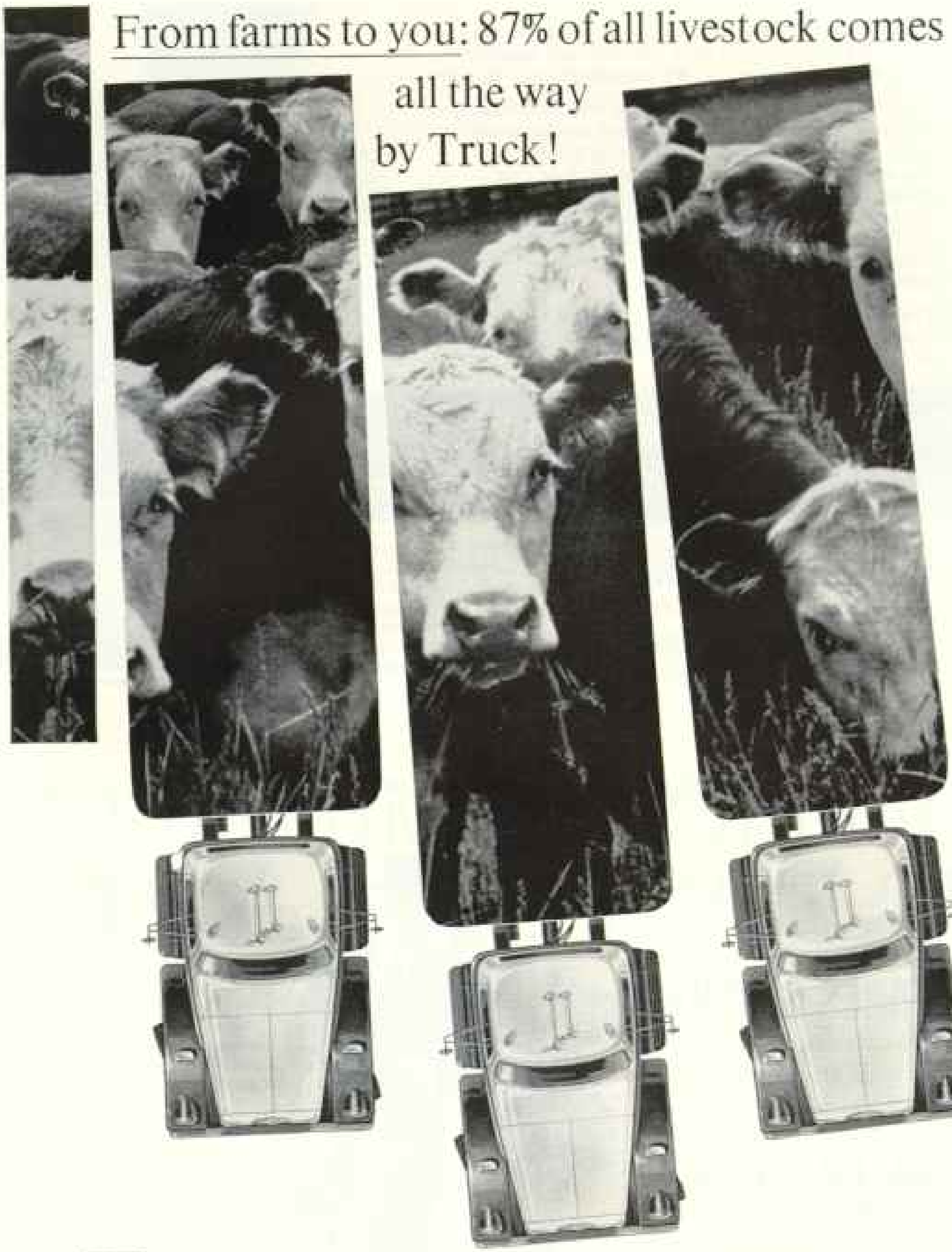

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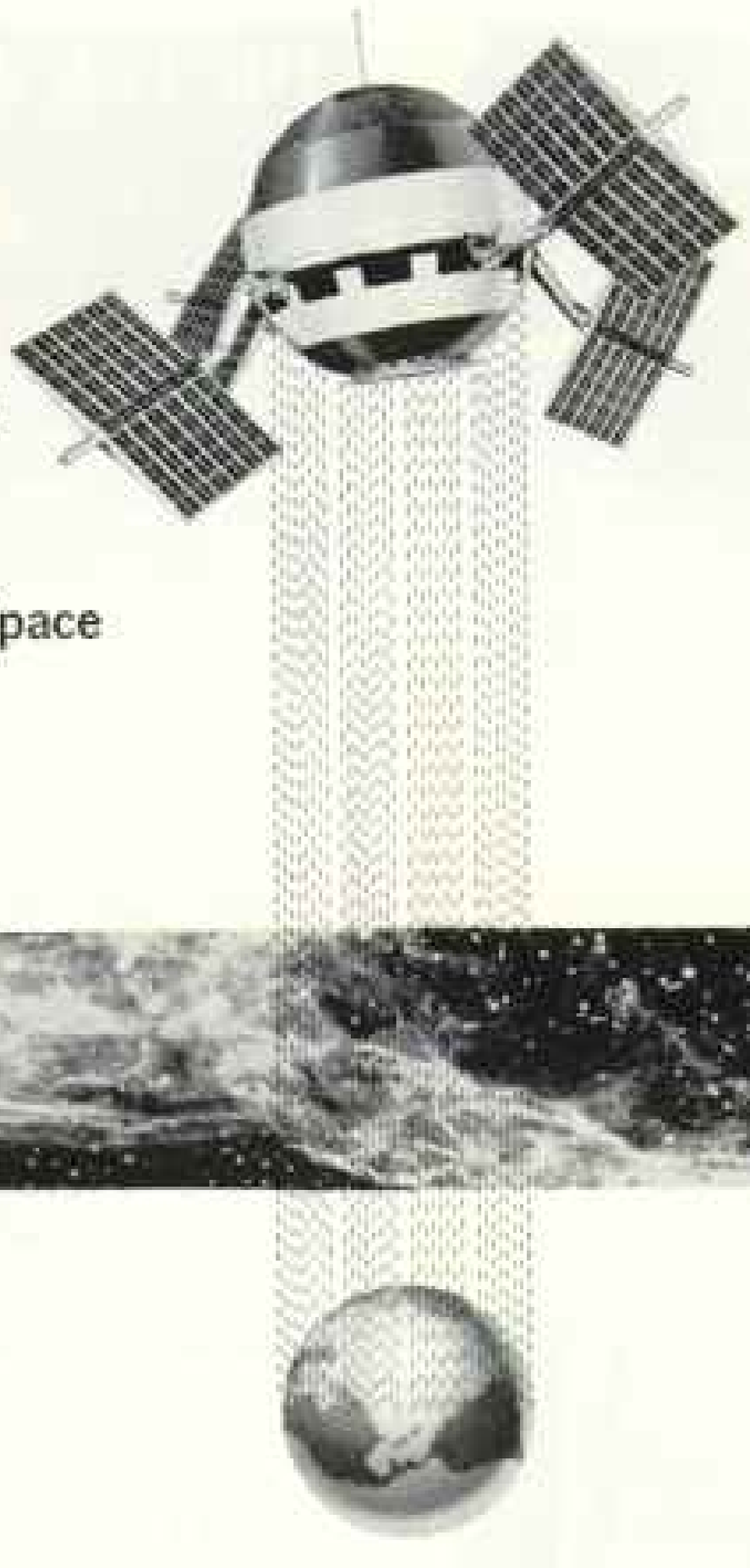

At this moment Pioneer V, one of the most advanced space probe vehicles ever launched, is on a course toward the path of Venus—26 million miles from earth. Blasted aloft March 11 by a Thor Able-4 rocket booster, this miniature space laboratory will reach its destination in about 130 days • The project, carried out by Space Technology Laboratories for the National Aeronautics and Space Administration under the direction of the Air Force Ballistic Missile Division, may confirm or disprove long-standing theories of the fundamental nature of the solar system and space itself • Energy from the sun—captured by almost 5,000 cells mounted in the four paddles—is used to supply all of the electrical power to operate the sophisticated array of instrumentation packed into the 94-pound spacecraft which measures only 26" in diameter • By combining a phenomenal digital electronic brain (telebit) with a powerful radio transmitter inside the satellite, STL scientists and engineers expect to receive communications from Pioneer V at their command over interplanetary distances up to 50 million miles • STL's technical staff brings to this space research the same talents which have provided over-all systems engineering and technical direction since 1954 to the Air Force missile programs including Atlas, Thor, Titan, Minuteman, and related space programs.

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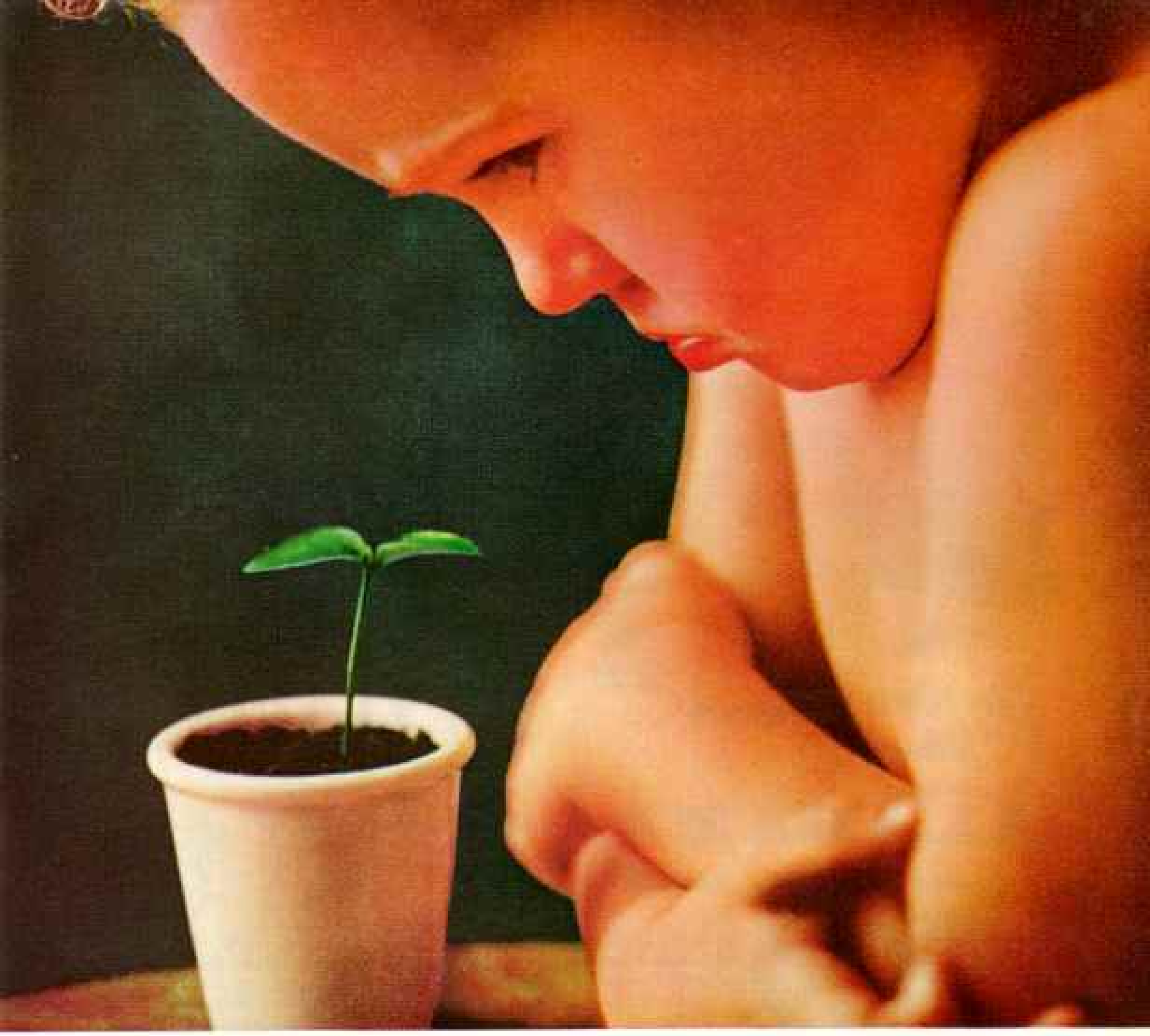

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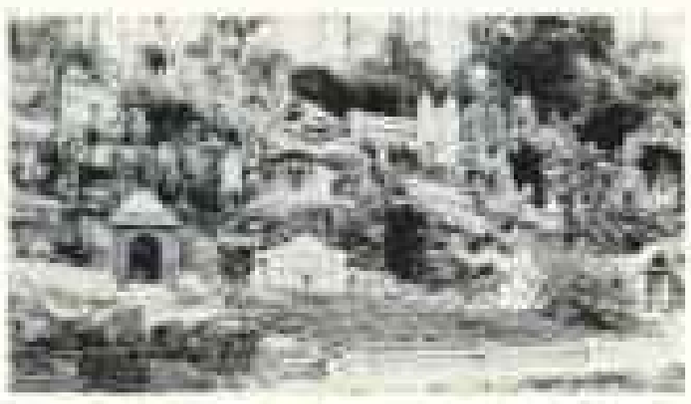

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WATER, WATER EVERYWHERE—and Americans are flocking to it in greater numbers than ever before. They're swimming, boating, skiing and diving into its once-forbidden depths.

Water sports are invigorating, relaxing and healthful. But they can be hazardous. Dangerous situations can develop quickly and when you least expect them.

So, before taking to the water this summer, consider its perils—and perfect your skills. Here are some suggestions for your fun, adventure and safety—in, on and under the water.

Swim with Safety. "Never swim alone, always go in the water with a buddy." Stick to this rule at all times—especially if you're a skin diver.

Until you've become an expert swimmer, always stay out of deep water. Inexperienced swimmers often lose their lives because of panic.

Swim only at a safe bathing place, preferably where there are life guards or with someone trained to give artificial respiration. Learn the new lifesaving technique, known as mouth-to-mouth rescue breathing. It is fully described and completely illustrated on Metropolitan's new first aid chart, offered below.

Never force a child into the water until he is ready to take the plunge. Around water—even shallow water—watch a young child constantly.

Boat with Safety. If possible, take a course in seamanship and master the "traffic laws" of the waterways. Keep these important points in mind:

When near swimmers, operate your boat at dead slow. And don't speed near wharves, fishing boats and sail boats.

Never overload a boat. Should it swamp or tip over, cling to it, keep calm and wait for help.

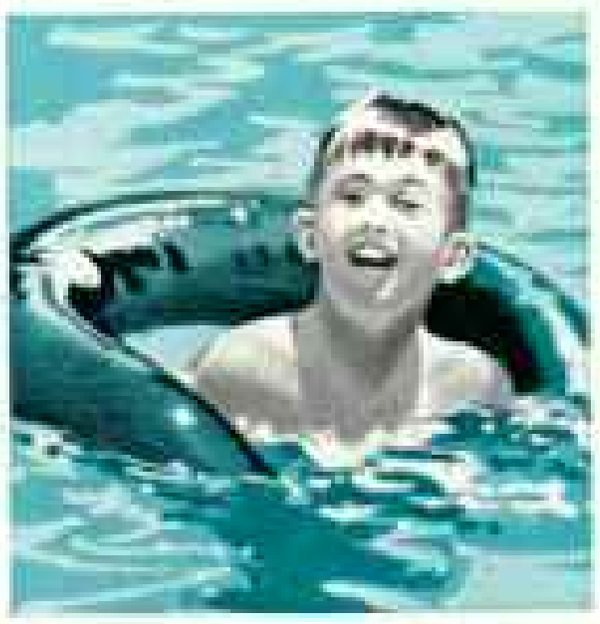
Always carry approved life-preservers for everyone aboard.

Dive with Safety. Skin diving demands the utmost skill, caution and good equipment. Don't attempt it unless your doctor finds that you have the physical and emotional stamina for it.

Plan dives. Know where you're going, how deep and how long you can stay under. Avoid outgoing tide.

Don't take chances or play practical jokes on others—especially unskilled swimmers. It's the skilled, courteous person able to cope with any emergency, who really enjoys the wonderful world of the water.

Can your child swim? Parents who wish to give their children swimming lessons should see the film, "Teaching Johnny to Swim." It covers the basic elements of water safety. This film was contributed as a public service by the Metropolitan Life Insurance Company to the American Red Cross.



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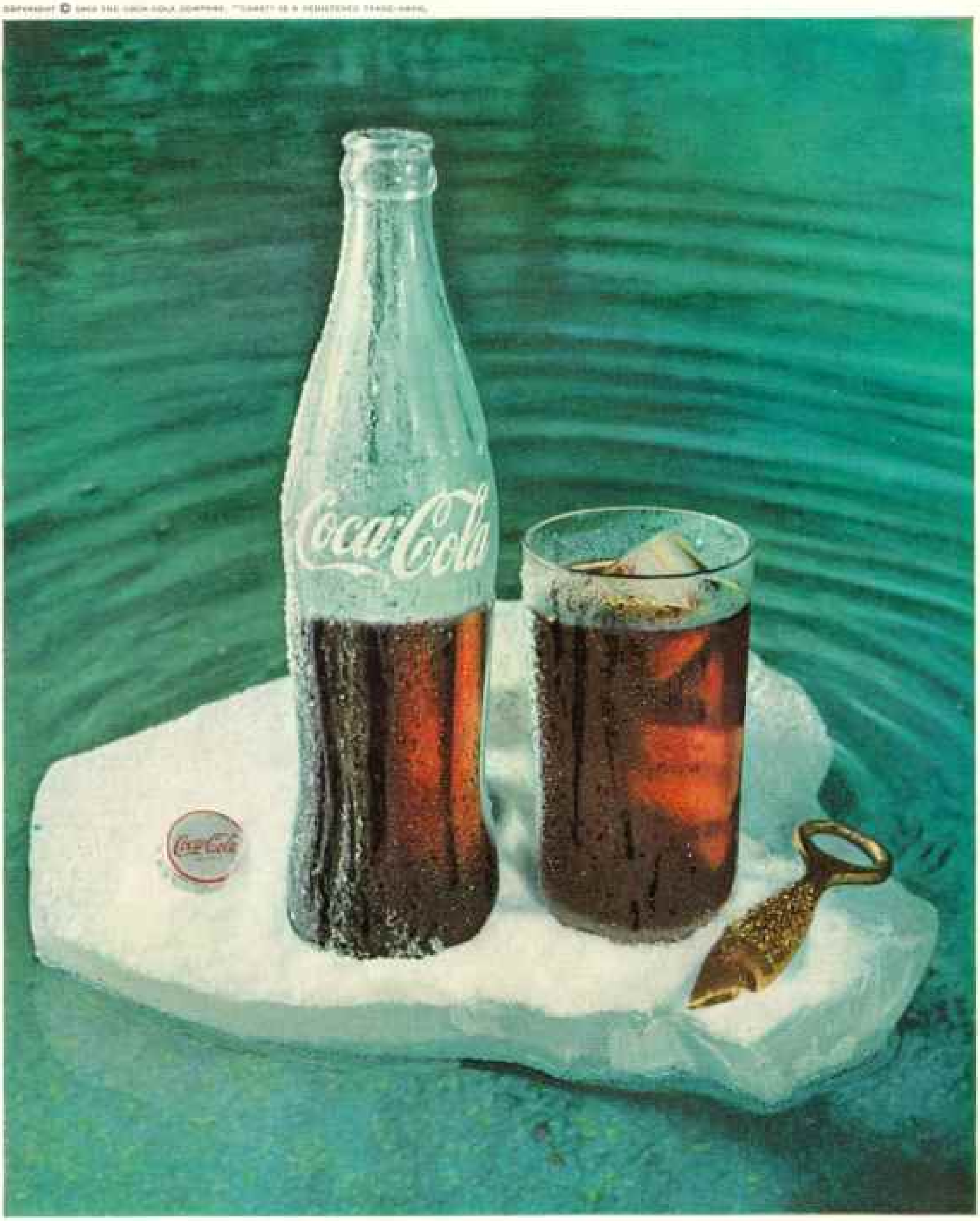

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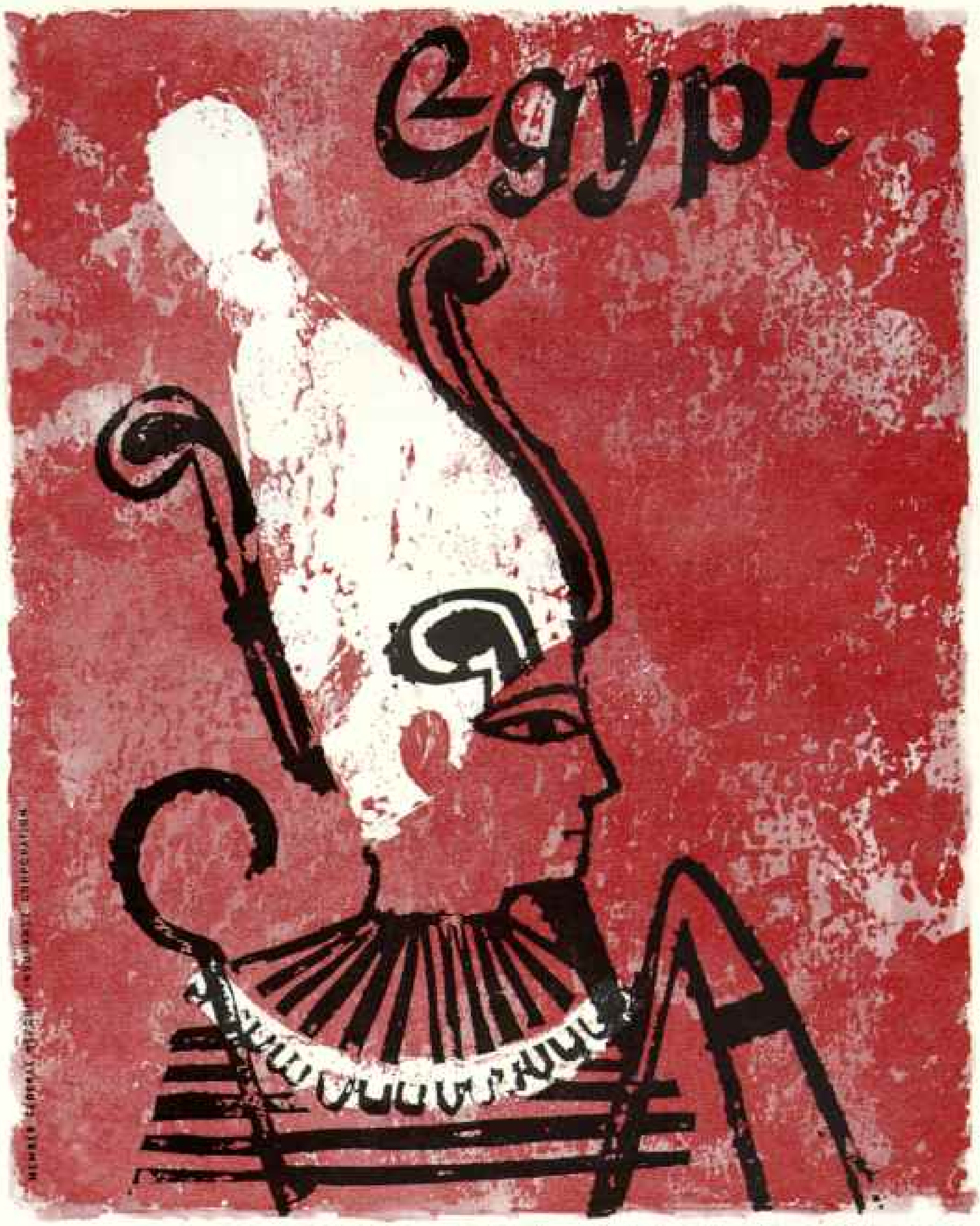

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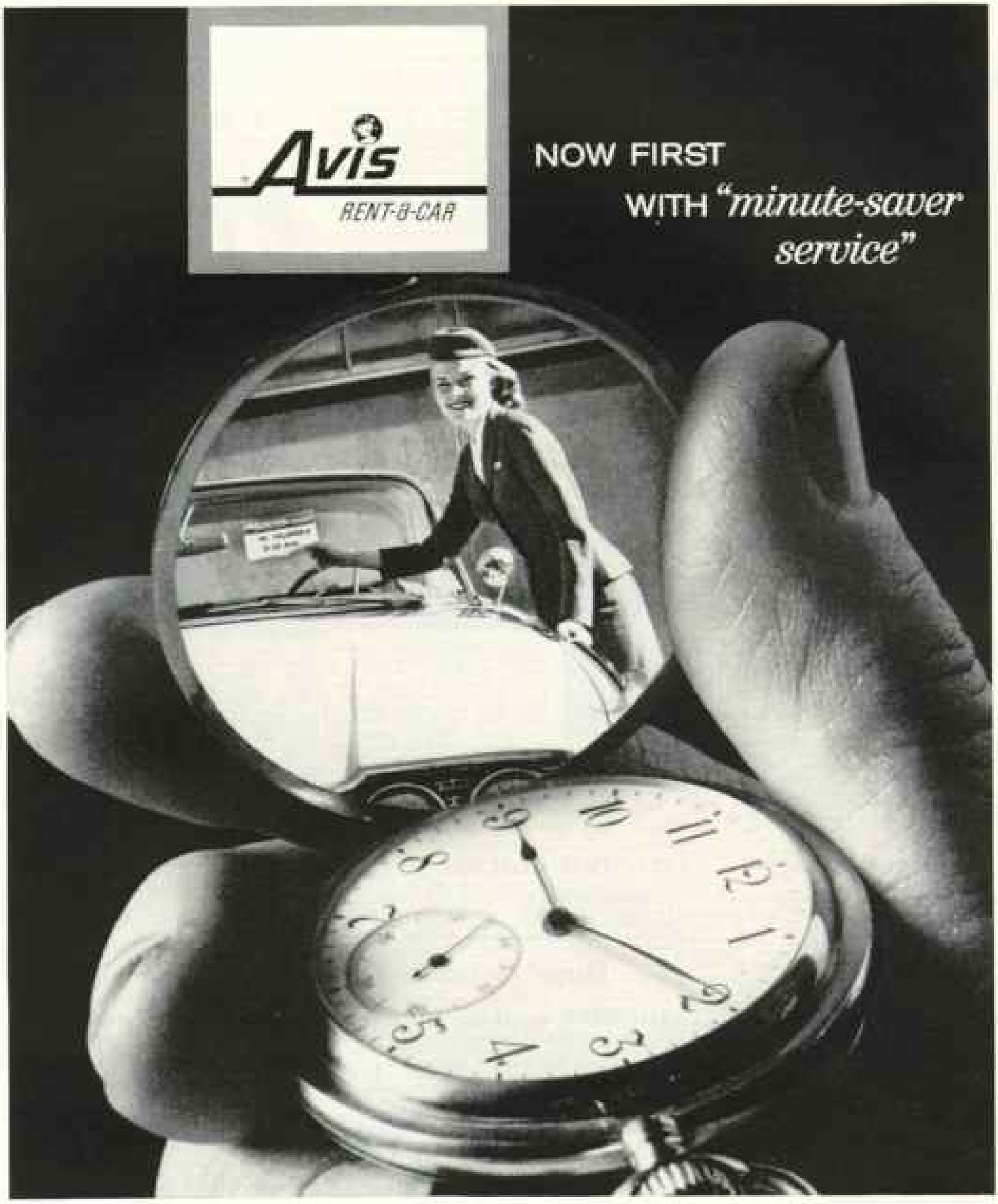

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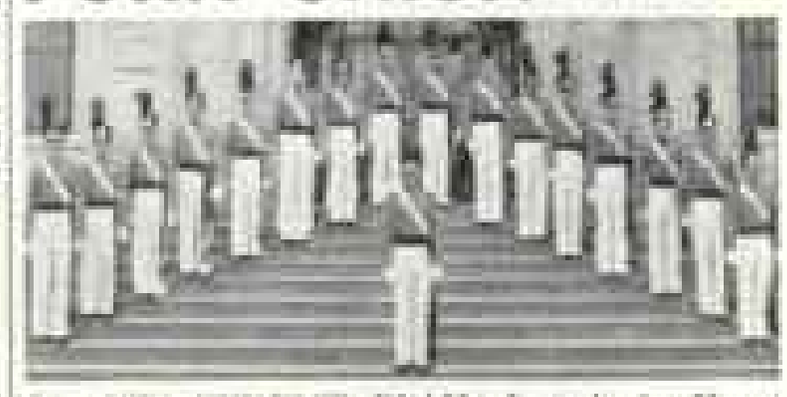

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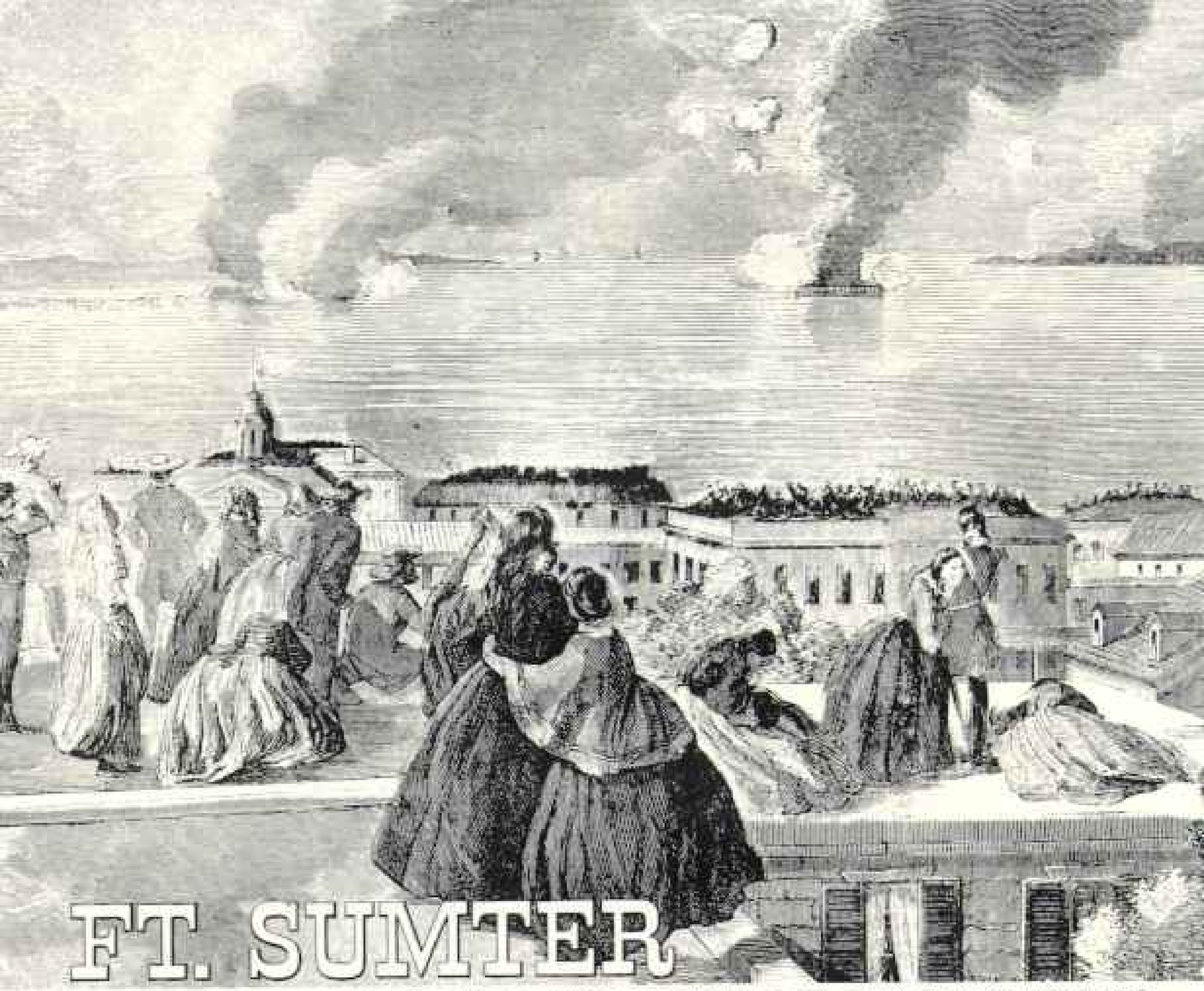

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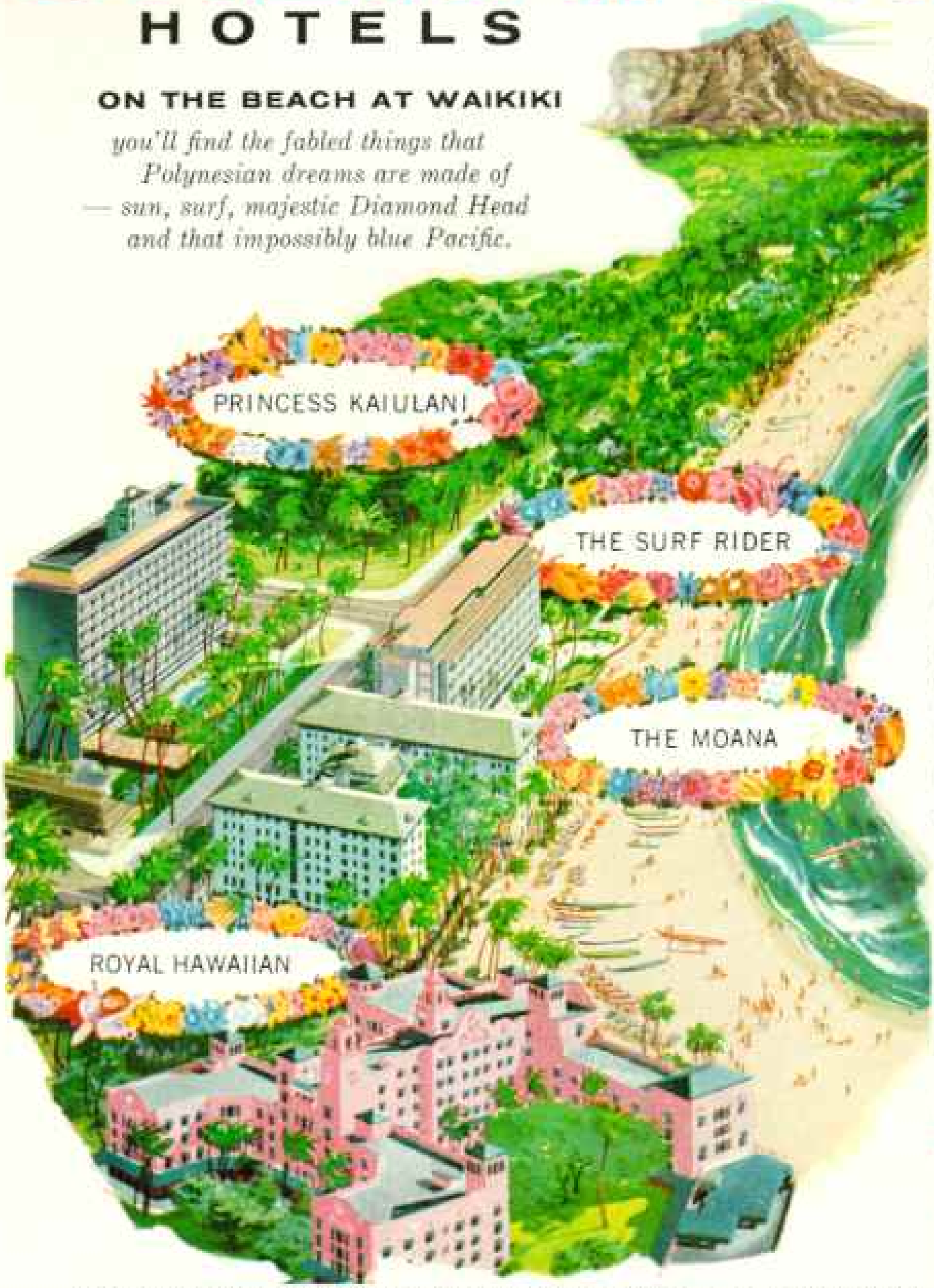

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